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**Working Paper**

## From destination- to origin-based consumption taxation: A dynamic CGE analysis

Tübinger Diskussionsbeiträge, No. 74

**Provided in Cooperation with:**

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*Suggested Citation:* Fehr, Hans (1996) : From destination- to origin-based consumption taxation: A dynamic CGE analysis, Tübinger Diskussionsbeiträge, No. 74, Eberhard Karls Universität Tübingen, Wirtschaftswissenschaftliche Fakultät, Tübingen

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**Wirtschaftswissenschaftliche Fakultät  
der Eberhard-Karls-Universität Tübingen**

From Destination- to Origin-Based  
Consumption Taxation:  
A Dynamic CGE Analysis

Hans Fehr



**Tübinger Diskussionsbeiträge**

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Diskussionsbeitrag Nr. 74  
Juli 1996

Wirtschaftswissenschaftliches Seminar  
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## Abstract

This paper discusses the macroeconomic adjustment and the intergenerational and international incidence of a switch from the current destination-based value-added taxation to a origin-based VAT within a *dynamic general equilibrium framework*. Such a reform will affect the welfare levels of individuals via changes in their net tax burdens, factor and asset price repercussions and efficiency effects due to endogenous labor supply. We isolate the quantitative importance of these effects in a numerical simulation exercise. The analysis highlights the crucial importance of the initial balance of payments conditions and tax rate levels for the short and long run results. Countries with a trade balance deficit will experience an intergenerational redistribution towards the elderly via the changes in the generational specific tax burdens. A short run international income effect will favor high tax countries with a large foreign ownership in domestic equity capital. Income effects due to factor price repercussions and substitution effects due to variable labor supply are quantitatively significant especially when the tax reform is preannounced.

## I. Introduction

After the abolition of physical border controls, the European Union (EU) now envisages a final system of the value-added tax (VAT). The current transitional arrangement in essence maintains the destination principle (DP), under which commodities are taxed where they are consumed. To overcome the administrative difficulties of levying the VAT on imports and rebating the VAT on exports the political objective is to switch to some sort of origin principle (OP) under which commodities are taxed where they are produced and consequently no border tax adjustment is necessary.

The issue is debated intensively in the academic and political community. The literature on the one hand focuses on the neutrality properties of the two principles, or tries on the other hand to reveal the allocative and distributive consequences of such a reform<sup>1</sup>. Most of these studies deal with the issue in a static context; only recently some papers started to evaluate the dynamic effects of such a policy change. Haufler et al. (1995) demonstrate in a simple two-period model with fixed labor supply that the intertemporal efficiency properties of the DP also prevail under the OP. When investment is deducted from the tax base, this favourable tax treatment is immediately capitalized in the value of the capital stock. Hence, the cost of capital is unaffected and the allocation of capital across countries will not be distorted by the OP. Although both principles are intertemporally neutral in the sense that they will not distort relative prices, a switch from DP to OP will have some real effects. Bovenberg (1994) studies the issue in a dynamic general equilibrium model with overlapping generations and foreign ownership of domestic equity. In such a setting a switch from DP to OP will generate intergenerational and international income effects and consequently affect the long run equilibrium. The model incorporates adjustment costs and derives the effects on aggregate consumption, savings, investment and the external account analytically.

This study is meant to extend the analysis of Bovenberg (1994) in different directions. Instead of using an analytical approach within a Blanchard-Yaari framework on the household side, we use the Auerbach-Kotlikoff structure and derive the solutions numerically. Furthermore we introduce variable labor supply into the model, consequently the indirect taxes will distort labor supply. Finally our policy reform is slightly different. Bovenberg (1994) compares a constant increase in the OP or DP tax rate which is balanced by constant increases in the transfers and endogenously adjusted public debt. This study starts with a DP based consumption tax in the benchmark and adjusts the OP tax rate after the reform endogenously to balance the budget. We compare the small open economy case with the case of two large countries which switch unilaterally and multilaterally from DP to OP. Since we always start from the same benchmark we can isolate the differences between the small and the large open economy as well as the difference between an immediate and a preannounced switch to the OP.

There is a growing body of literature which adopts the simulation approach for studying the saving and capital accumulation in intertemporal equilibrium models of a small or large open economy. In this sense the paper is closely related to Lipton and Sachs (1983), Frenkel et al. (1991) or Keuschnigg (1991). Compared to these studies, the present analy-

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<sup>1</sup>See Whalley (1979), Berglas (1981) or Lookwood et al. (1994) for the former issue and Sinn (1990), Haufler (1993) or Fehr et al. (1995) for the latter approach.

sis pays more attention to the interpretation of the individual welfare effects. While we do investigate the macroeconomic adjustment mechanism after the reform we also isolate and quantify the different transmission channels which affect intergenerational and international distribution. Similar to Fehr and Kotlikoff (1995) these income effects are disaggregated into changes in tax burdens and changes in factor income. By using an appropriate transfer mechanism we neutralize the redistributive content of the policy reform and isolate the pure efficiency effects.

The analysis highlights the crucial importance of the initial balance of payments conditions and tax rate levels for the short and long run results. We isolate three channels which are responsible for the income redistribution across generations and countries: *intergenerational* income effects mainly result from the change in the generationally specific tax burdens. The older generations in countries with a trade balance deficit will gain since their individual tax base decreases. Future generations on the contrary will lose since the tax rate has to increase in such countries. A second channel works through the changes in the marginal factor productivities during the transition to the new long run equilibrium. If the tax reform is implemented without a time lag, these income effects are only of minor importance. If the tax reform is announced two years in advance of implementation, behavioral reactions during the pre-implementation phase could dramatically alter the gross returns on capital. In this case the short run income effects will be quite significant. The last channel works through the impact revaluation of the asset prices when the reform is introduced. This *international* redistribution effect could reinforce or mitigate the income effects for the elderly in the short run. High tax countries with a large foreign ownership in domestic equity capital are able to expropriate some part of foreign residents wealth through this mechanism. Compared to the income effects, the efficiency gains or losses due to variable labor supply are moderate as long as the policy reform is implemented without time lag. If individuals and firms are not surprised by the tax reform their reactions during the pre-implementation phase could lead to enormous efficiency losses in the deficit countries and to gains in the surplus countries.

The paper proceeds as follows. The next section presents the model. In the third section we disaggregate the intergenerational welfare effects analytically in a simple two period model and explain how the efficiency effects are derived. The fourth section describes the structure and parametrization of the simulation model whereas section five presents the numerical calculations. Some directions for future research are discussed in the last section.

## II. The Model

The world economy is assumed to consist of two countries, the home country and the foreign country which both produce the same good. Since both countries are modelled symmetrically, it suffices here to describe the behavior of agents and the determination of the balance of payments in one country.

### 1. Production and investment

The production technology is assumed to be of the linear homogeneous neoclassical type. In period  $t$  output (per capita of the young, net of depreciation) of the single tradeable commodity is produced with capital  $K_t$  and labor  $L_t$ . In addition to the production technology, the production sector faces a second technological constraint describing the

accumulation of capital - the installation function. Following Summers (1981) we model adjustment costs as output losses associated with investment. The total adjustment costs in period  $t$  depend on the level of investment  $I_t$  and the stock of capital. As usual the installation function is assumed to be linear homogeneous in investment and capital and convex in investment. Output net of adjustment costs  $Y_t$  is therefore determined by

$$Y_t = F(K_t, L_t) - \Phi(I_t, K_t) \quad F_{K_t} > 0, F_{L_t} > 0, \Phi_{I_t} > 0, \Phi_{K_t} < 0. \quad (1)$$

In order to induce investors to hold equities, firm shares must pay the same after-tax return as alternative assets. The arbitrage condition is thus given by

$$r_t V_t = \{(1 - \tau_t^p)[Y_t - I_t] - w_t L_t\} + V_{t+1} - V_t, \quad (2)$$

where  $V_t$  stands for the market value of shares at time  $t$ ,  $r_t$  is the world interest rate,  $\tau_t^p$  denotes the origin-based consumption tax rate and  $w_t$  is the wage rate. The term between the curled brackets on the right side represents after-tax dividends, as the firm is assumed to be equity financed. Solving the difference equation (2) and ruling out explosive time paths of share prices yields the valuation of the firm by its owner

$$V_t = \sum_{s=t}^{\infty} \{(1 - \tau_s^p)[Y_s - I_s] - w_s L_s\} \prod_{j=t}^s (1 + r_j)^{-1}. \quad (3)$$

Firms maximize this market value subject to the accumulation equation of the capital stock

$$K_{t+1} - K_t = I_t. \quad (4)$$

This yields the following necessary conditions for an optimum:

$$w_t = (1 - \tau_t^p) F_{L_t} \quad (5)$$

$$q_{t+1} = (1 - \tau_t^p) [1 + \Phi_{I_t}] \quad (6)$$

$$q_{t+1} - q_t = r_t q_t - (1 - \tau_t^p) [F_{K_t} - \Phi_{K_t}]. \quad (7)$$

The equality of the real wage and the after-tax marginal product of labor characterizes optimal labor demand. According to (6) firms will invest until the marginal benefits  $q_{t+1}$  from an additional unit of capital in the next period equal the marginal cost of acquisition and installation. Tax savings due to the deduction of investment reduce the total marginal costs. Given the convexity of the adjustment cost function the first-order condition (6) can be inverted to derive an explicit investment function. Equation (7) gives the optimal path for the shadow price of capital.

Following Hayashi (1982) one can show that - given our homogeneity assumptions - marginal  $q_t$  is equal to the asset price of a share in the firm, i.e.

$$V_t = q_t K_t. \quad (8)$$

## 2. Consumption and asset accumulation

Consumption and saving behavior of private households is derived from the life-cycle motive. We consider fiscal incidence in a simple two-period life-cycle model. Each generation has the same size population which we normalize to one, and each agent has one unit of time each period to spend either working or as leisure time. The utility function of a generation born at time  $t$  depends on their consumption and leisure when they are young and old, i.e.

$$U_t = U(c_{yt}, c_{ot+1}, \ell_{yt}, \ell_{ot+1}), \quad (9)$$

where  $c$  indexes consumption,  $\ell$  indexes leisure,  $y$  indexes young, and  $o$  indexes old. The utility maximizing choice of consumption and leisure in period  $t$  determines by definition optimal life cycle savings  $A_{t+1}$  which finances, together with labor income in the second period, old age consumption

$$A_{t+1} = (1 - \ell_{yt})F_{L_t} - c_{yt} - T_{yt}; \quad (10)$$

$$c_{ot+1} = (1 + r_{t+1})A_{t+1} + (1 - \ell_{ot+1})F_{L_{t+1}} - T_{ot+1}. \quad (11)$$

In the above equations  $T_{yt}$  and  $T_{ot+1}$  define the direct tax burden of the generation  $t$  for young and old respectively. We have already substituted equation (5). Therefore this tax burden includes the payments of the destination principle consumption tax and the labor income component of the origin principle consumption tax.

Aggregating across generations one arrives at the aggregate per-capita variables and the accumulation equation for financial assets for the economy as a whole

$$C_t = c_{yt} + c_{ot}; \quad (12)$$

$$L_t = (1 - \ell_{yt}) + (1 - \ell_{ot}); \quad (13)$$

$$A_{t+1} - A_t = r_t A_t + F_{L_t} L_t - C_t - T_{yt} - T_{ot}. \quad (14)$$

## 3. Government behavior

The government collects taxes from individuals and companies in order to finance the public good  $G_t$ . For simplicity we assume that the government only levies either a destination-based or a origin-based consumption tax. The latter can be interpreted as a combination of a wage tax and a cash-flow tax. The budget constraint faced by the government is therefore

$$\begin{aligned} G_t &= \tau_t^c C_t + \tau_t^p [Y_t - I_t] = \tau_t^c C_t + \tau_t^p F_{L_t} L_t + \tau_t^p [Y_t - F_{L_t} L_t - I_t] \\ &= T_{yt} + T_{ot} + T_t^k \end{aligned} \quad (15)$$

where  $T_t^k$  denotes the cash-flow component of the origin-based consumption tax. Using Euler's theorem and the capital accumulation equation (4) we derive

$$T_t^k = \tau_t^p \left[ \underbrace{1 + \Phi_{I_t} + F_{K_t} - \Phi_{K_t}}_{\Theta_{K_t}} \right] K_t - \tau_t^p \left[ \underbrace{1 + \Phi_{I_t}}_{\Theta_{I_t}} \right] K_{t+1} = \underbrace{\tau_t^p \Theta_{K_t} K_t}_{T_{ot}^k} - \underbrace{\tau_t^p \Theta_{I_t} K_{t+1}}_{T_{yt}^k}.$$



Although all taxes are levied at the firm level, they are finally paid by the young and old generations. In order to determine the generation specific tax burdens in the next section it is convenient to disaggregate the cash-flow component of the origin-based consumption tax into a tax on the return from the old capital stock  $T_{ot}^k$  and a subsidy on the next period's capital stock  $T_{yt}^k$ . In the above equation the gross return on capital  $\Theta_{K_t}$  defines the marginal tax base for old capital and the gross price of capital  $\Theta_{I_t}$  defines the marginal subsidy base for new capital. Due to adjustment costs the gross price of capital differs from unity and the marginal product of capital now also includes the future savings of installation costs  $\Phi_{K_t}$ .

#### 4. External sector

The difference between domestic production and domestic absorption is exported to or imported from abroad. The trade balance  $TB_t$  is accordingly defined by

$$TB_t = Y_t - C_t - G_t - I_t. \quad (16)$$

For the overall budget constraint of the economy we combine the public government constraint (15), the aggregate budget constraint of private households (14) and the arbitrage condition (2) to arrive at

$$F_{t+1} - F_t = r_t F_t + TB_t, \quad (17)$$

where  $F_t (= A_t - V_t)$  are the net foreign assets per capita. Expression (17) states that net foreign investments of the home country have to be equal to the sum of net capital income received from abroad and the trade balance. For our simulations it is important that the trade account is not balanced in the initial steady state. Consequently the net foreign asset position is not zero. It is assumed that the residents in both countries can acquire domestic and foreign equity capital. We therefore define

$$A_t = s_t V_t + s_t^* V_t^* = q_t K_t + \underbrace{s_t^* q_t^* K_t^* - (1 - s_t) q_t K_t}_{F_t} \quad (18)$$

where  $s_t$  and  $s_t^*$  denote the home countries investment share in domestic and foreign equity capital respectively. All other variables marked with an asterisk denote foreign prices and quantities.

### III. Disaggregating the Welfare Effects of a Tax Reform

In an open economy where adjustment costs only allow for an imperfect international mobility of capital, the corporate tax burden can only be partially shifted to wage earners. Furthermore the macroeconomic adjustment and the generational incidence of a tax reform could be quite different depending on the size of the economy. While a small open economy has no influence on the international interest rate, a policy change in a large open economy will influence the international interest rate. The latter serves as an additional channel for international redistribution. This section reveals the different economic adjustment mechanisms which redistribute across generations and countries after the tax reform is implemented. The first section discusses the small open economy while the second section explains the welfare effects in a large economy.

### 1. The small open economy

In a small open economy the interest rate is fixed to the foreign level  $r^*$ . Suppose a change in policy occurs at time  $t$ . To understand its welfare effects, we need to examine the changes in utility of the old at time  $t$ , the young at time  $t$ , and all subsequent generations. We start by considering the old at time  $t$ , whose consumption is constrained by

$$c_{ot} = (1 + r^*)A_t + (1 - \ell_{ot})F_{L_t} - T_{ot}. \quad (19)$$

The utility change of the elderly at time  $t$  who were born in  $t-1$  is

$$dU_{t-1} = \frac{\partial U}{\partial c_{ot}} dc_{ot} + \frac{\partial U}{\partial \ell_{ot}} d\ell_{ot}.$$

Using the first-order condition of the elderly at time  $t$  and substituting the differential of (19) we get the normalized utility change

$$\frac{dU_{t-1}}{\lambda_{t-1}} = (1 + \tau_t^c)dc_{ot} + (1 - \tau_t^p)F_{L_t}d\ell_{ot} \quad (20)$$

$$= (1 + r^*)s_t K_t dq_t + (1 - \ell_{ot})dF_{L_t} - dT_{ot} + \tau_t^c dc_{ot} - \tau_t^p F_{L_t} d\ell_{ot} \quad (21)$$

where  $\lambda_{t-1}$  is the marginal utility of income of the elderly at time  $t$  (who were born at  $t-1$ ). Note that at time  $t$ ,  $K_t$  is given, so  $dK_t$  is zero. Next we substitute from the differentials of equations (6) and (7)

$$L_t dF_{L_t} = -K_t dF_{K_t} = -K_t \left[ (1 + r^*)dq_t + d\Phi_{K_t} - d\Phi_{L_t} + d(\tau_t^c \Theta_{K_t}) \right]$$

and arrive after some rearranging at

$$\begin{aligned} \frac{dU_{t-1}}{\lambda_{t-1}} = & - \left[ dT_{ot} + \alpha_{ot} dT_{ot}^k \right] + \left[ \alpha_{ot} K_t (d\Phi_{L_t} - d\Phi_{K_t}) + (s_t - \alpha_{ot})(1 + r^*)K_t dq_t \right] \\ & + \left[ \tau_t^c dc_{ot} - \tau_t^p F_{K_t} d\ell_{ot} \right]. \end{aligned} \quad (22)$$

In (22), the utility change of the elderly is decomposed into changes in their tax burdens, changes in their factor incomes and behavioral changes to avoid tax payments. In the above equation  $\alpha_{ot} = (1 - \ell_{ot})/L_t$  defines the old generations share in aggregate labor supply. In the first bracket we see that the change in the tax burden on old capital  $dT_{ot}^k$  affects the elderly in proportion to their labor supply. The capital stock is fixed in the first period and will only change gradually during the transition (depending on the degree of convexity of the installation function). In the initial period the price of the capital stock  $q_t$  will therefore adjust immediately according to the arbitrage condition (7). The income effect of this revaluation of the initial capital stock appears in the second bracket together with the change in the “indirect” marginal product of capital. The old generation will benefit from an initial increase in the price of capital proportionally to their ownership share in the aggregate capital stock (which is  $s_t$ ). At the same time such an asset price

reevaluation as well as an increase in the “indirect” marginal product of capital will lower the wage rate. Consequently the old generation will lose proportionally to their share in aggregate labor supply.

The utility change of those born at time  $t$  can be similarly decomposed. Differentiating (9) and substituting the first order conditions and the differential of the relevant budget constraint leads to

$$\begin{aligned} \frac{dU_t}{\lambda_t} = & - \left[ dT_{yt} + \alpha_{yt} dT_{ot}^k + \frac{d\tilde{T}_{ot+1}}{1+r^*} \right] + \left[ \alpha_{yt} K_t (d\Phi_{I_t} - d\Phi_{K_t}) + \frac{\alpha_{ot+1} K_{t+1} d\tilde{\Phi}_{t+1}}{1+r^*} \right. \\ & \left. - \alpha_{yt} (1+r^*) K_t dq_t \right] + \left[ \tau_t^c c_{yt} - \tau_t^p F_{L_t} d\ell_{yt} + \frac{d\Lambda_{ot+1}}{1+r^*} \right] \end{aligned} \quad (23)$$

where

$$\begin{aligned} d\tilde{T}_{ot+1} &= dT_{ot+1} + \alpha_{ot+1} \left[ dT_{ot+1}^k - (1+r^*) dT_{yt}^k \right] \\ d\tilde{\Phi}_{t+1} &= d\Phi_{I_{t+1}} - d\Phi_{K_{t+1}} - (1+r^*) d\Phi_{I_t} \\ d\Lambda_{ot+1} &= \tau_{t+1}^c c_{ot+1} - \tau_{t+1}^p F_{L_{t+1}} d\ell_{ot+1} + \alpha_{ot+1} \left[ \tau_{t+1}^p \Theta_{K_{t+1}} - \tau_t^p (1+r^*) \Theta_{I_t} \right] dK_{t+1}. \end{aligned}$$

The change in the tax burden for old capital is shared by the young and old generation in proportion to their respective labor supply. The change in the tax burden of new capital  $dT_{yt}^k$  affects the generation born in period  $t$  now in proportion to their labor supply in the next period. In the second bracket again the change in the “indirect” marginal product of capital and the change in the marginal costs of capital appear together with the initial asset price revaluation. The young generation in  $t$  owns no capital at the time of the policy change. Consequently all price reactions will affect the income of this generation via their impact on the wage rate in both living periods.

Finally we have to decompose the welfare effects for the generations born in year  $s > t$ , i.e.

$$\frac{dU_s}{\lambda_s} = - \left[ d\tilde{T}_{ys} + \frac{d\tilde{T}_{os+1}}{1+r^*} \right] + \left[ \alpha_{ys} K_s d\tilde{\Phi}_s + \frac{\alpha_{os+1} K_{s+1} d\tilde{\Phi}_{s+1}}{1+r^*} \right] + \left[ d\Lambda_{ys} + \frac{d\Lambda_{os+1}}{1+r^*} \right] \quad (24)$$

with  $d\tilde{T}_{ys} = dT_{ys} + \alpha_{ys} \left[ dT_{os}^k - (1+r^*) dT_{ys-1}^k \right]$ .

The impact revaluation disappears for generations born after the implementation of the reform. Note that the change in the subsidy from the previous period now affects the young in proportion to their respective labor supply.

In order to separate efficiency from the purely redistributive effects, we set up a lump-sum redistribution agency with the sole purpose of taking from one generation and giving to the other generation. Auerbach and Kotlikoff (1987) have introduced such an authority which used lump-sum taxes and transfers to keep the utility of cohorts born before a specified date at the initial level and to raise (or lower) the utility of cohorts born after this date by a uniform amount. The generations born before the reform are therefore not

affected and the generations born after the reform share equally the efficiency gains or losses. While it is possible in this way to measure the aggregate efficiency changes, one can not isolate the generation specific changes in excess burdens. Implicitly all efficiency gains (or losses) of the old generation are transferred to the newborn and future generations (see Gravelle, 1991). We therefore use a different concept of intergenerational neutrality, which is spelled out in Keuschnigg (1994). The lump-sum payments by the redistribution agency are designed to compensate all intergenerational income effects, so that after compensation the generations' utility change only reflects substitution effects. The transfers to the old and young generations at time  $s$  are therefore defined by

$$\begin{aligned}
Tr_{ot} &= dT_{ot} + \alpha_{ot} [ dT_{ot}^k - K_t(d\Phi_{I_t} - d\Phi_{K_t}) ] - (s_t - \alpha_{ot})(1 + r^*)K_t dq_t; \\
Tr_{yt} &= dT_{yt} + \alpha_{yt} [ dT_{ot}^k - K_t(d\Phi_{I_t} - d\Phi_{K_t}) ] + \alpha_{yt}(1 + r^*)K_t dq_t; \\
Tr_t^* &= -(1 - s_t)(1 + r^*)K_t dq_t; \\
Tr_{os} &= d\tilde{T}_{os} - \alpha_{os}K_s d\tilde{\Phi}_s; \\
Tr_{ys} &= d\tilde{T}_{ys} - \alpha_{ys}K_s d\tilde{\Phi}_s
\end{aligned}$$

for  $s > t$ .

In the above expression  $Tr_t^*$  is the international distribution effect which is only relevant, when foreigners own part of the initial domestic capital stock (see Bovenberg, 1994). The transfers for generations living in the initial year of the reform include payments to offset the capital price revaluation. Changes in "gross" corporate tax revenues as well the "indirect" marginal product of capital are redistributed in proportion to labor supply shares of currently living generations, while the changes in the corporate tax subsidy and the marginal costs of next period's capital are redistributed in proportion to next period's labor supply shares. Note that by holding the time path of government spending fixed, changes across all generations in their tax payments balance to zero. Furthermore the changes in generations' factor incomes also cancel across generations, i.e.

$$I_s d\Phi_{I_s} + K_s d\Phi_{K_s} = 0.$$

Adding up the tranfers in every period we get

$$\begin{aligned}
Tr_{ot} + Tr_{yt} + Tr_t^* &= dT_{yt}^k - K_{t+1}d\Phi_{I_t} \\
Tr_{os} + Tr_{ys} &= dT_{ys}^k - K_{s+1}d\Phi_{I_s} - (1 + r^*) [ dT_{ys-1}^k - K_s d\Phi_{I_{s-1}} ] .
\end{aligned}$$

The last term of period  $s$  discounted to period  $s - 1$  cancels out with the first term of period  $s - 1$ , therefore the present value of all transfers is zero.

The upshot of these observations is that one can, along the transition path, compensate every generation for changes in tax payments and factor returns. The compensated utility change then arises solely from the distortion of its economic choices. The compensated generationally specific utility changes are given in the last brackets of the above equations

(22), (23) and (24). Adding up the compensated utility changes of period  $s$  across the generations we get the total efficiency change in the economy in that period

$$\Delta EB_s = \Lambda_{ys} + \Lambda_{os} = \tau_s^c dC_s + \tau_s^p [dY_s - dI_s] .$$

## 2. The large open economy

Now we turn to the case of a large open economy which is able to influence the world interest rate. For the initial period we assume that the world interest rate will not change and only the domestic and foreign asset prices will immediately adjust after the policy change<sup>2</sup>. Again we start by considering the old at time  $t$ , whose consumption is now constrained by

$$\begin{aligned} c_{ot} &= (1 + r_t)q_t K_t + (1 + r_t)F_t + (1 - \ell_{ot})F_{L_t} - T_{ot} \\ &= (1 - \tau_t^p)\Theta_{K_t} K_t + (1 + r_t)F_t + (1 - \ell_{ot})F_{L_t} - T_{ot}. \end{aligned} \quad (25)$$

Substituting the differential of (25) into the normalized utility change (20) we get

$$\begin{aligned} \frac{dU_{t-1}}{\lambda_{t-1}} &= - \left[ dT_{ot} + dT_{ot}^k \right] + \left[ (1 - \ell_{ot})dF_{L_t} + K_t d\Theta_{K_t} \right] + \left[ (1 + r_t)dF_t \right] \\ &\quad + \left[ \tau_t^c dc_{yt} - \tau_t^p F_{L_t} d\ell_{ot} \right]. \end{aligned} \quad (26)$$

Again the utility change of the elderly is decomposed into changes in their remaining tax payments, changes in their factor incomes and behavioral changes to avoid tax payments. Comparing (26) with (22) we notice some important differences. The change in the tax burden of the old capital is now born totally by the elderly. In the second bracket the changes in the marginal product of labor and the gross return on capital are directly allocated to the owners of the factors. The third bracket contains the international redistribution effects. Asset prices will now immediately jump in both countries and home country residents will gain if this adjustment increases the domestic net foreign asset position.

The utility change of those born at time  $s \geq t$  can be similarly decomposed:

$$\begin{aligned} \frac{dU_s}{\lambda_s} &= - \left[ dT_{ys} - dT_{yt}^k + \frac{dT_{os+1} + dT_{os+1}^k}{1 + r_{s+1}} \right] + \left[ (1 - \ell_{ys})dF_{L_s} - K_{s+1}d\Theta_{I_s} + \right. \\ &\quad \left. \frac{(1 - \ell_{os+1})dF_{L_{s+1}} + K_{s+1}d\Theta_{K_{s+1}}}{1 + r_{s+1}} \right] + \left[ \tau_s^c dc_{ys} - \tau_s^p (F_{L_s} d\ell_{ys} + \Theta_{I_s} dK_{s+1}) \right] \\ &\quad + \left[ \frac{\tau_{s+1}^c dc_{os+1} - \tau_{s+1}^p (F_{L_{s+1}} d\ell_{os+1} - \Theta_{K_{s+1}} dK_{s+1})}{1 + r_{s+1}} \right]. \end{aligned} \quad (27)$$

<sup>2</sup>Since the initial price adjustment is a lump-sum redistribution across cohorts and countries it is arbitrary whether the revenue from the assets changes or whether the value of the asset stocks is adjusted. The arbitrage condition (7) ensures that any other adjustment mechanism of the financial variables  $r_t$ ,  $q_t$  and  $q_t^*$  will have the same real effects.

In (27), the normalized utility change of generation  $s \geq t$  consists of the change in its tax burden, the change in factor income and the marginal change in tax revenue associated with changes in economic behavior.

The required intergenerationally neutral transfer payments are now

$$\begin{aligned} Tr_{ot} &= dT_{ot} + dT_{ot}^k - K_t d\Theta_{K_t} - (1 - \ell_{ot}) dF_{L_t} - (1 + r_t) dF_t; \\ Tr_t^* &= (1 + r_t) dF_t; \\ Tr_{os} &= dT_{os} + dT_{os}^k - K_s d\Theta_{K_s} - (1 - \ell_{os}) dF_{L_s}; \quad s > t \\ Tr_{ys} &= dT_{ys} - dT_{ys}^k + K_{s+1} d\Theta_{L_s} - (1 - \ell_{ys}) dF_{L_s}, \quad s \geq t. \end{aligned}$$

Obviously they add up to zero in every period.

To summarize this section, the changes in the utilities of all generations alive after a policy reform depend on intergenerational (and international) income effects and generationally specific efficiency effects. The question is now to quantify the intergenerational incidence of our policy reform and the associated changes in excess burdens. This is the issue which we study through numerical simulations.

#### IV. The Simulation Model and its Parameters

The basic model used in this study extends the Auerbach and Kotlikoff (1987) life cycle simulation model by incorporating a second country with an identical structure. Each country contains three sectors: households, firms, and government.

The household sector in every country consists of fifty-five overlapping generations, with the total population growing at a constant rate  $n$ . Each adult agent lives for 55 years corresponding to ages 21 to 75, and is concerned only with his own welfare, i.e., there is no bequest motive. Since all agents within a national cohort are identical, economic opportunities differ only across cohorts. The model incorporates variable labor supply, including endogenous retirement. Preferences over current and future consumption and leisure are governed by the CES utility function

$$U_{it} = \frac{1}{1 - 1/\gamma} \sum_{a=i}^{55} (1 + \delta)^{i-a} [c_{as}^{1-1/\rho} + \alpha \ell_{as}^{1-1/\rho}]^{\frac{1-1/\gamma}{1-1/\rho}} \quad (28)$$

where the index  $i$  now denotes the age of the generation in period  $t$  and  $s = t + a - i$  is the time index for future periods,  $\delta$  is the "pure" rate of time preference,  $\rho$  is the intratemporal elasticity of substitution between consumption and leisure at each age  $a$ ,  $\gamma$  is the intertemporal elasticity of substitution between consumption of different years, and  $\beta$  is the leisure preference parameter. Agents are assumed to have perfect foresight and maximize lifetime utility (28) subject to the following budget constraint

$$\sum_{a=i}^{55} [p_s c_{as} + w_s e_a \ell_{as}] R_s = W_{it} = (1 + r_t) A_{it} + \sum_{a=i}^{55} w_s e_a R_s \quad (29)$$

where  $p_s = 1 + \tau_s^c$  denotes the consumer price of consumption and  $R_s$  is defined by

$$R_s = \begin{cases} 1 & s = t, \\ \prod_{j=t+1}^s (1 + r_j)^{-1} & s > t. \end{cases}$$

The  $e_a$  terms reflect the accumulation of human capital. They describe how many units of "standard" labor the household supplies per unit of leisure foregone in any given year. Thus,  $w_a e_a$  may be interpreted as the individual's gross wage rate. The age-wage profile  $e_a$  is set exogenously and is separate from the general level of wages, the time path of which is determined in solving the model.

Maximizing (28) subject to (29) yields the following expressions for the evolution of consumption and leisure during the life-cycle:

$$c_{as} = \left( \frac{1+r_s}{1+\delta} \right)^\gamma \left( \frac{p_{s-1}}{p_s} \right)^\gamma \left( \frac{v_{as}}{v_{a-1s-1}} \right)^{\rho-\gamma} c_{a-1s-1}$$

$$\ell_{as} = \alpha^\rho \left( \frac{w_s e_a}{p_s} \right)^{-\rho} c_{as} \quad \text{where} \quad v_{as} = \left[ 1 + \alpha^\rho \left( \frac{w_s e_a}{p_s} \right)^{1-\rho} \right]^{\frac{1}{1-\rho}}.$$

Using these expressions we derive the following individual consumption demand function

$$c_{it} = \Gamma_{it} W_{it} / p_t \tag{30}$$

where the marginal propensity to consume out of real wealth is defined by

$$\Gamma_{it} = \left[ v_{it}^{\gamma-\rho} \sum_{a=i}^{55} v_{as}^{1-\gamma} \left( \frac{p_s}{p_t} \right)^{1-\gamma} (1+\delta)^{\gamma(i-a)} R_s^{1-\gamma} \right]^{-1}.$$

We assume identical preference parameters in both countries, but country-specific human capital profiles. The age-consumption and age-earnings profiles will therefore differ across countries (see below).

The model's production sector is characterized by perfectly competitive firms. The production function is CES, i.e.

$$F(K_t, L_t) = A \left[ \epsilon K_t^{1-1/\sigma} + (1-\epsilon) L_t^{1-1/\sigma} \right]^{\frac{1}{1-1/\sigma}},$$

where  $\epsilon$  is the parameter measuring the intensity of the use of capital in production,  $\sigma$  is the elasticity of substitution in production and  $A$  is a technology parameter which is chosen to lead to a wage rate per one-year-old adult of exactly 1.0 in our base case steady state. Since we ignore depreciation, gross investment  $I_s$  is always equal to net investment. We assume that the firms' organization is geared to the growth rate of the population  $n$ . Total cost of new investment in years  $s$  are therefore

$$\Phi(I_s, K_s) = .5 b \left[ \frac{I_s}{K_s} - n \right]^2 K_s. \tag{31}$$

The term  $b$  is the adjustment cost coefficient. Larger values of  $b$  imply greater marginal cost of new capital goods for a given rate of investment. As long as the investment rate ( $I_s/K_s$ ) is at its steady state level  $n$  there are no adjustment costs<sup>3</sup>. Higher or lower investment rates involve costly changes in the production process. Because these costs

<sup>3</sup>For a similar approach see Summers (1981) or Nielsen and Sørensen (1991).

rise disproportionately with the difference between investment rate and natural growth rate, the firm will only gradually move the stock of capital toward its desired level. If the economy during the transition is for example only growing at 1 percent, then about 1.2 percent of costs of investment has to be spent on adjustment. The investment equation implied by (6) and (31) can be written as

$$\frac{I_s}{K_s} = n + \frac{1}{b} \left[ \frac{q_{s+1}}{1 - \tau_s^p} - 1 \right]. \quad (32)$$

Equation (32) states that the investment ratio is a positive function of the market value of one unit of next period's capital. If the future market value is higher (lower) than the acquisition price of capital then the investment rate will be above (below) the natural (steady state) rate  $n$ . Higher adjustment costs (via a lower  $n$  or a higher  $b$ ) imply a lower rate of investment.

The government has to raise taxes in order to pay for its own spending on collective consumption. We ignore the indirect effects that this spending has on consumer behavior and assume that government consumption grows at the same rate as the population. The only revenue source is a consumption tax which is either levied due to the destination principle or due to the origin principle. Table 1 displays the parametrization of our model and the base case steady state.

**Table 1: Simulation Parameters and initial Steady State values<sup>a</sup>**

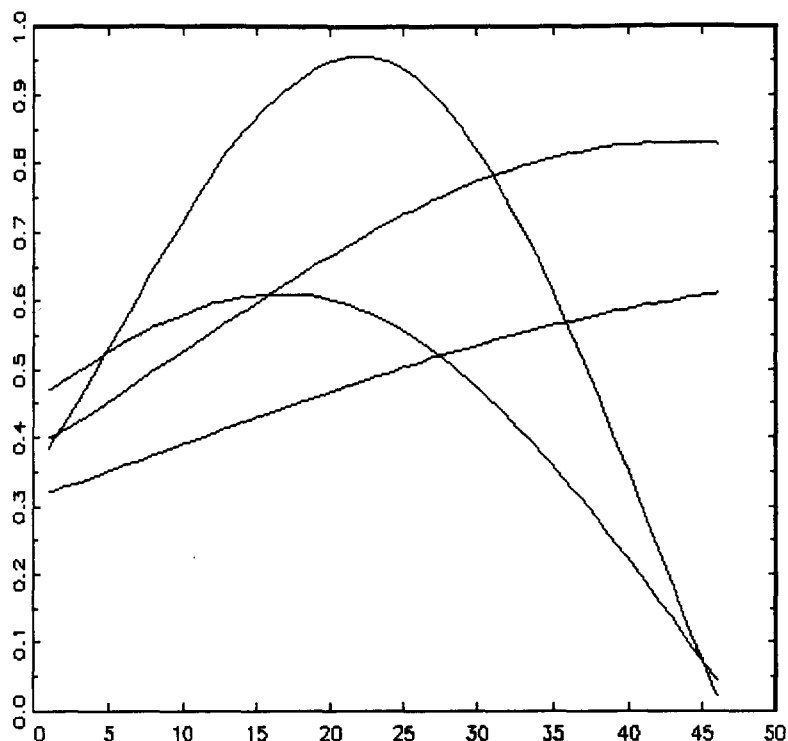
<i>Preference Parameters</i>		<i>Production Parameters</i>	
$\gamma = 0.25$	$\rho = 0.8$	$\epsilon = 0.3$	$\sigma = 1.0$
$\delta = 0.015$	$\beta = 1.5$	$n = 0.02$	$b = 10.0$
<i>Human Capital Profile</i>		<i>Domestic Asset Shares</i>	
$e_a = 4.47 + 0.033a - 0.00067a^2$		$s_t = 0.9$	
$e_a^* = 1.60 + 0.067a - 0.00127a^2$		$s_t^* = 0.24$	
<i>Initial steady state values</i>			
	domestic	foreign	
Capital stock	87.0	120.5	
Labor supply	14.8	20.5	
Wage rate	1.0	1.0	
Interest rate (in %)	7.3	7.3	
GDP	21.2	29.3	
Private consumption	16.3	22.6	
Government consumption	4.1	3.4	
Trade balance	-0.9	0.9	
Net foreign assets	17.7	-17.7	
Consumption tax rate (in %)	25.0	15.0	
National saving rate $S$ (in %)	9.3	7.3	

<sup>a</sup>Parameters are mostly taken from Auerbach and Kotlikoff (1987, 50f.),  $e_a^*$  is based on estimates with panel data from Germany.

Due to the steeper age-wage profile, labor supply is higher in the foreign economy. In order to equalize the rates of return on capital, the foreign capital stock has to be higher than



Figure 1: Age-earnings and Age-consumption Profiles



the domestic one. Consequently domestic net foreign assets are positive while the trade balance runs a deficit. The parametrization outlined above generates an age-earnings and age-consumption profile which is given in figure 1.

In the home country, earnings rise for 20 working years, then they begin to fall and people retire after 47 working years. In the foreign country, earnings peak after 23 working years, but they are much higher as a result of the steeper human capital profile and the resulting higher labor supply. Retirement also occurs after 47 working years. The consumption profile is increasing in both countries but the foreign profile always lies above the domestic one.

Our simulations start from an initial steady state. After year zero, tax parameters are changed and the perfect foresight path is calculated using an iterative Gauss-Seidel algorithm. The algorithm assumes that the economy reaches its new steady state after 150 years. After solving for the transition path of the economy arising from a change in fiscal policy, we compute the difference between each generation's utility under the new policy and the initial steady state level of utility, which represent the utility that the generation would have realized in the absence of the policy change. Generations' changes in utility are divided by the post-policy reform marginal utilities of income. Changes in generational accounts and factor incomes are calculated using the post-policy-reform interest rates to discount changes in net tax payments and factor income. In a second simulation we calculate the changes in generations' excess burdens. Now the lump-sum redistribution authority compensates every generation for the changes in net tax payments and factor incomes. The resulting utility changes of this simulation are therefore solely due to behavioral changes.

In presenting our calculated changes in utility, generational account, factor income and excess burden we scale these numbers (divide them) by the present value of the generation's expenditure on consumption and leisure, valued at the initial steady state pre-tax prices.

## V. Simulation Experiments

This section examines the dynamic paths of the variables of the model via a simulation study. We compare the dynamic effects of (1) a unilateral switch from DP to OP in a small and a large open economy; (2) a multilateral switch from DP to OP in a two-country model with immediate and preannounced implementation. For all the simulations we explain the macroeconomic adjustment and disaggregate the intergenerational and international welfare effects according to the formulas developed in section three.

### 1. Unilateral switch from DP to OP: small vs. large open economy

The impact, transitional and steady state effects of an unanticipated, permanent switch from the DP to the OP in a small open economy are summarized on the left side of table 2. Since the stock of capital is predetermined in the short run, the impact effect is zero. Moreover, since the new steady state equilibrium requires according to (6) and (7)

$$r^* = \frac{(1 - \tau^p)F_K}{q} = F_K \quad (33)$$

the long run policy effects on  $F_K$  and  $F_L$  are likewise zero<sup>4</sup>. The capital stock, labor supply and output therefore have to change by the same amount. Note that  $d\Theta_K$  is also zero, since  $\Phi_K = \Phi_I = 0$  in the long run equilibrium. From equation (17) we note that the long run change of the trade balance has to be matched by an opposite change in the net foreign asset position of the same size. Finally, since the capital stock has to grow with  $n$  on the new long run growth path, we know from equation (32) that the change in  $q$  and the tax rate change have to offset each other.

To understand the short run effects of the policy change we first note that the initial steady state features a trade balance deficit. The tax base for the OP tax is smaller than for the DP based tax and consequently the tax rate has to increase, i.e.

$$1 - \tau^p < \frac{1}{1 + \tau^c}. \quad (34)$$

As a result, the real wage  $w_t e_i / p_t$  will fall which induces individuals to consume more leisure and therefore aggregate labor supply falls by 1.3 percent. The lower labor supply will increase  $F_L$  and temporarily reduce  $F_K$ . The output of the production sector will fall by 1.3 percent. The short run reaction of the asset price could be calculated by solving equation (7) for  $q_t$

$$q_t = \sum_{s=t}^{\infty} (1 - \tau_s^p) [F_{K_s} - \Phi_{K_s}] (1 + r^*)^{t-s-1}. \quad (35)$$

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<sup>4</sup>This reflects the fact that the cash-flow component of the OP consumption tax is neutral with respect to investment when the tax rate is constant, see Sandmo (1979).

**Table 2: Unilateral Switch from DP to OP:  
Macroeconomic Effects (in % from Initial Value)**

	<i>Small Open Economy</i>			<i>Large Open Economy</i>		
	1	10	$\infty$	1	10	$\infty$
$K$	0.0	-0.2	0.2	0.0	-0.6	-1.3
$K^*$	-	-	-	0.0	-0.3	-1.4
$L$	-1.8	-1.1	0.2	-1.7	-1.1	-0.1
$L^*$	-	-	-	0.5	0.2	-0.2
$Y$	-1.3	-0.8	0.2	-1.2	-1.0	-0.5
$Y^*$	-	-	-	0.4	0.1	-0.6
$C$	0.9	0.2	-1.0	0.8	0.2	-1.2
$C^*$	-	-	-	-0.7	-0.5	-0.1
$TB$	-40.6	-21.3	21.5	-32.7	-18.8	12.2
$F$	10.6	-2.2	-21.5	10.5	1.2	-13.6
$F_L$	0.6	0.3	0.0	0.5	0.2	-0.4
$F_L^*$	-	-	-	-0.2	-0.1	-0.4
$\Theta_K$	-0.5	-0.1	0.0	-0.9	-0.5	0.1
$\Theta_K^*$	-	-	-	-0.2	-0.3	0.1
$r$	0.0	0.0	0.0	0.0	0.5	0.9
$q$	-21.6	-21.2	-20.9	-21.9	-21.5	-21.0
$q^*$	-	-	-	-0.2	-0.3	0.0
$\tau^p$	21.2	21.1	20.9	21.2	21.1	21.0
$S$	8.1	8.4	9.1	8.3	8.5	9.1
$S^*$	-	-	-	7.9	7.7	7.4

After the policy reform investors expect a lower discounted stream of future net marginal profits. In order to keep the rate of return unchanged, the asset price of a share in the domestic firm will drop immediately by 21.6 percent on the stock market and net foreign assets increase on impact by 10.6 percent. Note that the decrease in  $q_t$  is slightly stronger than the increase in the tax rate. This is due to the already mentioned decrease in the labor supply which further lowers the net marginal product of capital. Consequently investment will be reduced slightly (see equation (32)) and the capital stock decumulates in the first phase of the transition. In order to determine the impact effect on consumption we have to consider the individual consumption function (30). Total real wealth  $W_{it}/p_t$  of young generations in period  $t$  will fall due to the decrease in their human wealth. Older generations on the other hand will experience a positive real wealth effect since their non-human wealth only decreases depending on the share of their domestic asset holdings. The marginal propensity to consume out of real wealth will also change. For the oldest generation we simply have  $\Gamma_{it} = v_{it}^{\rho-1}$  and therefore the marginal propensity to consume will increase as long as  $\rho < 1$ . For younger generations the marginal propensity to consume falls since the future increase in  $v_{as}$  will substitute consumption to later years. The real wealth effect is always stronger than the effect on the marginal propensity to consume, consequently consumption of older generations increases while consumption of

younger generations falls. Adding up the generation specific consumption reactions we find that aggregate consumption increases by 0.9 percent. This increase in consumption is mirrored by a fall in the saving rate from 9.3 percent to 8.1 percent in the initial period. Finally, the reduced output and the increased aggregate consumption will deteriorate the trade balance by 40.6 percent in the initial period.

During the transition, the old generations die so that aggregate consumption falls while labor supply and output increase again. As a consequence, the trade balance improves steadily; in the long run the trade balance deficit is 21.5 percent smaller than the initial one. While on impact the net foreign asset position has improved due to the immediate asset price revaluation, the increase in the trade balance deficit in the first phase of the transition will reduce the net foreign asset position during the whole transition. Note that although the tax rate falls during the transition, the long run tax rate will still be higher than in the initial equilibrium. This will determine the long run distributional consequences which we analyze in the following.

Next we turn to welfare implications of the policy reform for the different generations. In the left part of table 3 these effects are decomposed according to the formulas developed in the third section. The generational specific income effects which are due to changes in individual tax burdens and macroeconomic price adjustments are given in column two and three respectively. Columns four and five contain the changes in utilities with and without intergenerationally neutral transfers. The first column reveals the birth years of the generations we have chosen. The oldest generation, which dies at the end of the reform year one, was born at the end of year -54. This generation is not working any more, consequently the tax burden of this generation is completely eliminated in the new tax regime, see equation (21), which amounts to an increase of their full lifetime income of 8.4 percent<sup>5</sup>. On the other hand, the oldest generation will be hurt the most by the initial drop in the price of capital. From the third column we observe that this negative income effect will not fully offset the reduction in the tax burden. Since behavioral reactions are only of minor importance, the utility of the older generations in the initial year of the transition will increase. Those generations who are working in the initial year now have to pay wage taxes and bear the full tax component of the cash-flow income tax, although they only receive part of the subsidy component in the next period, see equation (23). Depending on the labor supply share, their tax burden could now even increase compared to the initial steady state. On the other hand they will experience a positive income effect from the asset price revaluation as long as their saving share is low. For younger generations the tax burden effect is much stronger, consequently their utility decreases. Finally, generations born after the reform year will experience only a small increase in their tax burdens, since they fully receive the subsidy component of the cash-flow income tax (see equation (24)). These generations are not affected by the initial asset price revaluations and therefore column three only contains the changes in the marginal products of the adjustment cost function which are of minor importance. The future generations are all hurt by the policy reform.

In order to determine the efficiency effects of the policy change, we eliminate all income

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<sup>5</sup>Consumption of goods is taxed by 25 percent in the DP, but full lifetime income also includes the consumption of leisure.

**Table 3: Unilateral Switch from DP to OP: Decomposing Generations' Utility Changes**

Year of Birth	Small open economy				Large open economy									
	$\Delta T$	$\Delta Q$	$\Delta U^c$	$\Delta U$	$\Delta T$	$\Delta F_{K,L}$	$\Delta Q$	$\Delta U^c$	$\Delta U$	$\Delta T^*$	$\Delta F_{K,L}^*$	$\Delta Q^*$	$\Delta U^{c*}$	$\Delta U^*$
-54	8.38	-6.77	0.00	1.70	1.08	-0.31	0.74	0.00	1.59	0.07	-0.10	-0.72	0.00	-0.83
-40	6.61	-4.99	-0.03	1.53	1.11	-0.22	0.68	-0.03	1.49	0.03	-0.01	-0.66	0.00	-0.70
-25	1.05	-0.24	-0.04	0.69	0.47	-0.02	0.39	-0.04	0.72	0.00	0.04	-0.28	0.00	-0.27
-10	-3.04	2.99	-0.04	-0.08	-0.22	0.10	0.11	-0.04	-0.04	-0.02	0.02	0.00	0.00	-0.02
0	-4.07	3.67	-0.04	-0.38	-0.49	0.12	0.00	-0.04	-0.35	-0.01	-0.01	0.00	0.00	-0.04
10	-0.44	0.02	-0.04	-0.40	-0.47	0.04	0.00	-0.04	-0.41	0.00	-0.02	0.00	0.00	-0.03
$\infty$	-0.40	0.00	-0.05	-0.38	-0.43	-0.08	0.00	-0.05	-0.48	0.01	-0.09	0.00	0.00	-0.10

effects by using the transfer system outlined in section three. The compensated utility changes  $\Delta U^c$  which represent the changes in the excess burdens, are given in column four. In such a Barro-world the economy experiences an efficiency loss since the tax rate has to increase. During the transition, labor supply and the capital stock decrease gradually. Eliminating all intergenerational and international income effects will lead to an erosion of the tax base. Consequently the endogenous OP consumption tax has to increase during the transition<sup>6</sup>. The individual changes in the excess burdens are therefore growing with the remaining lifetime and during the transition. Compared to the income effects, the substitution effects are only of minor importance for the total utility change. The present value of the current and future changes in excess burdens sums up to 1.8 percent of the initial gross domestic product.

The above equations (33) - (35) also explain the neutrality result from Bovenberg (1994, 264-265). Suppose that the two tax wedges from equation (34) are identical, i.e. there is no initial trade imbalance. Shifting from DP to OP will immediately reevaluate  $q = 1 - \tau^p$  according to (35). From equation (33) we see that the cost of capital now will not change even in the short run. Firms will accordingly choose the same capital intensity. As a consequence the marginal product of labor doesn't change. Hence, by equation (5), the OP consumption tax is instantaneously back-shifted to labor; i.e. the wage drops by the full amount of the tax which in turn leaves labor supply unaffected in the case of a balanced trade. Since net foreign assets are zero, there is no international income redistribution. On the left hand side of table 3 the first and the second column would completely offset each other.

In the following we simulate the same tax reform in a two-country model where the international interest rate is endogenous. The home country switches unilaterally from DP to OP consumption taxation. The foreign country is assumed to adjust its DP consumption tax rate to balance the budget. The right side of table 2 presents the short, medium and long run effects on important domestic and foreign policy variables. Again, the stock of capital and the world interest rate are predetermined in the short run; the impact effect is zero. In the new steady state equilibrium the interest rate and the marginal products of capital and labor adjust simultaneously. Finally, on the new long run growth path the change in  $q$  and the tax rate change will again offset each other.

As in the small open economy the policy reform will cause a redistribution towards older generations. Consequently savings decline and the world interest rate increases. The discounted stream of future net marginal profits is therefore lower compared to the small open economy and the asset price will drop slightly further on the stock market. The increase in the future interest rate reduces real wealth, as a consequence leisure and consumption demand will increase less compared to the small open economy. The tax base is slightly higher and therefore the OP tax rate will increase less. Both the stronger fall in  $q$  and the dampened increase in the tax rate will tend to decrease investment, and as a result the capital stock decumulates further. Since the output fall and the consumption increase is dampened, the initial trade balance deterioration is only 32.7 percent.

In the large open economy we can identify a second channel which transmits the domestic policy to the foreign economy. As before, the fall in the domestic asset price will have

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<sup>6</sup>This is in contrast with the fall of the tax rate in the simulation without compensation, see table 2.

a negative wealth effect on foreigners depending on their investment share in domestic assets. Additionally the long run increase in the world interest rate will deteriorate the foreign wealth position. As a consequence, foreigners increase their labor supply and savings and decrease their consumption demand on impact. This further boosts the deterioration of the domestic trade balance. The increase in the interest rate will also cause a drop in  $q^*$  in the initial phase of the transition. Therefore investment falls and the foreign capital stock decumulates until  $q^*$  is back to its initial level.

During the transition the reduced capital stock implies a lower wage rate and a temporarily lower gross return on capital in both economies. Because in the initial year mainly the older generations have changed their leisure demand, labor supply will increase in the domestic economy and fall in the foreign economy. Since savings have decreased in the domestic economy on impact, consumption demand will fall during the transition. The opposite happens in the foreign economy. As a consequence, the trade balance of the domestic economy improves and net foreign assets fall. In the long run, output has fallen by 0.5 and 0.6 percent in the domestic and foreign economy respectively. Similarly consumption has fallen by 1.2 and 0.1 percent respectively.

Next we turn to the welfare effects which are presented in the right part of table 3. In the large open economy the older generations have to fully bear the increase of the tax on the old capital stock, see equation (26). On the other hand, this tax base is smaller compared to the previous destination based consumption tax regime which implicitly also included the (positive) net foreign assets. Therefore the tax burden of the old generations declines, but much less as compared to the small open economy case. Younger generations again have to bear a higher tax burden when labor income is taxed directly. Notice that the tax burden for future generations again declines slightly due to the fall in the tax rate and the interest rate increase. The next column isolates the income effects which are solely due to changes in the marginal product of labor and the gross return on capital. The older generations will be hurt due to the fall in the gross return on capital, the middle aged generations will gain slightly due to the short and medium term increase of the marginal product of labor while the future generations again will lose due to the long run fall in the marginal product of labor. Now all generations who have savings in the first year of the transition will gain due to the immediate increase in net foreign assets, see equation (26). Note that in contrast to the small open economy case the youngest generation – born at the end of year zero – is not affected now. As before, behavioral changes are only of minor importance, therefore the sum of all the income effects explains most of the total utility change. Finally, redistributing back the income changes gives quite similar substitution effects as in the small open economy case. The present value of the efficiency loss is now 1.9 percent of the initial GDP.

The last part of table three describes the different income effects which change the welfare level of foreigners. The older foreigners suffer a capital loss on their domestic asset holdings and lose due to the fall in the gross return on capital. Consequently they decrease their consumption which results in a slightly lower tax burden. The fall in the tax burden of future generations might be due to the increase in the interest rate which reduces the present value of total consumption<sup>7</sup>. The second column isolates the welfare impact due

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<sup>7</sup>The increase in the interest rate also shifts consumption to later periods which further reduces the

to the revaluation of the factor prices. The older generations lose due to the fall in the gross return on capital while the middle generations benefit from the short run fall in the price of capital. Future generations again will be hurt by the fall in long run wages. The income effect due to the initial deterioration of net foreign asset position is given in the next column. This income effect must be opposite to the effect for domestic residents. Note however that since saving behavior during the life cycle differs considerably between the two countries – see figure 1 – younger foreigners in the initial period are not affected by this. Since the foreign consumption tax base increases during the transition, the tax rate will fall slightly. Compensating all income effects will result in almost no efficiency improvements  $\Delta U^c$  in the foreign economy. The present value of these effects sums up to 0.1 percent of the initial foreign GDP.

The question is now how our quantitative results from table 3 depend on some key assumptions of our benchmark. Assuming that foreigners do not own part of the domestic capital stock, i.e.  $s_t = 1$ , has no effect on the long run equilibrium. In the short run the domestic elderly now have to bear the full domestic asset price fall. Consequently they gain considerably less while middle aged generations lose more, and foreign residents are hardly affected any more<sup>8</sup>. The international redistribution effect will always favor the tax reforming country as long as foreigners hold some domestic equity. On the other hand the intergenerational redistribution via changes in tax burdens will be reversed when a country with a trade balance surplus switches to the OP consumption tax. In this case the elderly will face a higher net tax burden and future generations will experience a lower net tax burden.

This completes the analysis of the unilateral tax reform. While the second simulation could be interpreted as the appropriate scenario for the EU countries as a whole and the rest of the world, we next want to analyze macroeconomic adjustment and welfare effects within the EU when different countries switch to the OP consumption tax simultaneously.

## 2. Multilateral tax reform: immediate vs. preannounced implementation

Table 4 presents the relative changes of the domestic and foreign macroeconomic variables when both countries switch to origin based consumption taxation in year one. Since the world interest rate is kept constant in the first year of the transition, the domestic and foreign price of capital fall by 21.3 and 12.7 percent respectively. Given a multilateral tax reform the international redistribution effect depends on both countries investment shares in foreign equity capital  $s_t^*$  and  $1 - s_t$  and on the difference between the tax rate levels in the initial equilibrium. A high investment share in foreign equity capital will hurt a country and a high tax rate level will favour a country since it can expropriate foreign residents wealth relatively more. Given our benchmark parametrization, the international redistribution effect will now hurt the domestic residents. Their net foreign assets fall on impact by 8.4 percent. As a consequence labor supply decreases less compared to the last simulation while aggregate consumption even falls on impact. The trade balance now deteriorates only slightly by 1.2 percent. During the transition labor supply will again increase while consumption further falls due to the decrease in real wealth. This

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present value of the tax burden.

<sup>8</sup>In the right part of table 3 the  $\Delta Q$  columns are almost zero now, but the effects in the other columns change only slightly.



is mirrored by an improvement in the trade balance and a fall in the net foreign assets stronger than in the last simulation. In the new long run equilibrium the capital stock is 0.5 percent lower and consumption has fallen by 1.1 percent. Turning to the foreign economy we observe from the right side of table 4 that almost all variables change in the opposite direction on impact. Since the tax base has increased due to the initial trade balance surplus, the origin based consumption tax rate can fall which improves labor supply and consumption. Although consumption increases more than output, the trade balance still improves on impact due to the fall in investment. The latter is explained by the increase in the world interest rate which further decreases  $q^*$ . During the transition the falling capital stock will decrease the wage rate. On the other hand, due to the improved net foreign asset position labor supply will fall and consumption will increase in the long run.

**Table 4: Multilateral Switch from DP to OP:  
Macroeconomic Effects (in % from Initial Value)**

	<i>Domestic Economy</i>			<i>Foreign Economy</i>		
	<i>1</i>	<i>10</i>	$\infty$	<i>1</i>	<i>10</i>	$\infty$
<i>K</i>	0.0	-0.2	-0.5	0.0	-0.1	-0.7
<i>L</i>	-0.6	-0.4	0.1	0.2	0.0	-0.2
<i>Y</i>	-0.4	-0.3	-0.1	0.1	0.0	-0.3
<i>C</i>	-0.3	-0.6	-1.1	0.2	0.3	0.4
<i>TB</i>	-1.2	5.0	17.7	1.2	-5.0	-17.7
<i>F</i>	-8.4	-12.5	-18.1	8.4	12.5	18.1
<i>F<sub>L</sub></i>	0.2	0.1	-0.2	-0.1	-0.1	-0.2
$\Theta_K$	-0.3	-0.1	0.0	-0.1	-0.1	0.0
<i>r</i>	0.0	0.2	0.4	0.0	0.2	0.4
<i>q</i>	-21.3	-21.1	-21.0	-12.7	-12.7	-12.6
$\tau^p$	21.0	21.0	21.0	12.6	12.6	12.6
<i>S</i>	8.8	8.9	9.1	7.7	7.6	7.5

Turning to the welfare effects of table 5 we notice first that the changes in the individual tax burdens of the domestic economy are quite similar to those in the previous simulation. The income effects due to changes in the marginal products have the same sign, but they are now, as one would expect, much smaller. The main difference appears in the next column which captures the effects of the impact asset price revaluation. As already explained above, domestic savers experience now a negative income effect. After redistribution the domestic substitution effects again sum up to 1.9 percent of the initial GDP. Summing up the different income and uncompensated substitution effects, the utility of the older domestic generations increases but much less than in the previous simulation. The loss of the future generations is almost the same as before.

Next we turn to the welfare effects for the different foreign generations in the right part of table 5. The tax burden of the older foreign generations increases. Since the initial net foreign asset position is negative in the foreign economy, the switch to the origin

**Table 5: Multilateral Switch from DP to OP:  
Decomposing Generations' Utility Changes**

Year of Birth	Domestic economy					Foreign economy				
	$\Delta T$	$\Delta F_{K,L}$	$\Delta Q$	$\Delta U^c$	$\Delta U$	$\Delta T^*$	$\Delta F_{K,L}^*$	$\Delta Q^*$	$\Delta U^{c*}$	$\Delta U^*$
-54	1.08	-0.10	-0.60	0.00	0.38	-0.66	-0.05	0.58	0.00	-0.14
-40	1.02	-0.07	-0.55	-0.03	0.34	-0.62	-0.02	0.53	0.01	-0.09
-25	0.41	-0.01	-0.31	-0.04	0.05	-0.16	0.02	0.22	0.01	0.08
-10	-0.20	0.04	-0.09	-0.04	-0.25	0.18	0.01	0.00	0.01	0.19
0	-0.44	0.04	0.00	-0.04	-0.38	0.19	0.00	0.00	0.01	0.18
10	-0.43	0.01	0.00	-0.04	-0.40	0.18	0.00	0.00	0.01	0.17
$\infty$	-0.41	-0.03	0.00	-0.05	-0.42	0.18	-0.04	0.00	0.01	0.13

based consumption tax will increase the tax base of the elderly and consequently their tax burden. On the other hand, the tax burden for younger and future generations decreases. Income effects due to factor price adjustments are similar as in the domestic economy and foreigners who have savings in the initial equilibrium experience a positive income effect due to the immediate asset price adjustment. Summing up all income effects and uncompensated substitution effects, the utility of the elderly in the first reform year decreases. On the other hand future foreign generations now gain due to the lower tax burden. Finally, redistributing back all the income effects we observe a slight improvement in efficiency due to the decrease in the tax rate. The present value of all the efficiency changes sums up to 0.5 percent of the initial GDP.

In all our previous simulations the switch from DP to OP is unexpected by individuals and completed after one period. Such a scenario is quite unrealistic, since such a tax reform is usually implemented with a considerable time-lag due to the legislative process. In our last simulation we therefore assume that the multilateral switch to the OP is announced two years in advance of implementation. In the first and the second year of the transition (before the move towards the OP) the DP tax rate is endogenous to balance the budget. In the third year the OP regime is introduced and the OP tax rate is set endogenously. Since the long run effects are exactly the same as in table 4 and 5 we can concentrate on the short run dynamics before and after the actual reform. Table 6 describes the macroeconomic adjustment in the first four years of the transition.

On impact, the domestic price of capital falls by 5.2 percent, while the foreign price of capital even increases by 3.4 percent. This will lead to asymmetric short run investment responses in the two countries. While the capital stock decreases sharply in the domestic economy until the actual implementation of the reform, the capital stock increases in the foreign economy. The impact revaluation will also increase domestic net foreign assets by 7.6 percent in the first period. Domestic consumers now expect that their real wage will fall in period three. Consequently they increase their labor supply and decrease their consumption. The trade balance therefore improves dramatically during the pre-reform periods, and since the increased savings are not used for domestic investment, net foreign assets also increase enormously in period two and three. Note that since the tax base

**Table 6: Preannounced Multilateral Switch from DP to OP:  
Macroeconomic Effects (in % from Initial Value)**

	<i>Domestic Economy</i>				<i>Foreign Economy</i>			
	1	2	3	4	1	2	3	4
$K$	0.0	-0.5	-1.1	-1.1	0.0	0.4	0.7	0.7
$L$	1.5	1.5	-1.1	-1.1	-1.2	-1.1	0.5	0.5
$Y$	1.1	0.9	-1.1	-1.1	-0.8	-0.7	0.6	0.6
$C$	-1.6	-1.6	-0.4	-0.4	1.2	1.2	0.2	0.2
$TB$	101.8	102.0	-17.0	-16.1	-101.8	-102.0	17.0	16.1
$F$	7.6	13.3	19.3	-0.8	-7.6	-13.3	-19.3	0.8
$F_L$	-0.5	-0.6	-0.0	-0.0	0.4	0.4	0.1	0.1
$\Theta_K$	-5.2	-5.5	0.2	0.2	3.4	3.6	-0.4	-0.4
$r$	0.0	-0.1	-237.1	0.1	0.0	-0.1	-237.1	0.1
$q$	-5.2	-5.5	-5.9	-21.1	3.4	3.6	3.9	-12.9
$\tau^{c,p}$	25.4	25.4	21.2	21.2	14.8	14.8	12.4	12.4
$S$	11.8	11.9	-7.8	8.7	5.2	5.1	17.7	7.8

decreases, the endogenous DP consumption tax rate has to increase slightly before the reform year. Exactly the opposite happens in the foreign economy during the first two years. In year three foreign residents will increase their saving rate to 17.7 percent and although domestic residents absorb part of these assets, the world interest rate turns negative. As a consequence  $q$  will fall in both economies after the reform year almost to its long run level. The future price of capital and the OP tax rate now determine the investment demand in every country, see equation (32). Starting in the reform year investment and consumption will increase again in the domestic economy. Since at the same time output will fall due to reduced labor supply, the trade balance deteriorates dramatically and net foreign assets fall in the next period. Exactly the opposite happens in the foreign economy. After the reform year all variables will move gradually towards their long run levels as reported in table 4.

Table 7 sums up the welfare effects of a preannounced reform. Compared to all the previous simulations we notice some important differences. Now the short run price adjustments in the  $\Delta F_{K,L}$  column and the short run substitution effects have quite significant welfare implications. In the domestic economy the oldest generation experiences a dramatic income loss due to the fall in the gross return on capital. Middle aged generations on the contrary will gain slightly due to the fall in the price of capital. From the above discussion we know that savings and labor supply will increase before the implementation of the new tax system but fall dramatically afterwards. As we observe from the  $\Delta U^c$  column this behavioral responses imply dramatic efficiency losses for some middle aged generations. The aggregate loss in the domestic economy now sums up to 18.3 percent of the initial GDP. Except for the oldest generation the aggregate welfare effects are quite similar to those reported in table 5, but nevertheless their composition could be quite different for some generations.

**Table 7: Preannounced Multilateral Switch from DP to OP:  
Decomposing Generations' Utility Changes**

Year of Birth	Domestic economy					Foreign economy				
	$\Delta T$	$\Delta F_{K,L}$	$\Delta Q$	$\Delta U^c$	$\Delta U$	$\Delta T^*$	$\Delta F_{K,L}^*$	$\Delta Q^*$	$\Delta U^{c*}$	$\Delta U^*$
-54	0.15	-1.80	0.54	0.00	-1.34	-0.08	1.59	-0.52	0.00	1.17
-40	1.09	-0.03	0.50	-1.23	0.32	-0.67	-0.10	-0.48	1.24	-0.10
-25	0.54	0.10	0.28	-0.77	0.10	-0.23	-0.10	-0.20	0.58	0.03
-10	-0.16	0.06	0.08	-0.24	-0.29	0.18	0.03	0.00	0.01	0.24
0	-0.47	0.00	0.00	0.00	-0.49	0.23	0.09	0.00	-0.06	0.29
10	-0.45	-0.03	0.00	-0.05	-0.46	0.19	0.03	0.00	0.01	0.21
$\infty$	-0.41	-0.03	0.00	-0.05	-0.42	0.18	-0.04	0.00	0.01	0.13

In the right part of Table 7 we observe exactly the opposite pattern for the foreign economy. Here the aggregate efficiency gains sum up to 12.8 percent of the initial GDP.

## VI. Concluding Remarks

The integration of the national commodity tax systems is still one of the major reform projects on the move towards a single European market. In this paper we have analyzed the short, medium and long run effects of a radical reform option for the future European VAT system. Using a dynamic simulation model of an open economy we have demonstrated that the effects of a switch to the OP consumption taxation on important macroeconomic variables could be very significant. Such a reform would generate considerable welfare redistributions across generations and countries in and outside the European Union. Finally, in a realistic setting with variable labor supply also quantitatively important efficiency effects have to be taken into account.

These results of course have to be interpreted with some caution due to the chosen numerical parameter values and the strong assumptions underlying the model. If the economic agents would be more altruistic the intergenerational redistributions would be dampened by appropriate adjustments in the bequest levels. Furthermore the spillovers of domestic tax policies to foreign countries operate solely through the integrated world capital market. Since in the model both countries produce the same good, the second important transmission channel through changes in relative commodity prices is automatically excluded. A useful extension of the model therefore would be to disaggregate into different commodities. Such a model would also allow for an examination of non-uniform commodity taxes. A more realistic modelling would also have to include features such as liquidity constraints and labor market imperfections. Finally, future research could also extend the current model to a three-country world where two countries substitute the OP for the DP. Such a setting would facilitate a deeper analysis of the international spillovers generated by regional economic integration.

## References

- Auerbach, A.J., and L.J. Kotlikoff, 1987, *Dynamic fiscal policy*, Cambridge: Cambridge University Press.
- Berglas, E., 1981, Harmonisation of commodity taxes, *Journal of Public Economics* 16, 377-387.
- Bovenberg, L.A., 1994, Destination- and origin-based taxation under international capital mobility, *International Tax and Public Finance* 1, 247-273.
- Fehr, H., and L.J. Kotlikoff, 1995, *Generational accounting in general equilibrium*, NBER Working Paper 5090, Cambridge.
- Fehr, H., C. Rosenberg and W. Wiegard, 1995, *Welfare effects of value-added tax harmonization in Europe*, Berlin: Springer.
- Frenkel, J.A., A. Razin and S. Symansky, 1991, International VAT harmonization, *IMF Staff Papers* 38, 789-827.
- Genser, B., A. Haufler and P.B. Sørensen, 1995, Indirect taxation in an integrated europe: Is there a way to avoid trade distortions without sacrificing national tax autonomy? *Journal of Economic Integration* 10, 178-205.
- Gravelle, J.G., 1991, Income, consumption and wage taxation in a life-cycle model: Separating efficiency from redistribution, *American Economic Review* 81, 985-995.
- Haufler, A., 1993, *Commodity tax harmonization in the European Community*, Heidelberg: Physica Verlag.
- Hayashi, F., 1982, Tobin's marginal  $q$  and average  $q$ : A neoclassical interpretation, *Econometrica* 50, 213-224.
- Keuschnigg, C., 1991, The transition to a cash flow income tax, *Swiss Journal of Economics and Statistics* 127, 113-140.
- Keuschnigg, C., 1994, Dynamic tax incidence and intergenerationally neutral reform, *European Economic Review* 38, 343-366.
- Lipton, D. and J. Sachs, 1983, Accumulation and growth in a two-country model, *Journal of International Economics* 15, 135-159.
- Lockwood, B., D. de Meza, and G.D. Myles, 1994, When are origin and destination regimes equivalent? *International Tax and Public Finance* 1, 5-24.
- Nielsen, Søren B., and Peter B. Sørensen, 1991, Capital income taxation in a growing open economy, *European Economic Review* 34, 179-197.

- Sandmo, A., 1979, A note on the neutrality of the cash flow corporation tax, *Economics Letters* 4, 173-176.
- Sinn, H.-W., 1990, Tax harmonization and tax competition in Europe, *European Economic Review* 34, 489-504.
- Summers, L.H., 1981, Taxation and corporate investment: A q-theory approach, *Brookings Papers on Economic Activity* 1, 67-127.
- Whalley, J., 1979, Uniform domestic tax rates, trade distortions and economic integration, *Journal of Public Economics* 11, 213-221.