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Welfare Effects of Investment Incentive Policies: A Quantitative Assessment

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Welfare Effects of Investment Incentive Policies: A Quantitative Assessment*

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November 1995

Abstract

This paper deals with the intergenerational incidence of corporate tax policies in the overlapping generation model. Corportate tax reforms affect the welfare levels of individuals via three channels: (i) changes in the net tax burdens, (ii) changes in the factor prices, and (iii) changes in deadweight loss associated with the taxes. We develop formulas to isolate these effects in a closed and a small open economy and then apply these formulas to a policy experiment similar to a recent German corporate tax reform plan. The simulations suggest that generations' utility changes are mainly due to intergenerational income effects. While in closed economies changes in net tax burdens are most important especially in the short-run, the revaluation of the initial capital stock is an important redistribution channel in the small open economy.

JEL Classification: C68; H22
Keywords: Dynamic CGE modelling; investment incentives; intergenerational tax incidence; equal yield tax reform;

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1. Introduction

Many OECD countries try to stimulate investment and growth by subsidizing investment expenditures by firms through investment tax credits or accelerated depreciation allowances (see OECD, 1991). This study aims to separate the distributional and efficiency consequences of such policies and explores the quantitative importance of the different effects in a numerical simulation exercise. There is a growing body of literature that has investigated the dynamic efficiency effects of such corporate taxation policies in infinite horizon models[1]. This paper deals with the intergenerational incidence of corporate tax policies in the overlapping generation model when agents have a pure life cycle motive for savings. The welfare effects of tax reforms in the life cycle model are due to both price distortions and intergenerational redistribution[2]. The intergenerational burden of a reform depends on changes of tax liabilities across generations and the changes in factor rewards which affect generations quite differently. For a meaningful measure of the efficiency effects, a compensation scheme has to offset all induced income effects due to tax and price changes.

In this sense the present paper elaborates on the theoretical analysis by Keuschnigg (1994). In the basic two-period life cycle model he isolates changes in the generationally-specific excess burdens by combining the increase of a distortive tax with a so called "intergenerationally neutral" rebatement policy. This study uses a very similar compensation mechanism. In contrast to Keuschnigg (1994) it incorporates endogenous labor supply and extends the analysis to corporate tax reforms in small open economies. Similar to Fehr and Kotlikoff (1995) income effects are explicitly disaggregated into changes in net tax burdens (i.e. the generational accounts) and changes in factor incomes. These intergenerational effects can be offset by an appropriate choice of generational transfers. After offsetting the redistributive content of the policy reform, the remaining utility changes are solely due to efficiency gains or losses.

For an empirical application of our welfare decomposition we use the Auerbach-Kotlikoff (1987) dynamic life-cycle model (henceforth the AK Model) to analyze a policy change similar to a recent German corporate tax reform plan. The original draft of the so called "Standortsicherungsgesetz" proposed a decrease of the corporate tax rate financed by an equal yield reduction of depreciation allowances. However, as will become clear later, such a policy is not feasible in our context. We therefore will decrease both the corporate tax rate and investment incentives while

[1]For a theoretical analysis see Sinn (1987). Numerical general equilibrium calculations in closed economies are presented in Goulder and Summers (1989), Goulder and Thalmann (1993) and Pereira (1994). Bovenberg and Goulder (1993) study the distortions generated by such policies in open economies.

[2]For a theoretical analysis of investment incentive policies in an overlapping generation model see Bovenberg (1993) and Keuschnigg (1994). Intergenerational welfare calculations for closed economies are found in Auerbach and Kotlikoff (1987, chp. 9), while Söderlind (1990), Frederiksen (1994) and Bettendorf (1995) simulate corporate tax reforms in open economies.

endogenously adjusting the wage tax in our simulations. The intergenerational incidence of such a policy is measured by comparing the resulting changes in generations' utilities with the associated generational-specific income effects. In a second simulation we calculate the generational-specific efficiency effects by running the same reform with intergenerationally neutral transfers. Since the AK Model can incorporate an early announcement of future policy changes, the paper also sheds some light on the quantitative consequences of intertemporal price speculations due to pre-announcement.

The simulations suggest that generations' utility changes are mainly due to intergenerational income effects. In closed as well as in small open economies the generationally-specific changes in excess burdens are only of minor importance. In closed economies the income redistribution is mainly due to changes in generational accounts. Income effects due to macroeconomic price repercussions are of second order. In the short-run they will dampen the effects of the generations' changes in net tax burdens while in the long-run they will reinforce them. Since the rate of return is fixed to the world interest rate, the adjustment mechanism in small open economies works quite differently. In the short-run the revaluation of the inital capital stock is the most important redistribution channel. Generations will benefit (or lose) depending on the difference between their ownership share in the initial capital stock and their share in aggregate labor supply. In the long-run macroeconomic price repercussions could be neglected and income effects are only chaused by changes in the net tax burdens. In general, policy pre-announcement will not change our results qualitatively but it will dampen the income redistribution across generations.

The remainder of the paper is organized as follows. Section 2 sets up the theoretical framework. Consumption and saving decisions of households follow from a simple two-period life-cycle model without bequest. On the production side the "Q"-theory of investment is applied to model the investment decisions of firms. Section 3 illustrates how policy-induced changes in generations' utilities can be decomposed into three components: 1) the change in their net tax payments, 2) the change in their factor income, and 3) the change in their economic behavior. If lump-sum transfers are used to offset the income effects 1) and 2), component 3) measures the change in generational-specific excess burdens. The decomposition is outlined for the closed economy as well as the small open economy case. Section 4 proceeds with a short introduction in the AK Model. Section 5 reports our simulation results. Some sensitivity analysis sheds light on how some critical parameters change the numerical calculations. Finally, section 6 summarizes our findings and draws conclusions.

2. The framework

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.

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

where c indexes consumption, ℓ indexes leisure, y indexes young, and o indexes old. The budget constraint facing the generation born at time t is

$$c_{yt} + \frac{c_{ot+1}}{1 + r_{t+1}} = (1 - \ell_{yt})w_t(1 - \tau_t^w) + \frac{(1 - \ell_{ot+1})w_{t+1}(1 - \tau_{t+1}^w)}{1 + r_{t+1}}, \tag{2}$$

where w_t is the wage per unit of labor supply[3], τ_t^w is the wage tax and r_t is the time-t rate of return.

The production technology is assumed to be of the linear homogeneous neoclassical type. In period t output (per capita of the young) y_t is produced with capital k_t and labor l_t, i.e.

$$y_t = f(k_t, l_t) \qquad f_{k_t} > 0, f_{l_t} > 0 \tag{3}$$

with $l_t = (1 - \ell_{yt}) + (1 - \ell_{ot})$. Following Summers (1981) we model adjustment costs as output losses associated with investment. The total adjustment costs in period t, x_t, depend on the level of investment and the stock of capital, i.e.

$$x_t = \Psi(i_t, k_t) \qquad \Psi_{i_t} > 0, \Psi_{k_t} < 0. \tag{4}$$

with $i_t = k_{t+1} - k_t$. As usual the installation function is assumed to be linear homogeneous in investment and capital and convex in investment.

Perfectly competitive firms hire capital and labor to maximize the wealth of their share holders V_t. Dividend payments (per capita) are net of a corporate tax at rate τ_t^c. Producers are allowed to subtract a fraction e_t of their total investment expenditures (including adjustment costs). Assuming that investment is financed via retained earnings[4], the after tax dividends are therefore

$$\chi_t = (1 - \tau_t^c)\left[y_t - w_t l_t\right] - (1 - e_t\tau_t^c)\left[i_t + x_t\right]. \tag{5}$$

[3]To keep the analysis simple, we assume that the young and old receive the same wage per unit of labor supply at a point in time.

[4]This simplification seems to be justified on empirical grounds. Meyer and Alexander (1990) found that large corporations in Germany finance 89.6 percent of their investment through retained earnings.

From the firms optimization problem we derive the following necessary conditions for an optimum[5]

$$
\begin{aligned}
w_t &= f_{l_t}, && (6)\\
q_{t+1} &= (1 - e_t\tau_t^c)\left[\, 1 + \Psi_{i_t} \,\right], && (7)\\
r_t &= \frac{(1-\tau_t^c)f_{k_t} - (1 - e_t\tau_t^c)\Psi_{k_t} + q_{t+1} - q_t}{q_t}. && (8)
\end{aligned}
$$

The equality of the real wage rate and the marginal product of labor characterizes optimal labor demand. According to (7) firms will invest until the marginal benefits q_{t+1} from an additional unit of capital in the next period will equal the marginal cost of acquisition and installation. Tax savings due to investment incentive policies reduce the total marginal costs. Given the convexity of the adjustment cost function the first-order condition (7) can be inverted to derive an explicit investment function. Equation (8) finally defines the equilibrium rate of return for investment. The rate of return must be equal to the net marginal profits plus capital gains that are earned on equity investment. Net marginal profits include the marginal productivity of capital in production and the marginal contribution of capital in lowering the costs of installing investment. Equation (8) also gives the optimal path for the shadow value of capital. The difference $q_{t+1} - q_t$ is the increase in equity value due to the investment of an additional unit of capital. We can solve this equation for q_t to see how investors evaluate an incremental unit of capital, i.e.

$$
q_t = \sum_{s=t}^{\infty}\Big[(1-\tau_s^c)f_{k_s} - (1 - e_s\tau_s^c)\Psi_{k_s}\Big]\Pi_{u=t}^{s}(1+r_u)^{-1}. \qquad (9)
$$

The marginal benefit of a unit of newly installed capital is equal to the future discounted stream of additional future profits net of taxes (including savings in future installation costs). Hayashi (1982) has shown that - given our homogeneity assumptions - marginal q_t is equal to the asset price of a share in the firm, i.e. $V_t = q_t k_t$.

The government collects taxes from individuals and companies in order to finance the public good G_t, i.e.

$$
\begin{aligned}
G_t &= \tau_t^w w_t l_t + \tau_t^c\left[\, y_t - w_t l_t - e_t\Big(i_t + x_t\Big) \,\right]\\
&= \underbrace{\tau_t^w w_t(1-\ell_{yt})}_{T_{yt}^p} + \underbrace{\tau_t^w w_t(1-\ell_{ot})}_{T_{ot}^p} + \underbrace{\tau_t^c\left[\, f_{k_t}k_t - e_t\Big(i_t + \Psi_{i_t}k_{t+1} + (\Psi_{k_t} - \Psi_{i_t})k_t\Big) \,\right]}_{T_t^c}.
\end{aligned}
\qquad (10)
$$

[5]In appendix A we derive the optimality conditions and show Hayashi's (1982) result that marginal q_t is equal to the asset price of a share in the firm.

The above equation defines the personal tax burden of the young and old generation T^p_{yt}, T^p_{ot}, which is their respective wage tax payment. Furthermore it uses the identities

$$y_t = f_{k_t} k_t + f_{l_t} l_t \tag{11}$$

$$x_t = \Psi_{i_t} i_t + \Psi_{k_t} k_t \tag{12}$$

implied by the constant returns to scale technologies to decompose the corporate tax revenus T^c_t. Although corporate taxes are levied at the firm level, they are finally paid by the young and old generation. Without investment incentives ($e_t = 0$) the corporate tax would burden the old generation, since this generation owns the capital stock. The tax basis (per unit of capital) in this case would be the direct marginal product of capital f_{k_t}. If investment expenditures, but not adjustment costs can be partially deducted from the tax base, income from old assets is taxed at a higher rate than income from new assets. A simple arbitrage argument (see Auerbach and Kotlikoff, 1987, 132) dictates, that this less favourable tax treatment should be capitalized into these assets' values. The older generation therefore bears an extra tax burden on their capital stock while the young generation - who buys the capital stock at the end of the period from the old generation - receives a tax subsidy. The subsidy basis (per unit of capital) would be the expensing rate e_t and the subsidy rate would be τ^c_t. Adjustment costs can be decomposed into marginal costs of new capital and an "indirect" marginal product of old capital. The deduction of the costs of new capital will consequently increase the subsidy to the young generation while at the same time the deduction of the benefits from old capital will (implicitly) raise the tax burden of the current capital stock through tax capitalization effects. We can therefore disaggregate the total corporate tax revenue into a "gross" corporate tax revenue term T^c_{ot} and a corporate tax subsidy term T^c_{yt}, i.e.

$$T^c_{ot} = \tau^c_t \left[f_{k_t} + e_t(1 + \Psi_{i_t} - \Psi_{k_t}) \right] k_t = \tau^c_t f^a_{k_t} k_t,$$

$$T^c_{yt} = -\tau^c_t e_t \left[1 + \Psi_{i_t} \right] k_{t+1} = -\tau^c_t e^a_t k_{t+1}.$$

In the above equation $f^a_{k_t}$ defines the (adjusted) marginal tax base for old capital and e^a_t defines the (adjusted) marginal subsidy base for new capital . Since in the closed economy the old generation owns the current period capital stock while the young generation owns the next periods capital stock, T^c_{ot} and T^c_{yt} also define the corporate tax burdens of old and young generations respectively.

3. Intergenerational incidence of dynamic tax reforms

3.1 The closed economy

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

$$\begin{aligned} c_{ot} &= (1+r_t)q_t k_t + (1-\ell_{ot})w_t(1-\tau_t^w) \\ &\overset{(8)}{=} \left[q_{t+1} + (1-\tau_t^c)f_{k_t} - (1-e_t\tau_t^c)\Psi_{k_t}\right]k_t + (1-\ell_{ot})w_t(1-\tau_t^w). \end{aligned} \tag{13}$$

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

$$\mathrm{d}U_{t-1} = \frac{\partial U}{\partial c_{ot}}\,\mathrm{d}c_{ot} + \frac{\partial U}{\partial \ell_{ot}}\,\mathrm{d}\ell_{ot}. \tag{14}$$

Differentiating (13) and using the first-order condition of the elderly at time t as well as their budget constraint we get the normalized utility change[6]

$$\frac{\mathrm{d}U_{t-1}}{\lambda_{t-1}} = \mathrm{d}c_{ot} + w_t(1-\tau_t^w)\mathrm{d}\ell_{ot} \tag{15}$$

$$\begin{aligned} &= -\left[\mathrm{d}T_{ot}^p + \mathrm{d}T_{ot}^c\right] + \left[k_t\left(\mathrm{d}\Psi_{i_t} + \mathrm{d}f_{k_t} - \mathrm{d}\Psi_{k_t}\right) + (1-\ell_{ot})\mathrm{d}w_t\right] \\ &\quad - \left[\tau_t^w w_t \mathrm{d}\ell_{ot}\right] \end{aligned} \tag{16}$$

where λ_{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 $\mathrm{d}k_t$ is zero. In (16), the utility change of the elderly is decomposed into changes in their remaining tax payments, i.e. their generational account changes (the first bracketed term on the equation's right side), changes in their factor incomes (the second bracketed term on the right-hand-side) and behavioral changes to avoid tax payments (the third bracketed term on the right-hand-side).

The utility change of those born at time $s \geq t$ can be similarly decomposed. Differentiating equation (1) and using relevant first-order conditions leads to

$$\frac{\mathrm{d}U_s}{\lambda_s} = \mathrm{d}c_{ys} + w_s(1-\tau_s^w)\mathrm{d}\ell_{ys} + \frac{\mathrm{d}c_{os+1} + w_{s+1}(1-\tau_{s+1}^w)\mathrm{d}\ell_{os+1}}{1+r_{s+1}}. \tag{17}$$

Combining (17) with the differential of (2) yields

$$\begin{aligned} \frac{\mathrm{d}U_s}{\lambda_s} = &- \left[\mathrm{d}T_{ys}^p + \mathrm{d}T_{yt}^c + \frac{\mathrm{d}T_{os+1}^p + \mathrm{d}T_{os+1}^c}{1+r_{s+1}}\right] + \left[(1-\ell_{ys})\mathrm{d}w_s - k_{s+1}\mathrm{d}\Psi_{i_s}\right. \\ &\left. + \frac{(1-\ell_{os+1})\mathrm{d}w_{s+1} + k_{s+1}[\mathrm{d}\Psi_{i_{s+1}} + \mathrm{d}f_{k_{s+1}} - \mathrm{d}\Psi_{k_{s+1}}]}{1+r_{s+1}}\right] \\ &- \left[\tau_s^w w_s \mathrm{d}\ell_{ys} + \tau_s^c e_s^a \mathrm{d}k_{s+1} - \frac{\tau_{s+1}^c f_{k_{s+1}}^a \mathrm{d}k_{s+1} - \tau_{s+1}^w w_{s+1}\mathrm{d}\ell_{os+1}}{1+r_{s+1}}\right]. \end{aligned} \tag{18}$$

[6]In appendix B we derive all wealth decompositions in detail.

In (18), the normalized utility change of generation $s \geq t$ consists of of the same three components encountered in (16): the change in its generational account, the change in factor income and the marginal change in tax revenue associated with changes in economic behavior.

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 effciency gains or losses. While it is possible by this to measure the overall efficiency changes, one can not isolate the generation-specific substitution effect. Implicitly all efficiency gains (or losses) of the old generation are transfered 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 generation at time s are therefore defined by

$$\begin{aligned} Tr_{os} &= \mathrm{d}T^p_{os} + \mathrm{d}T^c_{os} - k_s \left[\mathrm{d}\Psi_{i_s} + \mathrm{d}f_{k_s} - \mathrm{d}\Psi_{k_s} \right] - (1-\ell_{os})\mathrm{d}w_s; \\ Tr_{ys} &= \mathrm{d}T^p_{ys} + \mathrm{d}T^c_{ys} + k_{s+1}\mathrm{d}\Psi_{i_s} - (1-\ell_{ys})\mathrm{d}w_s. \end{aligned}$$

Note that by holding the time path of government spending fixed, changes across all generations in their tax payments balance to zero. Furthermore by differentiating (11) and (12) we see that changes in generations' factor incomes also cancel across generations, i.e.

$$l_s \mathrm{d}w_s + k_s \mathrm{d}f_{k_s} = 0 \tag{19}$$

$$i_s \mathrm{d}\Psi_{i_s} + k_s \mathrm{d}\Psi_{k_s} = 0. \tag{20}$$

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 third brackets of the above equations (16) and (18). Adding up the compensated utility changes of period s across the generations we get the total efficiency change in the economy in that period[7]:

$$\Delta \mathrm{EB}_s = \tau^c_s \left[f_{k_s} \mathrm{d}k_s - e_s \Big(\mathrm{d}i_s + \mathrm{d}x_s \Big) \right] - \tau^w_s w_s \mathrm{d}l_s.$$

[7]The formula equals equation (11) in Keuschnigg (1994) adjusted for variable labor supply and our adjustment cost formulation.

3.2 The small open economy

In an open economy where corporate capital has the option of migrating to other countries, the incidence of the corporate tax could be quite different in the long-run as well as in the short-run compared to the closed economy. A domestic corporate tax reform will tend to cause an inflow (outflow) of corporate capital in the long-run, resulting in a shortage (oversupply) of capital in the domestic economy which will reduce (increase) labor productivity and real wage rates. In the extreme case of a small open economy with perfect international mobility of capital the corporate tax burden will be completely shifted to wage earners. In the more realistic case of imperfect capital mobility at least a partial shifting of the tax will occur. Since the rate of return is fixed, the adjustment mechanism works quite differently in a small open economy. As we will see in this section the most important redistribution channel is the revaluation of the initial capital stock immediately after a corporate tax reform is implemented.

In a small open economy the real rate of return is fixed to the foreign level r^*. The asset portfolio of the old generation at time t, a_t, will now include domestic as well as foreign assets b_t^f, i.e.

$$a_t = s_t^h q_t k_t + b_t^f \qquad \text{with} \qquad 0 \leq s_t^h \leq 1. \tag{21}$$

Since foreigners could also own part of the domestic capital, we define s_t^h as the share of the domestic capital stock initially owned by domestic households and $1 - s_t^h$ as the share owned by foreigners. The budget constraint of the old at time t is now given by

$$c_{ot} \;=\; (1 + r^*)a_t + (1 - \ell_{ot})w_t - T_{ot}^p. \tag{22}$$

Substituting the differential of (22) into the normalized utility change (15) we get

$$\frac{\mathrm{d}U_{t-1}}{\lambda_{t-1}} = (1 + r^*)s_t^h k_t \mathrm{d}q_t + (1 - \ell_{ot})\mathrm{d}w_t - \mathrm{d}T_{ot}^p - \tau_t^w w_t \mathrm{d}\ell_{ot}. \tag{23}$$

Using equation (19) and the differential of the modified arbitrage condition (8) leads to

$$\begin{aligned}\frac{\mathrm{d}U_{t-1}}{\lambda_{t-1}} \;=\; & -\Big[\mathrm{d}T_{ot}^p + \alpha_{ot}\mathrm{d}T_{ot}^c\Big] + \Big[(s_t^h - \alpha_{ot})(1 + r^*)k_t \mathrm{d}q_t + \alpha_{ot}k_t\Big(\mathrm{d}\Psi_{i_t} - \mathrm{d}\Psi_{k_t}\Big)\Big] \\ & -\Big[\tau_t^w w_t \mathrm{d}\ell_{ot}\Big].\end{aligned} \tag{24}$$

In the above equation $\alpha_{ot} = (1-\ell_{ot})/l_t$ defines the old generations share in aggregate labor supply. Again, the utility changes are decomposed into changes in remaining tax burdens as well as price and behavioral changes. Comparing (24) with (16) we

notice some important differences. In the first bracket we see that the change in the "gross" corporate tax revenue, dT^c_{ot}, now affects the elderly only in proportion to their labor supply. Due to installation costs the capital stock is fixed in the first period and will only change gradually (depending on the degree of convexity of the installation function) during the transition. In the initial period the price of the capital stock q_t will therefore adjust immediately according to the arbitrage condition (8). 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 aggregate capital stock (which is s^h_t). At the same time such an asset price revaluation 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. Note that equation (24) could be easily adjusted to include perfect capital mobility and no investment incentives ($e_t = 0$) as a special case. In such a setting the second bracket disappears, dT^c_{ot} would measure the change in total corporate tax revenue and the third bracket would also include $\alpha_{ot}\tau^c_t f_{k_t} dk_t$. This corresponds to the case analyzed by Bovenberg (1986, 353) and Fehr and Kotlikoff (1995) where corporate tax changes are completely shifted to labor.

Next we turn to the utility change of those born at time t which can be decomposed as follows:

$$\begin{aligned}\frac{dU_t}{\lambda_t} = &-\left[dT^p_{yt} + \alpha_{yt}dT^c_{ot} + \alpha_{ot+1}dT^c_{yt} + \frac{dT^p_{ot+1} + \alpha_{ot+1}dT^c_{ot+1}}{1+r^*}\right] \\ &+\left[\alpha_{yt}k_t(d\Psi_{i_t} - d\Psi_{k_t}) - \alpha_{ot+1}k_{t+1}d\Psi_{i_t} + \frac{\alpha_{ot+1}k_{t+1}(d\Psi_{i_{t+1}} - d\Psi_{k_{t+1}})}{1+r^*}\right. \\ &\left.- \alpha_{yt}(1+r^*)k_t dq_t\right] - \left[\alpha_{ot+1}\tau^c_t e^a_t dk_{t+1} + \tau^w_t w_t d\ell_{yt}\right. \\ &\left.- \frac{\alpha_{ot+1}\tau^c_{t+1} f^a_{k_{t+1}} dk_{t+1} - \tau^w_{t+1} w_{t+1} d\ell_{ot+1}}{1+r^*}\right].\end{aligned} \tag{25}$$

The differences compared to (18) are obvious. The change in the "gross" corporate tax revenue (dT^c_{ot}) is shared by the young and old generation in proportion to their respective labor supply. The change in the corporate tax subsidy (dT^c_{yt}) affects the generation born in period t now in proportion to their labor supply in the next period. In the second bracket again the initial asset price revaluation appears as well as the change in the "indirect" marginal product of capital and the change in the marginal costs of capital. The young generation in t owns no capital at the time of the policy change. Consequently all price effects will affect the income of this generation via their impact on the wage rate in both living periods.

In a small open economy the adjustment in the first period differs from all future periods. Furthermore changes in the corporate tax subsidy and the marginal costs

of capital in period $s \geq t$ are shared by the young and old generation in period $s+1$. To see this we have to decompose the welfare effects for the generations born in year $s > t$,

$$\begin{aligned}\frac{\mathrm{d}U_s}{\lambda_s} = &-\left[\mathrm{d}T^p_{ys} + \alpha_{ys}\Big(\mathrm{d}T^c_{os} + (1+r^*)\mathrm{d}T^c_{ys-1}\Big) + \alpha_{os+1}\mathrm{d}T^c_{ys} + \frac{\mathrm{d}T^p_{os+1} + \alpha_{os+1}\mathrm{d}T^c_{os+1}}{1+r^*}\right] \\ &+\left[\alpha_{ys}k_s\Big(\mathrm{d}\Psi_{is} - \mathrm{d}\Psi_{k_s} - (1+r^*)\mathrm{d}\Psi_{i_{s-1}}\Big) - \alpha_{os+1}k_{s+1}\mathrm{d}\Psi_{i_s}\right. \\ &\left.+\frac{\alpha_{os+1}k_{s+1}(\mathrm{d}\Psi_{i_{s+1}} - \mathrm{d}\Psi_{k_{s+1}})}{1+r^*}\right] - \left[\alpha_{ys}\Big((1+r^*)\tau^c_{s-1}e^a_{s-1} - \tau^c_s f^a_{k_s}\Big)\mathrm{d}k_s\right. \\ &\left.+\alpha_{os+1}\tau^c_s e^a_s \mathrm{d}k_{s+1} + \tau^w_s w_s \mathrm{d}\ell_{ys} - \frac{\alpha_{os+1}\tau^c_{s+1}f^a_{k_{s+1}}\mathrm{d}k_{s+1} - \tau^w_{s+1}w_{s+1}\mathrm{d}\ell_{os+1}}{1+r^*}\right].\end{aligned} \tag{26}$$

In equation (26) the initial wealth effect disappears from the second bracket for generations born after the implementation of the reform. Furthermore part of the tax subsidy change and the change in marginal costs of the previous period is shifted to them and therefore interest payments have to be included.

The required intergenerationally neutral transfer payments are now

$$\begin{aligned}Tr_{ot} &= \mathrm{d}T^p_{ot} + \alpha_{ot}\Big[\mathrm{d}T^c_{ot} - k_t(\mathrm{d}\Psi_{i_t} - \mathrm{d}\Psi_{k_t})\Big] - (s^h_t - \alpha_{ot})(1+r^*)k_t\mathrm{d}q_t; \\ Tr_{yt} &= \mathrm{d}T^p_{yt} + \alpha_{yt}\Big[\mathrm{d}T^c_{ot} - k_t(\mathrm{d}\Psi_{i_t} - \mathrm{d}\Psi_{k_t})\Big] - \alpha_{ot+1}\Big[\mathrm{d}T^c_{yt} - k_{t+1}\mathrm{d}\Psi_{i_t}\Big] \\ &\quad +\alpha_{yt}(1+r^*)k_t\mathrm{d}q_t; \\ Tr^*_t &= -(1-s^h_t)(1+r^*)k_t\mathrm{d}q_t \\ Tr_{os} &= \mathrm{d}T^p_{os} + \alpha_{os}\Big[\mathrm{d}T^c_{os} - k_s(\mathrm{d}\Psi_{i_s} - \mathrm{d}\Psi_{k_s})\Big]; \\ Tr_{ys} &= \mathrm{d}T^p_{ys} + \alpha_{ys}\Big[\mathrm{d}T^c_{os} - k_s(\mathrm{d}\Psi_{is} - \mathrm{d}\Psi_{ks})\Big] - \alpha_{ys}(1+r^*)\Big[\mathrm{d}T^c_{ys-1} - k_s\mathrm{d}\Psi_{i_{s-1}}\Big] \\ &\quad -\alpha_{os+1}\Big[\mathrm{d}T^c_{ys} - k_{s+1}\mathrm{d}\Psi_{i_s}\Big]\end{aligned}$$

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 (1993). 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 periods capital are redistributed in proportion to the next period's labor supply shares. Now the transfers don't add up to zero in every period, i.e.,

$$
\begin{aligned}
Tr_{ot} + Tr_{yt} + Tr_t^* &= \alpha_{yt+1}\left[\mathrm{d}T_{yt}^c - k_{t+1}\mathrm{d}\Psi_{i_t}\right] \\
Tr_{os} + Tr_{ys} &= -(1+r^*)\alpha_{ys}\left[\mathrm{d}T_{ys-1}^c - k_s\mathrm{d}\Psi_{i_{s-1}}\right] + \alpha_{ys+1}\left[\mathrm{d}T_{ys}^c - k_{s+1}\mathrm{d}\Psi_{i_s}\right].
\end{aligned}
$$

However, in every period $s > t$ the first term on the right-hand-side of the last equation discounted to period s-1 cancels out with the last term on the right-hand-side when the above equation is evaluated in period s-1. Therefore the present value of all transfers is still zero.

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 fiscal reforms and the associated changes in excess burdens. This is the issue which we now explore in the AK Model.

4. The simulation model and its parameters

The AK Model contains three sectors: households, firms, and government. The life cycle version of the model used in this study incorporates expensing of new capital and costs of adjusting the level of the capital stock. In addition to expensing, the government's policy instruments include corporate income and wage taxes.
The household sector 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 cohort are identical, economic opportunities differ only across cohorts. The model incorporates variable labor supply, including endogenous retirement whenever households would choose to demand more than one unit of leisure in a given period. Preferences over current and future consumption and leisure are governed by the CES utility function

$$
U = \frac{1}{1-1/\gamma}\sum_{j=1}^{55}(1-\delta)^{1-j}\left[c_j^{1-1/\rho} + \beta\ell_j^{1-1/\rho}\right]^{\frac{1-1/\gamma}{1-1/\rho}}. \tag{27}
$$

where δ is the "pure" rate of time preference, ρ is the intratemporal elasticity of substitution between consumption and leisure at each age j, γ is the intertemporal elasticity of substitution between consumption of different years, and β is the leisure preference parameter. Table 1 displays the parametrization of our model.
Since government spending does not enter into the utility function, changes in generations' utilities reflect only the incidence of the method of financing the spending. Agents are assumed to have perfect foresight and experience a realistic growth in their wages during their working years. This age-wage profile is separate from the general level of wages, the time path of which is determined in solving the model.

The model's production sector is characterized by perfectly competitive firms. The production function is CES. Since we ignore depreciation, gross investment i_s is always equal to net investment. We assume that the firms organization is geared to the "natural" growth rate n[8]. Total costs of installing new investment in year s are therefore

$$\Psi(i_s, k_s) = .5\ b \left[\frac{i_s}{k_s} - n\right]^2 k_s. \tag{28}$$

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. Higher or lower investment rates involve costly changes in the production process. Because these costs rise disproportionately with the difference between the investment rate and the natural growth rate, the firm will only gradually move the stock of capital toward its desired level. Figure 1 shows the relationship between the adjustment costs and the rate of investment given the parameter values of table 1. 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 (7) and (28) can be written as

$$\frac{i_s}{k_s} = n + \frac{1}{b}\left[\frac{q_{s+1}}{1 - e_s \tau_s^c} - 1\right]. \tag{29}$$

Equation (29) states that the investment ratio is a positive function of the market value of one unit of next periods 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.

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 in year 150. 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. Of course the decompositions in equations (16), (18) and (24)-(26) are only valid for infinitesimal changes in policy. To determine the generations' changes in utility, generational account and factor income arising from a finite policy change, one needs to integrate these equations over a dummy variable indicating the degree to which the policy reform is implemented. Fehr and Kotlikoff (1995) approximate

[8]For a similar approach see Summers (1981), Nielsen and Sørensen (1991) or Funke and Willenbockel (1994).

these integrals by simulating each policy reform in five steps and then add together the resulting changes in utility, generational account and factor income of each step. Since it does not materially affect the results we refrain from such a numerical integration and simulate each policy reform in one step[9]. Generations' changes in utility are divided by the post-policy reform marginal utility of income. Changes in generational account and factor income are calculated using the post-policy-reform interest rates to discount changes in net tax payment and factor income. In a second simulation we calculate the changes in generations' excess burden. Now the lump-sum redistribution authority compensates every generation for the changes in net tax payment and factor income. The resulting utility changes of this simulation are therefore solely due to behavioral reactions.
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 remaining lifetime expenditure on consumption and leisure in the initial steady-state.

5. Some illustrative simulation findings

This section considers the following questions: How important are efficiency effects compared to the intergenerational income effects of corporate tax policies? How do macroeconomic price repercussion effects compare to the changes in net tax burdens for different generations on the transition path and the new steady-state? How do policy pre-announcement and the openness of an economy alter the results?

In order to answer these questions we analyze the impact, dynamic and steady state effects of a tax reform stimulated by the "Draft Law for Improving Tax Conditions for Enhancing the Attractiveness of Germany as an Industrial Location in the European Single Market" ("Standortsicherungsgesetz") from December 1992 (see Deutscher Bundestag, 1992). The idea of this draft was to reduce the corporate tax rate and finance the revenue losses through reductions in depreciation allowances. Since Germany's corporate tax rate was extremely high compared to other countries the decrease in the tax rate was aimed to improve growth and international competitiveness. The government calculated a revenue loss of about 9 bill. DM in the initial year due to the reduced corporate tax rate which would be almost completely financed by revenue increases due to less generous tax deductions.
A number of studies have already analyzed this reform package. Schaden (1995, 100) compares the effective marginal tax rate before and after the reform. She concludes that the effective marginal tax burden will increase and therefore the reform is likely to decrease growth and competitiveness. Funke and Willenbockel (1994) simulate the effects of this policy on capital accumulation in the context of a partial equilibrium model which only considers the investment decision of the

[9]The initial policy experiments were also simulated in five steps similar to Fehr and Kotlikoff (1995). The percentage changes in utility, generational account and factor income differed from the one step procedure only in the second decimal place.

firm. Their calculations show a contractionary impact effect on investment due to early policy announcement, but a long-run positive effect on the capital stock. Our general equilibrium model features a similar parametrization of the policy parameters (see table 1). The corporate tax rate and the expensing rate of initial steady-state are directly derived from their data. The latter is calculated as the net present value of a hypothetical stream of depreciation allowances resulting from an investment of one unit of output[10]. This produces a steady-state value of Q - the effective price of investment - equal to 0.58[11]. The wage tax rate was defined as 30 percent, total tax revenues therefore constitute about 34 percent of total output, which is a reasonable figure for Germany.
After year zero we change the tax parameters and calculate the transition path and the new long-run equilibrium. The following two subsections describe our simulation results for the closed and the small open economy case.

5.1 The closed economy case

Endogenous corporate tax

The idea of the reform proposal was to decrease the corporate tax rate and finance the revenue loss through reductions in the depreciation allowances. In our first simulation we want to check whether such a policy would be feasible at all. We therefore decrease the expensing rate in year one from 75 to 72 percent and adjust the corporate tax endogenously to balance the budget. Table 2 reports initial steady-state (year 0) macro variables as well as the values of these variables during the economy's transition path.
Since the tax reform will increase net marginal profits, on impact the price of capital will increase, see equation (9). But at the same time marginal costs of investment will increase even more, therefore investment drops in the initial year. The older generations own the capital stock, consequently they experience a positive income effect. This redistribution towards the elderly will decrease aggregate savings and labor supply in the year of the policy reform. During the transition the lower investment rate will cause a decline in the capital stock from 96.9 to 93.3. This implies a decrease (increase) in labor (capital) productivity, which explains the fall in the the wage rate by 1 percent in the long-run and the increase in the marginal product of capital by 2 basis points. Note that although the net wage rate is decreasing, aggregate labor supply will slightly increase again after the initial year of the transition. The lower lifetime income of future generations will decrease their leisure consumption and increase aggregate labor supply. A decreasing capital stock also implies a shrinking tax base for the corporate tax. Consequently the

[10]The corporate tax rate also includes the trade tax rate. The expensing parameter does not take into account technical progress. Including this would result in a lower expensing rate, see Auerbach et al. (1991, 96). Calculations of e_t's for different OECD countries can also be found in OECD (1991, 69).

[11]Funke and Willenbockel (1994) start with an initial Q value of 0.62.

endogenous corporate tax rate is reduced in the year of the tax reform to 55 percent, then it rises again during the transition and finally converges to a long-run level even above the original one. As a first result we therefore note that it is not feasible in our model to decrease investment incentives and corporate taxes at the same time without altering any other taxes. Aggregate investment will fall, the tax base for the corporate tax therefore decreases during the transition. In order to preserve revenue neutrality the corporate tax rate has to be increased.

The welfare implications for the different generations are decomposed according to our formulas in table 3. The intergenerational income effects due to changes in generational accounts (multiplied by minus 1) and factor income are given in columns one and two respectively. Columns three and four contain the changes in utilities with and without intergenerational neutral transfers.

As already noted above, the simulated tax reform redistributes from young and future generations towards the older generations. The first column reveals the redistribution which is solely due to changes in net tax burdens. The lower corporate tax burden will cause an income increase for the oldest generation of 2.43 percent of their remaining lifetime resources, whereas the lower corporate tax subsidy implies a negative income effect for all generations younger than 20 years in the year of the tax reform and for all future generations. Since the corporate tax rate is increasing again during the transition, the tax subsidy will also increase. Consequently the generations born between year -10 and 0 of the transition are hurt the most. During the transition the increase in the corporate tax subsidy will tend to lower the net tax burdens of future generations again.

The second column of table 3 measures the welfare consequences of macroeconomic price repercussion effects following the redistribution of net tax burdens. The drop in income of younger generations will cause a short-run decline in the demand for capital, mirrored by the lower saving rate of table 2. Consequently the price of capital will fall which in turn hurts the older generations, while the younger generations experience a positive income effect at the time of the tax reform. During the transition capital is crowded out, resulting in lower wages which hurt generations in the long-run. In this simulation macroeconomic price repercussion effects will even outweigh the changes in net tax burdens in the new steady-state.

After eliminating the income effects, the changes in excess burdens of the third column of table 3 measure the additional distortions caused by the policy change. With accelerated tax depreciation the effective corporate tax rate will differ from the nominal rate. The drop in depreciation allowances will tend to raise the effective tax rate[12] while the decline in the nominal corporate tax rate will tend to decrease the effective tax rate. The combined effect of both the reduction in depreciation allowances and the nominal corporate tax rate on the effective corporate tax is therefore not clear. From the third colum of table 3 we notice that the tax reform

[12]This corresponds to the so called *taxation paradox* where an increase in the tax rate induces a firm to employ a higher stock of capital, see Sinn (1987, 145f.).

experiment causes an increase in the excess burdens for almost all generations. We therefore conclude that due to a higher effective tax rate after the reform the intertemporal distortions have increased. Not surprisingly the generations living in the new steady-state experience the strongest efficiency losses. Compared to the income effects they explain about 15-20 percent of the total utility change.

Since it is not possible in our model to decrease both investment incentives and corporate tax rates without altering any other taxes, all following simulations analyze a different tax experiment: we reduce investment incentives and the corporate tax rate but adjust now the wage tax to balance the budget.

Baseline simulation

Table 4 describes the macroeconomic adjustment to the new long-run equilibrium when the corporate tax rate is reduced - as in Fünke and Willenbockel (1994) - to 51 percent and the expensing rate is set to 72 percent starting in year one as in the previous experiment.
Due to the lower corporate tax rate the price of capital now increases strongly more compared to the first simulation. Since marginal costs of investment also jump up, the capital decumulation is even stronger and the wage tax has to increase during the transition. The dynamic adjustment of the capital stock and the price of capital is illustrated in figure 2, where the difference equations in k and q are derived from the equations (7) and (8) respectively. The initial steady-state equilibrium is given in E_0. The policy experiment shifts the $dk = 0$ curve upward, q jumps after the reform year to point A on the stable saddle path corresponding to the long-run equilibrium in E_1. Then the capital stock decumulates while at the same time the price of capital increases[13]. Aggregate labor supply will now be affected by income and price effects. Since the wage tax increases, the fall in labor supply in the first year is stronger compared to the previous experiment. During the transition the effect of the decreased lifetime income of future generations is balanced by the effect of the decreasing net wage rate. Labor supply will therfore only increase slightly.
The welfare effects in table 5 reveal that in this experiment the welfare redistribution towards the old is much more severe. This is mainly due to the changes in the generational accounts. While the tax burden of the older generations has decreased with the lower corporate tax rate, the tax burden of young and future generations rises with the wage tax. Generations living in the new steady-state are therefore hurt the most. Since the redistribution via changes in net tax burdens is stronger, macroeconomic price repercussions are also more severe. Due to the stronger reaction of the price of capital the older generations lose more on impact compared to the previous experiment, while in the long-run future generations are

[13]The policy reform will of course also shift the $dq = 0$ curve. On impact it will be shifted upward, while the increase in r will shift it back again. It is not clear which effect will dominate. For a discussion see Ho and Hoon (1995). For simplicity we keep the $dq = 0$ curve in the initial position.

hurt more due to the lower wage rate. Compared to table 3, generationally-specific efficiency losses are in general higher now which is due to the labor supply reactions. Note that the losses fall slightly during the transition. This reflects the fact already mentioned above, that future generations will decrease their labor supply less compared to generations living in the initial years of the tax reform.

Sensitivity Analysis

Table 6 reports some sensitivity analysis with respect to the adjustment cost parameter and the substitution elasticity between capital and labor in production. A higher or lower adjustment speed will only change the short-run welfare consequences. While the changes in the net tax burdens are hardly affected, the macroeconomic repercussion effects are dampend when adjustment costs are low. In this case the price of capital will fall only modestly due to the reduced savings[14].
Different substitution elasticities between labor and capital will have important short-run and long-run consequences. A lower (higher) elasticity of substitution implys a weaker (stronger) change in the capital intensities following the policy change. This results in a slower (faster) speed in the capital decumulation during the transition and a lower (higher) decrease in the long-run capital stock. Lower (higher) substitution elasticities therefore imply a slower (faster) shifting of the tax bases from corporate tax to wage taxes. Consequently the redistribution via changes in the net tax burdens is weaker (stronger) compared to the baseline simulation. Note that the oldest generation is not affected since the capital stock is fixed in the first year. Macroeconomic price repercussion effects do of course also increase with the substitution elasticities. A weaker (stronger) redistribution towards the elderly results in a less (more) severe fall of the price of capital and a weaker (stronger) crowding out of the long-run capital stock will result in a less (more) dramatic fall in long-run wages. Of course the substitution effects of the third column also increase with the substitution elasticities[15].

Announcement effects

Tax reforms are usually implemented with a considerable time-lag, consequently short-run effects of anticipated changes in tax regimes are an important question. With perfect foresight, preannounced changes in the future depreciation allowances and corporate tax rates will lead to immediate substitution responses. In this simulation we therefore assume - similar to Funke and Willenbockel (1994) - that investment incentives are reduced in year two but people already know of the reform in year one.
From table 7 we observe that - similar to the previous experiments - the market value of the future capital stock increases. Since the marginal costs of investment

[14]In the extreme case of no adjustment costs the price of capital will not change at all after changes in demand.

[15]The oldest generation is not working in the initial steady-state when $\sigma = 1.25$. They experience therefore no changes in excess burdens.

are not altered in year one when the policy is announced, investment will increase in the initial year. When the reform is implemented in the following year, investment falls sharply. Figure 2 explains the dynamic adjustment for the case of a preannounced policy. When the government announces the future tax reform the system starts to follow an unstable trajectory until in year two - when the policy takes effect - it reaches point B on the stable saddle path corresponding to the long-run equilibrium E_1. We therefore can observe an increasing capital stock immediately after the announcement and contraction after the implementation. Note that aggregate labor supply even increases slightly in the first year. Since the net wage rate is lower in future years individuals will increase their labor supply in year one and decrease it in the following periods.

The welfare effects are reported in table 8. While the long-run welfare changes are the same as in table 5, the short-run effects differ quite remarkably. The oldest generation now has to bear a higher tax burden, while at the same time the income effects due to price repercussions are positive. The increase of investment and labor supply in the first year drives up the direct and "indirect" marginal product of capital which in turn increases both the corporate tax burden and the factor income of the oldest generation, see equation (16). For the other generations policy announcement dampens the income redistribution in the short-run. Since the reduction in the tax burdens of older generations is now delayed by one year, the present value of the tax burden change is smaller. Given the reduced redistribution via net tax burdens repercussion effects through factor price changes will be dampened as well.

This completes our analysis for the closed economy case. In the following simulations we start with the initial steady-state of the closed economy, but assume that the interest rate is now fixed by the world capital market.

5.2 The small open economy case

Macroeconomic effects of corporate tax reforms in small open economies with adjustment costs are analyzed in Nielsen and Sørensen (1991), Sen and Turnovsky (1990) and Bovenberg (1993). We therefore don't explain all the details of the adjustment process and concentrate on the differences in the welfare effects compared to the closed economy case.

Baseline Simulation

Table 9 reports the adjustment to the long-run equilibrium when investment incentives and corporate taxes are decreased in a small open economy. The rate of return is now fixed, consequently the present value of net marginal profits increases more compared to the closed economy, which explains the sharper increase in the price of capital of table 9 (compared to table 4). In order to maintain the asset market equilibrium, the price of domestic shares will immediately jump upwards in the first period. Contrary to the closed economy, investment now increases, since

the increase in Q overcompensates the increase in the marginal costs of investment. Higher investment will decrease the corporate tax base, consequently the wage tax has to increase much more strongly and labor supply will fall further compared to the closed economy case. Higher investment, higher consumption of the old and the reduced output (due to reduced labor supply) will cause an immediate current account deterioration. As capital intensity grows during the transition, the marginal product of capital will fall, thereby gradually driving back the price of capital and investment to their long-run values. This is illustrated in figure 3 where the economy again starts at the initial steady-state E_0. Since the interest rate is now fixed, the policy change will shift the $dq = 0$ curve to the right. When the government introduces the new policy, the system jumps to point A and follows the stable saddle path to the new long-run equilibrium E_1. The resulting rise in real wages during the transition will induce workers to substitute labor for consumption, aggregate labor supply therefore increases now much more strongly than in table 4. Consequently the gross national product will rise during the transition and the current account improves again.

The welfare effects of table 10 show that the reduction of the net tax burden for the old is now much smaller than in the closed economy case. Since the reduction of corporate taxes is shared in proportion to the labor supply - compare equation (24)- the older generations only receive modest gains from that. On the contrary the losses of middle aged generation due to increased wage taxes are now dampened by the reduced corporate tax burden. While in the closed economy case the net tax burden is increasing during the transition, now the net tax burden is decreasing due to the falling wage tax. The changes in factor income of the second column now include the initial wealth revaluation. As pointed out above this effect depends on the difference between the respective generations' ownership of initial capital and labor supply share. We assume that domestic residents own the total domestic capital stock ($s_t^h = 1$), older generations will therefore gain strongly while younger generations will lose[16]. It is clear that this income effect only applies to the generations living in the initial year of the tax reform. Generations born after the reform year experience very modest losses, in the long-run the changes in the "indirect" marginal product of capital and marginal cost changes completely offset each other. The changes in the excess burdens of the third column are therefore mainly due to labor supply responses. Since aggregate labor supply drops in the initial year and then increases during the transition even slightly above the initial steady-state level, the efficiency losses peak for the oldest generation and decline to zero for future generations. If we finally add up the different components and compare the overall welfare effects of tables 10 and 5 we see that the older generations are gaining considerably more in a small open economy but their welfare

[16]We also run a simulation with $s_t^h = 0$. In this case the changes in factor income show a negative sign for the old generations. Labor supply, savings and investment is higher compared to $s_t^h = 1$, the shifting of tax burden from old to middle aged generations is therefore less severe. The long-run and the efficiency effects are of course the same.

improvements are more at the expense of middle aged generations. The welfare losses of future generations are less severe in a small open economy compared to the closed economy case.

Sensitivity Analysis

Table 11 again reports the sensitivity analysis experiments. A higher or lower adjustment speed has now almost no effect on short-run welfare consequences. The price of capital increases more when adjustment costs are high, but these price effects seem to be very modest. Again the changes in net tax burdens are almost not affected.

A lower (higher) elasticity of substitution implys a weaker (stronger) change in the capital intensities following the policy change. Lower (higher) substitution elasticities therefore imply a slower (faster) shifting of the tax bases from corporate tax to wage taxes. Consequently the redistribution via changes in the net tax burdens is weaker (stronger) compared to the baseline simulation[17]. Again, macroeconomic price repercussion effects increase with the degree of the redistribution through changes in net tax burdens and the efficiency losses of the older generations are stronger in the case of a high substitution elasticity.

Announcement effects

Next we assume that the policy change is preannounced one year before it is implemented. Table 12 reports the resulting macroeconomic effects. The sharp increase in the price of capital which is not counterbalanced by an increase in the marginal costs of investment in the initial year will cause a dramatic jump in investment in the year of the policy announcement. The sharp increase in investment is mirrored by a 5 percent increase in the wage tax to balance the budget, resulting in an even stronger fall in labor supply (compared to table 9). Notice that the initial jump in the price of capital is less compared to the previous experiment of table 9. Anticipating future capital gains on shares, investors start buying domestic shares, resulting in an immediate jump in q from point E_0 to B in figure 3. Then the system follows an unstable pattern until in year two – when the policy is implemented – it reaches point C on the stable saddle path to the new long-run equilibrium[18]. When the policy is implemented in year two investment falls back, consequently the wage tax could be decreased by 3 percent and aggregate labor supply jumps up. After year two aggregate labor supply will rise toward its long-run level due to the net wage rate increase.

When comparing the changes in the net tax burdens of tables 10 and 13 we notice that – in contrast to the closed economy – the policy pre-announcement has no

[17]When $\sigma = 1.25$ the oldest generation is not working in the initial steady-state. This generation therefore experiences no changes in either the personal or the corporate tax burden.

[18]See Nielsen and Sørensen (1991) for similar short-run anticipation effects when the investment tax credit is increased.

effect on the net tax burden changes for the oldest generations. Without preannouncement, the corporate tax burden for the oldest generation will fall while the personal tax burden will increase slightly. When the policy is preannounced the corporate tax burden will increase in the first year but now labor supply will fall dramatically thereby decreasing the personal tax burden. The redistribution from middle aged generations to the older generations is less severe when the policy is anticipated. Since the capital stock is now higher after year one of the transition the corporate tax burden for the older generations has increased (compared to table 10). On the contrary since the wage tax rate is now lower after year one (compare table 12 and table 9), generations born right after the implementation have to pay now lower taxes. The modest initial increase in the price of capital also explains the less severe income effects of the second column. Finally we notice the extreme efficiency loss for the oldest generation in the third column. Since the wage tax is increasing by 5 percent the oldest generation will dramatically reduce its labor supply. The other generations of course reduce their labor supply as well on impact, but in the next period they will increase it again. Their aggregate efficiency loss is therefore much smaller.

6. Conclusion

The paper studies the generational incidence of corporate tax policies. Intergenerational income effects are decomposed into changes in net tax payments (i.e. generational accounts) and changes in factor income. The generational-specific substitution effects are isolated by compensating the income effects of every generation along the transition. For a quantitative assessment, we simulate a policy change which was stimulated by a recent German corporate tax reform plan in a general equilibrium model. Specifically we consider a reduction in depreciation allowances and the corporate tax rate financed by a revenue neutral adjustment in wage taxes.

The macroeconomic adjustment differs sharply whether we assume a closed or a small open economy. In the closed economy the capital stock will fall during the transition, decreasing output and wages. Since the tax reform redistributes towards the older generations savings will decline. In the small open economy the tax reform will result in an inflow of foreign capital leading to a deterioration of the current account. The capital stock will therefore increase during the transition and wages go up. This is the intention of the reform package and the long-run results are similar to those of Funke and Willenbockel (1994) who also assume a constant interest rate[19].

The welfare effects of our simulations reveal that such a policy has very negative consequences for future generations. In all our simulations welfare is redistributed

[19]The short-run effects of our simulations differ sharply from the calculations of Funke and Willenbockel (1994). They report sharp short-run decreases in investment even in the case of an isolated preannounced reduction of investment incentives.

from the younger and future generations towards the current older generations. Since the adjustment speed is faster in a small open economy, the younger generations at the time of the policy implementation are more hurt in a small open economy while future generations are worse off in the closed economy case. Comparing substitution and income effects we find that the income effects are the main cause of the welfare redistribution. Although labor supply is endogenous substitution effects explain not more than 10-15 percent of the welfare change. Decomposing the income effects into changes in net tax burdens and price effects we find that in the closed economy changes in the net tax burdens seem to dominate while in the small open economy the income redistribution mainly works through the initial asset price revaluation. Of course these results only apply to the specific tax reform considered. If the corporate tax is endogenously adjusted then the income effects through factor price changes dominate the changes in the net tax burdens.
In general our simulations highlight the importance of the general equilibrium formulation. Increasing the capital stock alone does not automatically imply a welfare improvement of future generations.

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Appendix A

In this appendix we first want to derive the optimality conditions (6)-(8) and then show that the marginal q_t is equal to the average Q_t, i.e.

$$q_t = \frac{V_t}{k_t} = Q_t. \tag{A-1}$$

Firm value (per capita) being V_t the total income from firm ownership includes capital gains $[V_{t+1} - V_t]$ and dividend payments. For simplicity we refrain from personal capital income taxation. Since all assets must earn a return equal to the market rate of interest, arbitrage behavior dictates

$$r_t V_t = \chi_t + V_{t+1} - V_t.$$

By forward solution, and imposing the transversality condition

$$\lim_{T\to\infty} V_{T+1} d_{T,t} = 0; \qquad \text{with} \qquad d_{T,t} = \prod_{u=t}^{T} (1 + r_u)^{-1}$$

the market value of the firm is obtained by

$$V_t = \sum_{s=t}^{\infty} \chi_s d_{s,t}. \tag{A-2}$$

The value of the firm is the present value of the future stream of dividend payments to the owners. The optimization problem for the managers of the firm is

$$\max_{l_s, i_s} V_t = \sum_{s=t}^{\infty} \chi_s d_{s,t} \qquad \text{s.t.} \quad k_{s+1} - k_s = i_s$$

To solve the intertemporal problem we set up the following Lagrange function:

$$\mathcal{L} = \sum_{s=t}^{\infty} \left\{ \chi_s d_{s,t} + \tilde{q}_{s+1} \left[i_s + k_s - k_{s+1} \right] \right\} \quad \text{with} \quad \tilde{q}_{s+1} = q_{s+1} d_{s,t}$$

The variable q_{s+1} and $\tilde{q}_{s+1}$ denote the current and the present value multiplier of the state variable k_{s+1} respectively. While the value of q_{s+1} is the marginal value at time $s+1$ of an additional unit of capital at time $s+1$, $\tilde{q}_{s+1}$ denotes the marginal value at time t. Necessary and sufficient conditions for a maximum are

$$\frac{\partial \mathcal{L}}{\partial l_s} = 0; \quad \Longrightarrow \quad w_s = f_{l_s} \tag{A-3}$$

$$\frac{\partial \mathcal{L}}{\partial i_s} = 0; \quad \Longrightarrow \quad q_{s+1} = (1 - e_s \tau_s^c) \left[1 + \Psi_{i_s} \right] \tag{A-4}$$

$$\frac{\partial \mathcal{L}}{\partial k_s} = 0; \quad \Longrightarrow \quad q_{s+1} - q_s = r_s q_s - (1 - \tau_s^c) f_{k_s} + (1 - e_s \tau_s^c) \Psi_{k_s} \tag{A-5}$$

$$\lim_{T\to\infty} k_{T+1}\tilde{q}_{T+1} = \lim_{T\to\infty} q_{T+1}k_{T+1}d_{T,t} = 0. \tag{A-6}$$

Hayashi (1982) has shown that - given our homogeneity assumptions - marginal q_t is equal to the average asset price Q_t. For our model formulation we will reproduce Hayashi's proof in the following. We start with the discounted difference in capital along the optimal path.

$$q_{s+1}k_{s+1}d_{s,t} - q_s k_s d_{s-1,t} = \Big[q_{s+1}k_{s+1} - q_s k_s(1+r_s)\Big] d_{s,t}$$

$$\begin{aligned}
&= \Big[q_{s+1}\Big(k_{s+1} - k_s\Big) + k_s\Big(q_{s+1} - q_s\Big) - r_s q_s k_s\Big] d_{s,t} \\
&= \Big[(1-e_s\tau_s^c)[1+\Psi_{i_s}]i_s + k_s\Big(r_s q_s - (1-\tau_s^c)f_{k_s} + (1-e_s\tau_s^c)\Psi_{k_s}\Big) - r_s q_s k_s\Big] d_{s,t} \\
&\quad \text{by (A-4) and (A-5)} \\
&= -\Big[(1-\tau_s^c)[y_s - w_s l_s] - (1-e_s\tau_s^c)[i_s + x_s]\Big] d_{s,t} \quad \text{by (11) and (12)} \\
&= -\chi_s\, d_{s,t} \quad \text{by (5)}
\end{aligned}$$

Repeatedly applying

$$q_{s+1}k_{s+1}(1+r_s)^{-1} = q_s k_s - \chi_s(1+r_s)^{-1}$$

starting at time t and taking the limit $T \to \infty$ yields

$$\lim_{T\to\infty} q_{T+1}k_{T+1}d_{T,t} = q_t k_t - \sum_{s=t}^{\infty} \chi_s d_{s,t}.$$

Using the transversality condition (A-6) and the definition of the firm value (A-2) we can directly deduce the equality (A-1).

Appendix B

In this appendix the first-order conditions for the consumers maximization problem are presented and then the decomposition of the welfare changes is derived. We start in the closed economy. To solve the optimization problem of the old generation we set up the following Lagrange function:

$$\mathcal{L}_{t-1} = U(c_{ot}, \ell_{ot}) - \lambda_{t-1} \left[c_{ot} - (1 + r_t)q_t k_t - w_t(1 - \tau_t^w)(1 - \ell_{ot}) \right] . \tag{B-1}$$

The first-order conditions for this problem are:

$$\frac{\partial \mathcal{L}_{t-1}}{\partial c_{ot}} = 0; \quad \Longrightarrow \quad \frac{\partial U}{\partial c_{ot}} = \lambda_{t-1} \tag{B-2}$$

$$\frac{\partial \mathcal{L}_{t-1}}{\partial \ell_{ot}} = 0; \quad \Longrightarrow \quad \frac{\partial U}{\partial \ell_{ot}} = \lambda_{t-1} w_t (1 - \tau_t^w) \tag{B-3}$$

Using (B-2) and (B-3) in (14) gives (15). Differentiating equation (13) and using the differential of (7) gives

$$\begin{aligned} \mathrm{d}c_{ot} = & \left[\mathrm{d}\Psi_{i_t} + \mathrm{d}f_{k_t} - \mathrm{d}\Psi_{k_t} - \mathrm{d}(\tau_t^c f_{k_t}^a) \right] k_t + \left[\mathrm{d}w_t - \mathrm{d}(\tau_t^w w_t) \right] (1 - \ell_{ot}) \\ & - w_t(1 - \tau_t^w)\mathrm{d}\ell_{ot}. \end{aligned} \tag{B-4}$$

We have already used the fact that in the first period the capital stock is fixed. Now substituting the differentials of T_{ot}^p and T_{ot}^c into equation (B-4) and rearranging the terms we get

$$\begin{aligned} \mathrm{d}c_{ot} = & - \left[\mathrm{d}T_{ot}^p + \mathrm{d}T_{ot}^c \right] + \left[\mathrm{d}\Psi_{i_t} + \mathrm{d}f_{k_t} - \mathrm{d}\Psi_{k_t} \right] k_t + \mathrm{d}w_t(1 - \ell_{ot}) \\ & - \tau_t^w w_t \mathrm{d}\ell_{ot} - w_t(1 - \tau_t^w)\mathrm{d}\ell_{ot}. \end{aligned} \tag{B-5}$$

Using this definition in equation (15) directly leads to the decomposition in equation (16). Next we turn to the generations born in and after the year of the policy change. Their optimization problem is captured by the following Lagrange function:

$$\begin{aligned} \mathcal{L}_s = U(c_{ys}, \ell_{ys}, c_{os+1}, \ell_{os+1}) - \lambda_s \Bigg[& c_{ys} + \frac{c_{os+1}}{1 + r_{s+1}} - (1 - \ell_{ys}) w_s (1 - \tau_s^w) \\ & - \frac{(1 - \ell_{os+1}) w_{s+1} (1 - \tau_{s+1}^w)}{1 + r_{s+1}} \Bigg]. \end{aligned} \tag{B-6}$$

The first-order conditions for this problem are:

$$\frac{\partial \mathcal{L}_s}{\partial c_{ys}} = 0; \quad \Longrightarrow \quad \frac{\partial U}{\partial c_{ys}} = \lambda_s \tag{B-7}$$

$$\frac{\partial \mathcal{L}_s}{\partial \ell_{ys}} = 0; \quad \Longrightarrow \quad \frac{\partial U}{\partial \ell_{ys}} = \lambda_s w_s (1 - \tau_s^w) \tag{B-8}$$

$$\frac{\partial \mathcal{L}_s}{\partial c_{os+1}} = 0; \quad \Longrightarrow \quad \frac{\partial U}{\partial c_{os+1}} = \frac{\lambda_s}{1 + r_{s+1}} \tag{B-9}$$

$$\frac{\partial \mathcal{L}_s}{\partial \ell_{os+1}} = 0; \quad \Longrightarrow \quad \frac{\partial U}{\partial \ell_{os+1}} = \frac{\lambda_s w_{s+1}(1 - \tau_{s+1}^w)}{1 + r_{s+1}} \tag{B-10}$$

Using (B-7) - (B-10) in the total differential of (1) gives (17). Differentiating the budget constraint (2) and substituting the budget constraint of the second period we get

$$\begin{aligned}
&\mathrm{d}c_{ys} + w_s(1 - \tau_s^w)\mathrm{d}\ell_{ys} + \frac{\mathrm{d}c_{os+1} + w_{s+1}(1 - \tau_{s+1}^w)\mathrm{d}\ell_{os+1}}{1 + r_{s+1}} = \\
&=(1 - \ell_{ys}) \left[\mathrm{d}w_s - \mathrm{d}(\tau_s^w w_s) \right] + \frac{(1 - \ell_{os+1}) \left[\mathrm{d}w_{s+1} - \mathrm{d}(w_s \tau_s^w) \right] + q_{s+1} k_{s+1} \mathrm{d}r_{s+1}}{1 + r_{s+1}} \\
&=(1 - \ell_{ys}) \left[\mathrm{d}w_s - \mathrm{d}(\tau_s^w w_s) \right] - k_{s+1} \left[\mathrm{d}\Psi_{i_s} - \mathrm{d}(\tau_s^c e_s^a) \right] + \\
&\frac{(1 - \ell_{os+1}) \left[\mathrm{d}w_{s+1} - \mathrm{d}(w_s \tau_s^w) \right] + k_{s+1} \left[\mathrm{d}f_{k_{s+1}} + \mathrm{d}\Psi_{i_{s+1}} - \mathrm{d}\Psi_{k_{s+1}} - \mathrm{d}(\tau_{s+1}^c f_{k_{s+1}}^a) \right]}{1 + r_{s+1}}
\end{aligned}$$

In the second step we have used the differentials of (7) and (8). Now we substitute on the right hand side of the above equation the differentials of $T_{ys}^p, T_{ys}^c, T_{os+1}^p$ and T_{os+1}^c. After rearranging the terms we end up with the final decomposition in equation (18).

In the small open economy we start with equation (23). The differential of the modified arbitrage condition (8) now is

$$\mathrm{d}f_{k_t} = (1 + r^*)\mathrm{d}q_t + \mathrm{d}\Psi_{k_t} - \mathrm{d}\Psi_{i_t} + \mathrm{d}(\tau_t^c f_{k_t}^a). \tag{B-11}$$

Next we multiply on both sides with k_t and substitute into this equation the differential of $\mathrm{d}T_{ot}^c$. Now replacing the wage change in equation (23) directly gives - after rearranging - equation (24). For generations born in the year of the policy reform the differential of their budget constraint (2) now yields

$$\begin{aligned}
&\mathrm{d}c_{yt} + w_t(1 - \tau_t^w)\mathrm{d}\ell_{yt} + \frac{\mathrm{d}c_{ot+1} + w_{t+1}(1 - \tau_{t+1}^w)\mathrm{d}\ell_{ot+1}}{1 + r^*} = \\
&(1 - \ell_{yt}) \left[\mathrm{d}w_t - \mathrm{d}(\tau_t^w w_t) \right] + \frac{(1 - \ell_{ot+1}) \left[\mathrm{d}w_{t+1} - \mathrm{d}(\tau_{t+1}^w w_{t+1}) \right]}{1 + r^*}
\end{aligned} \tag{B-12}$$

This identity is used to replace the right hand side of equation (17). Now we substitute the differential of the personal tax payments and the right hand side of equation (B-11) and get after rearranging equation (25). The same steps are applied to future generations in order to derive equation (26).

Table 1
Parametrization of the Model

Preference and Technology Parameters	
Intertemporal elasticity of substitution (γ)	0.25
Intratemporal elasticity of substitution (ρ)	0.8
Pure rate of time preference (δ)	0.015
Leisure preference pameter (β)	1.5
Population growth rate (n)	0.015
Elasticity of substitution between capital and labor (σ)	1.0
Capital share in income	0.25
Adjustment cost parameter (b)	7.5
Policy variables of initial Steady-state	
Corporate tax rate (τ^c)	0.56
Wage tax rate (τ^w)	0.30
Investment tax credit rate (e)	0.75

Source: Auerbach and Kotlikoff (1987)
Funke und Willenbockel (1994)

Figure 1
Adjustment costs (in percent of investment)

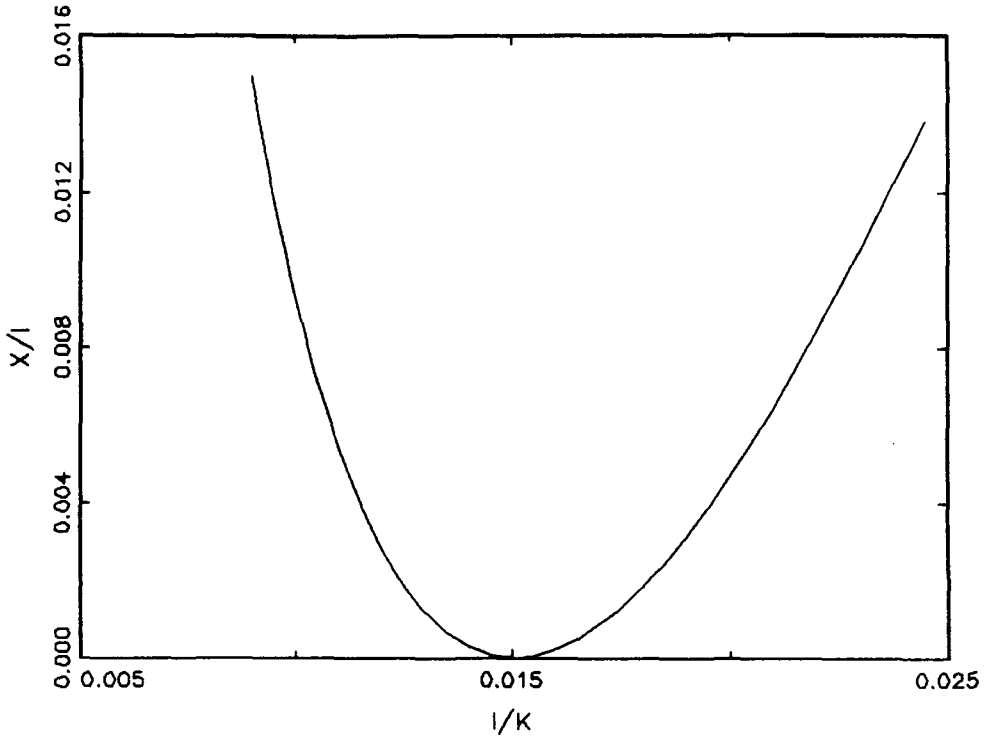

Table 2
Reduction of Investment Incentives (Endogenous Corporate Tax)
The Transition Path

Year	*Invest-ment*	*Capital*	*Labor*	*Output*	*Wage*	F_K	*Q*	*Corporate Tax Rate*	*Saving Rate*
0	1.45	96.89	18.60	24.80	1.000	0.064	0.580	0.560	0.055
1	1.29	96.89	18.51	24.71	1.001	0.064	0.580	0.550	0.050
2	1.30	96.73	18.51	24.70	1.001	0.064	0.597	0.550	0.050
3	1.30	96.58	18.52	24.70	1.000	0.064	0.597	0.551	0.050
4	1.30	96.43	18.52	24.69	1.000	0.064	0.596	0.551	0.050
5	1.31	96.29	18.53	24.69	0.999	0.064	0.596	0.552	0.050
10	1.32	95.67	18.55	24.67	0.998	0.064	0.596	0.554	0.054
20	1.35	94.77	18.58	24.65	0.995	0.065	0.595	0.558	0.055
60	1.39	93.55	18.63	24.61	0.991	0.066	0.594	0.564	0.054
∞	1.40	93.34	18.64	24.61	0.990	0.066	0.593	0.565	0.054

Table 3
Reduction of Investment Incentives (Endogenous Corporate Tax)
Decomposing Generations' Utility Changes
(changes, expressed as percent of remaining lifetime expenditures)

Generation's Year of Birth	*Generational Account*	*Factor Income*	*Excess Burden*	*Generation's Utility*
-54	2.43	-0.92	0.01	1.26
-50	2.05	-0.73	0.00	1.08
-45	1.60	-0.50	-0.01	0.87
-40	1.18	-0.29	-0.02	0.68
-35	0.80	-0.11	-0.03	0.49
-30	0.47	0.03	-0.04	0.33
-25	0.20	0.14	-0.04	0.18
-20	-0.01	0.20	-0.05	0.05
-15	-0.16	0.23	-0.05	0.06
-10	-0.25	0.22	-0.05	-0.13
-5	-0.27	0.17	-0.05	-0.18
0	-0.24	0.11	-0.04	-0.20
5	-0.22	0.06	-0.05	-0.24
10	-0.20	0.00	-0.05	-0.28
20	-0.18	-0.08	-0.06	-0.34
50	-0.14	-0.18	-0.07	-0.42
∞	-0.13	-0.21	-0.07	-0.44

Table 4
Corporate Tax Reform: Base Case
The Transition Path

Year	Investment	Capital	Labor	Output	Wage	F_K	Q	Wage Tax Rate	Saving Rate
0	1.45	96.89	18.60	24.80	1.000	0.064	0.580	0.300	0.059
1	1.25	96.89	18.35	24.55	1.003	0.063	0.580	0.314	0.051
2	1.26	96.69	18.35	24.54	1.003	0.063	0.623	0.314	0.051
3	1.26	96.50	18.35	24.53	1.002	0.064	0.623	0.314	0.051
4	1.26	96.31	18.36	24.52	1.002	0.064	0.624	0.314	0.052
5	1.27	96.13	18.36	24.51	1.001	0.064	0.624	0.315	0.052
10	1.28	95.32	18.37	24.47	0.999	0.064	0.625	0.316	0.052
20	1.31	94.09	18.40	24.42	0.995	0.065	0.628	0.317	0.054
60	1.35	91.94	18.44	24.31	0.989	0.066	0.631	0.320	0.056
∞	1.37	91.05	18.45	24.27	0.987	0.067	0.633	0.321	0.056

Table 5
Corporate Tax Reform: Base Case
Decomposing Generations' Utility Changes
(changes, expressed as percent of remaining lifetime expenditures)

Generation's Year of Birth	Generational Account	Factor Income	Excess Burden	Generation's Utility
-54	5.05	-1.18	-0.15	3.52
-50	4.89	-0.99	-0.14	3.22
-45	4.28	-0.73	-0.13	2.83
-40	3.57	-0.49	-0.13	2.38
-35	2.81	-0.26	-0.12	1.89
-30	2.04	-0.07	-0.12	1.37
-25	1.30	0.08	-0.12	0.87
-20	0.62	0.18	-0.11	0.39
-15	0.04	0.24	-0.11	-0.02
-10	-0.41	0.26	-0.12	-0.36
-5	-0.71	0.24	-0.12	-0.61
0	-0.84	0.18	-0.12	-0.75
5	-0.86	0.12	-0.12	-0.83
10	-0.88	0.05	-0.11	-0.92
20	-0.91	-0.05	-0.11	-1.05
50	-0.96	-0.19	-0.10	-1.23
∞	-0.99	-0.29	-0.10	-1.36

Figure 2
Dynamic Adjustment in a Closed Economy

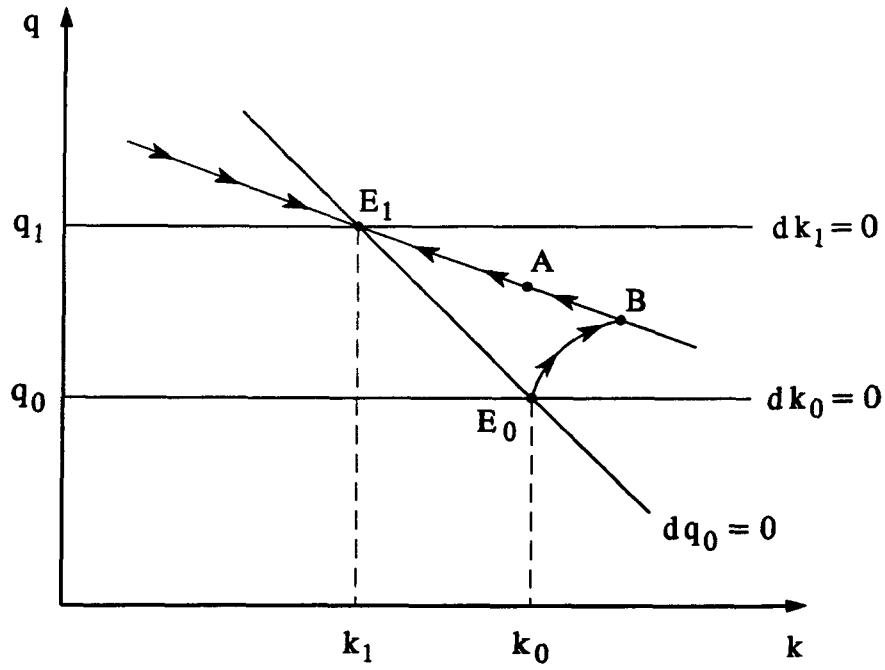

Table 6
Corporate Tax Reform: Sensitivity Analysis
Decomposing Generations' Utility Changes
(changes, expressed as percent of remaining lifetime expenditures)

Generation's Year of Birth	*Generational Account*	*Factor Income*	*Excess Burden*	*Generation's Utility*
		$b = 5$		
-54	4.95	-0.90	-0.15	3.73
-40	3.55	-0.36	-0.13	2.48
-25	1.30	0.10	-0.11	0.88
-10	-0.40	0.24	-0.12	-0.38
0	-0.84	0.16	-0.12	-0.78
10	-0.88	0.02	-0.11	-0.95
50	-0.97	-0.21	-0.10	-1.26
∞	-0.99	-0.29	-0.10	-1.36
		$b = 10$		
-54	5.14	-1.42	-0.15	3.34
-40	3.58	-0.60	-0.13	2.31
-25	1.29	0.05	-0.12	0.85
-10	-0.42	0.27	-0.12	-0.35
0	-0.85	0.20	-0.12	-0.73
10	-0.88	0.08	-0.12	-0.89
50	-0.96	-0.17	-0.10	-1.21
∞	-0.99	-0.29	-0.10	-1.36
		$\sigma = 0.75$		
-54	4.61	-0.92	-0.08	3.08
-40	2.90	-0.32	-0.07	2.04
-25	0.97	0.11	-0.06	0.74
-10	-0.28	0.20	-0.06	-0.21
0	-0.47	0.10	-0.07	-0.43
10	-0.48	0.02	-0.06	-0.52
50	-0.50	-0.11	-0.05	-0.66
∞	-0.51	-0.14	-0.05	-0.70
		$\sigma = 1.25$		
-54	4.60	-1.38	0.00	3.52
-40	4.17	-0.66	-0.18	2.75
-25	1.63	0.05	-0.18	1.01
-10	-0.58	0.33	-0.19	-0.56
0	-1.31	0.27	-0.20	-1.15
10	-1.41	0.10	-0.19	-1.42
50	-1.63	-0.31	-0.17	-2.01
∞	-1.76	-0.57	-0.17	-2.37

Table 7
Corporate Tax Reform: Policy Pre-announcement
The Transition Path

Year	*Investment*	*Capital*	*Labor*	*Output*	*Wage*	F_K	*Q*	*Wage Tax Rate*	*Saving Rate*
0	1.45	96.89	18.60	24.80	1.000	0.064	0.580	0.300	0.059
1	1.78	96.89	18.75	24.95	0.998	0.064	0.580	0.304	0.071
2	1.26	97.21	18.35	24.57	1.004	0.063	0.595	0.313	0.051
3	1.26	97.01	18.35	24.56	1.004	0.063	0.623	0.314	0.051
4	1.26	96.82	18.35	24.55	1.003	0.063	0.623	0.314	0.052
5	1.27	96.63	18.36	24.54	1.003	0.063	0.624	0.314	0.052
10	1.28	95.78	18.37	24.50	1.000	0.064	0.625	0.315	0.052
20	1.31	94.46	18.39	24.44	0.996	0.065	0.627	0.317	0.054
60	1.35	92.05	18.43	24.32	0.989	0.066	0.631	0.320	0.056
∞	1.37	91.05	18.45	24.27	0.987	0.067	0.633	0.321	0.056

Table 8
Corporate Tax Reform: Policy Pre-announcement
Decomposing Generations' Utility Changes
(changes, expressed as percent of remaining lifetime expenditures)

Generation's Year of Birth	*Generational Account*	*Factor Income*	*Excess Burden*	*Generation's Utility*
-54	-0.46	1.84	-0.09	1.08
-50	3.60	-0.46	-0.04	2.59
-45	3.62	-0.57	-0.04	2.46
-40	3.18	-0.46	-0.04	2.13
-35	2.59	-0.31	-0.05	1.73
-30	1.94	-0.15	-0.06	1.28
-25	1.29	-0.01	-0.08	0.84
-20	0.68	0.10	-0.09	0.41
-15	0.14	0.17	-0.11	0.04
-10	-0.29	0.21	-0.12	-0.28
-5	-0.59	0.22	-0.13	-0.51
0	-0.75	0.19	-0.14	-0.65
5	-0.85	0.16	-0.11	-0.78
10	-0.87	0.09	-0.11	-0.87
20	-0.90	-0.02	-0.10	-1.01
50	-0.96	-0.18	-0.10	-1.22
∞	-0.99	-0.29	-0.10	-1.36

Table 9
Corporate Tax Reform in a Small Open Economy
The Transition Path

Year	*Investment*	*Capital*	*Labor*	*GNP*	*Current Account*	*Wage*	*Q*	*Wage Tax Rate*	*Saving Rate*
0	1.45	96.89	18.60	24.80	0.00	1.000	0.580	0.300	0.059
1	1.52	96.89	18.03	24.23	-0.60	1.008	0.636	0.325	0.038
2	1.52	96.95	18.06	24.24	-0.59	1.008	0.636	0.325	0.039
3	1.53	97.02	18.10	24.25	-0.57	1.007	0.636	0.324	0.039
4	1.53	97.09	18.13	24.26	-0.55	1.007	0.636	0.323	0.040
5	1.53	97.16	18.16	24.27	-0.54	1.007	0.636	0.322	0.041
10	1.54	97.55	18.31	24.33	-0.45	1.006	0.637	0.319	0.045
20	1.55	98.32	18.52	24.46	-0.29	1.005	0.636	0.314	0.051
60	1.50	99.67	18.65	24.66	-0.08	1.006	0.633	0.309	0.057
∞	1.50	99.67	18.62	24.64	-0.11	1.007	0.633	0.310	0.056

Table 10
Corporate Tax Reform in a Small Open Economy
Decomposing Generations' Utility Changes
(changes, expressed as percent of remaining lifetime expenditures)

Generation's Year of Birth	*Generational Account*	*Factor Income*	*Excess Burden*	*Generation's Utility*
-54	0.60	4.18	-0.17	4.63
-50	1.47	3.34	-0.16	3.98
-45	1.47	2.61	-0.15	3.27
-40	1.33	1.94	-0.14	2.55
-35	1.14	1.31	-0.13	1.86
-30	0.93	0.72	-0.13	1.20
-25	0.72	0.21	-0.12	0.61
-20	0.51	-0.23	-0.11	0.10
-15	0.31	-0.55	-0.10	-0.30
-10	0.13	-0.75	-0.10	-0.59
-5	-0.02	-0.83	-0.09	-0.75
0	-0.13	-0.78	-0.09	-0.79
5	-0.74	-0.08	-0.07	-0.70
10	-0.63	-0.09	-0.05	-0.59
20	-0.48	-0.08	-0.03	-0.43
50	-0.42	-0.02	0.00	-0.29
∞	-0.45	0.00	0.00	-0.30

Figure 3
Dynamic Adjustment in a Small Open Economy

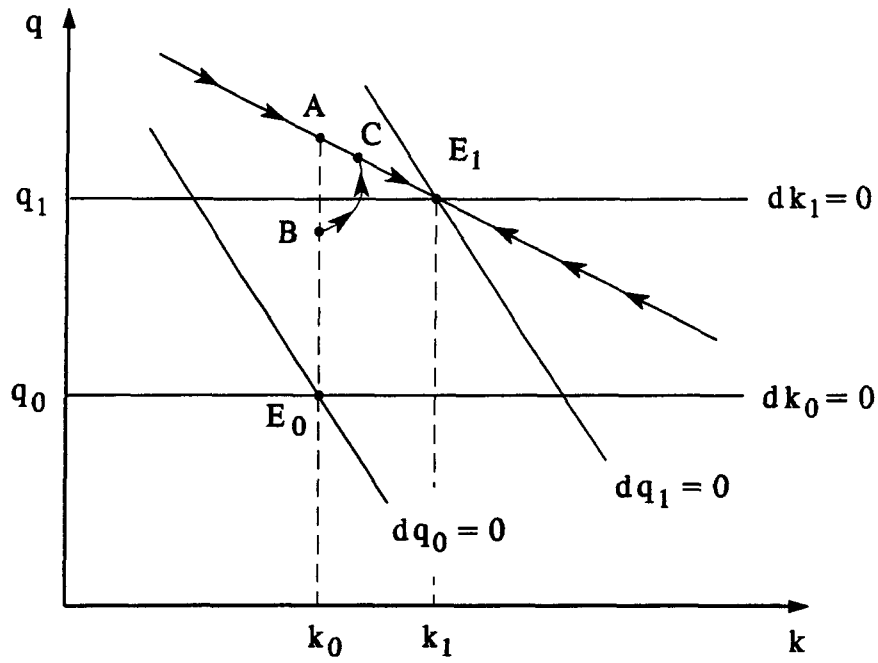

Table 11
Corporate Tax Reform in a Small Open Economy: Sensitivity Analysis
Decomposing Generations' Utility Changes
(changes, expressed as percent of remaining lifetime expenditures)

Generation's Year of Birth	*Generational Account*	*Factor Income*	*Excess Burden*	*Generation's Utility*
		$b = 2$		
-54	0.60	4.03	-0.19	4.45
-40	1.32	1.83	-0.14	2.44
-25	0.71	0.15	-0.10	0.56
-10	0.13	-0.75	-0.07	-0.57
0	-0.13	-0.76	-0.06	-0.76
10	-0.63	-0.04	-0.02	-0.52
50	-0.42	0.00	0.00	-0.26
∞	-0.45	0.00	0.00	-0.30
		$b = 10$		
-54	0.60	4.23	-0.16	4.69
-40	1.33	1.98	-0.14	2.59
-25	0.72	0.22	-0.12	0.62
-10	0.13	-0.75	-0.10	-0.59
0	-0.13	-0.79	-0.09	-0.80
10	-0.63	-0.10	-0.06	-0.61
50	-0.42	-0.03	-0.01	-0.30
∞	-0.45	0.00	0.00	-0.30
		$\sigma = 0.75$		
-54	2.16	2.45	-0.10	3.83
-40	1.11	1.56	-0.08	2.12
-25	0.58	0.15	-0.07	0.51
-10	0.14	-0.55	-0.05	-0.39
0	-0.03	-0.49	-0.05	-0.46
10	-0.37	-0.04	-0.03	-0.35
50	-0.27	-0.01	-0.01	-0.20
∞	-0.28	0.00	-0.01	-0.21
		$\sigma = 1.25$		
-54	0.00	4.33	0.00	4.86
-40	1.45	2.40	-0.21	3.04
-25	0.87	0.27	-0.18	0.71
-10	0.13	-1.01	-0.15	-0.83
0	-0.23	-1.17	-0.13	-1.19
10	-0.93	-0.16	-0.08	-0.87
50	-0.57	-0.04	0.03	-0.32
∞	-0.62	0.00	0.05	-0.33

Table 12
Corporate Tax Reform in a Small Open Economy: Policy Pre-announcement
The Transition Path

Year	*Investment*	*Capital*	*Labor*	*GNP*	*Current Account*	*Wage*	*Q*	*Wage Tax Rate*	*Saving Rate*
0	1.45	96.89	18.60	24.80	0.00	1.000	0.580	0.300	0.059
1	2.71	96.89	17.60	23.79	-2.07	1.014	0.631	0.350	0.027
2	1.49	98.07	18.18	24.35	-0.47	1.009	0.634	0.320	0.042
3	1.50	98.09	18.20	24.36	-0.46	1.009	0.634	0.320	0.043
4	1.50	98.12	18.23	24.36	-0.45	1.008	0.634	0.319	0.043
5	1.51	98.15	18.25	24.37	-0.44	1.008	0.634	0.319	0.044
10	1.52	98.34	18.37	24.41	-0.37	1.007	0.635	0.317	0.047
20	1.53	98.80	18.54	24.51	-0.25	1.006	0.635	0.313	0.052
60	1.50	99.67	18.64	24.65	-0.09	1.007	0.633	0.309	0.057
∞	1.50	99.67	18.62	24.64	-0.11	1.007	0.633	0.310	0.056

Table 13
Corporate Tax Reform in a Small Open Economy: Policy Pre-announcement
Decomposing Generations' Utility Changes
(changes, expressed as percent of remaining lifetime expenditures)

Generation's Year of Birth	*Generational Account*	*Factor Income*	*Excess Burden*	*Generation's Utility*
-54	0.60	3.84	-0.39	4.21
-50	1.23	3.21	-0.18	3.59
-45	1.23	2.49	-0.14	2.95
-40	1.12	1.86	-0.13	2.31
-35	0.96	1.26	-0.11	1.69
-30	0.79	0.71	-0.10	1.10
-25	0.62	0.22	-0.09	0.57
-20	0.45	-0.19	-0.08	0.11
-15	0.28	-0.50	-0.07	-0.25
-10	0.14	-0.70	-0.07	-0.51
-5	0.02	-0.78	-0.06	-0.65
0	-0.07	-0.74	-0.05	-0.69
5	-0.67	-0.03	-0.03	-0.56
10	-0.59	-0.04	-0.02	-0.49
20	-0.47	-0.05	-0.01	-0.38
50	-0.43	-0.01	0.00	-0.29
∞	-0.45	0.00	0.00	-0.30