Implementing a Dual Income Tax in Germany: Effects on Investment and Welfare*

Doina Radulescu
Ifo Institute, Munich†

Michael Stimmelmayr
Center for Economic Studies,
University of Munich

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Abstract

This paper investigates the effects of implementing a dual income tax in Germany. We follow the reform proposal presented in the latest report of the German Council of Economic Advisors (2003) and analyze its implications on capital formation, investment and welfare using a dynamic computable general equilibrium model. The model consists of four building blocks: an intertemporal investment model in spirit of Tobin's Q theory; the traditional Ramsey model on the household side; a public sector and the rest of the world which closes the model. Our findings suggest that the introduction of a dual income tax with a proportional capital income tax rate of 30% and progressive labour income tax rates up to 35% leads to higher investments as well as an increased capital accumulation up to 3.6% and welfare gains of about 0.2% of GDP.

Keywords: Capital income taxation, computable general equilibrium modeling, welfare analysis
JEL-Classification: C68, D58, D92, E62, H25

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†**Address:** Ifo Institute, Poschingerstrasse 5, D-81679 Munich, Germany. E-mail: Radulescu@ifo.de, Stimmelmayr@cesifo.de

1 Introduction

This paper investigates the effects of implementing a dual income tax (DIT) in Germany. For this purpose we apply a dynamic computable general equilibrium model and analyze the implications of such a reform on capital formation, investment and welfare. In the light of recent discussions especially brought about by the latest report of the German Council of Economic Advisors (GCEA), a dual income tax has increasingly become popular as an option for reforming the German tax system.

A redesign of the German tax system is imperatively required since the present tax law is complicated, non-transparent and a major obstacle for the country to survive in the international tax competition. Furthermore, the existing German income tax system, labeled as a comprehensive income tax, requires all types of income to be taxed in the same manner, irrespective of their source. In practice, however, the tax system systematically deviates from this principle of horizontal equity by allowing legal tax loopholes and therefore creating severe distortions and welfare losses. The loose implementation of the comprehensive income tax leads to double taxation, distorts the financial decisions of firms and their choice of organizational form. A dual income tax which has been applied in several Nordic countries and practiced in Austria and Belgium in some rudimentary form, would not only reduce these distortions but also create substantial efficiency gains.

We take the proposal made in the latest report of the GCEA (2003) and measure the economic effects such a reform would have. Our findings suggest that the introduction of a dual income tax with a proportional capital income tax rate of 30% and progressive labour income tax rates up to 35% leads to higher investments as well as an increased capital accumulation up to 3.6% and welfare gains of about 0.2% of GDP.

The computable general equilibrium growth model we use is calibrated to the German economy and consists of four blocks. Optimal investment behavior is derived from an intertemporal investment model with convex adjustment costs in spirit of Tobin's Q theory. Since we mainly focus on the efficiency effects of the tax reform on welfare, we model the household sector using the traditional Ramsey model of an infinitely lived household. The public sector introduces various distortions on the behavioral margins of agents through taxation. The model's fourth building block is the Rest of the World (RoW) which closes the model. While the home economy is considered in detail, the foreign economy is just

roughly modelled.

The next section of the paper describes the experiences of Nordic countries with the dual income tax and presents the advantages and shortcomings of such a tax. The subsequent part three introduces the baseline model and derives several important behavioral responses. Section four discusses the comparative static results as well as the simulation results which are checked with regard to their robustness by a sensitivity analysis. Finally, some further extensions of the model are addressed, suggesting directions for future research.

2 The DIT - An Option for Germany

Germany, once the country of the Economic Miracle, the leader of European growth statistics has now fallen behind all other European countries in terms of growth. Germany faces persistent structural problems, an increased European tax competition and a weak economic climate. In addition, the misuse of the German tax policy as a discretionary instrument for short-run cyclical interventions is another crucial reason for the poor economic performance. According to the GCEA (2003), the tangled mass of partly proposed, partly enforced tax reliefs and modifications in the tax system did not lead to any improvements, but induced a severe credibility loss, resulting in decreasing investments. Furthermore, the partial alteration of the tax system undermined the principles underlying the comprehensive income tax system and led to many distortions concerning investment behavior, the financial decision or the organizational choice of a firm. While the German income tax system is labelled as a comprehensive one it systematically deviates from this principle in reality; e.g. distributed profits are taxed differently than earnings stemming from other sources according to the half-income principle of dividend taxation. Additional violations arise due to the multitude of tax exemptions, including for instance returns from institutional savings or capital gains. Another incompatibility consists in the methodical difference of determining the respective tax base of labor and capital income. While the capital income tax base is determined on the accrual basis the labor tax base is calculated on a cash basis.[1] Thus, income stemming from labour

[1] Accrual basis: difference in wealth between the beginning and end of each tax period.

enjoys tax privileges, since expenses linked to human capital investments are immediately deductible while those required for capital investments can only be deducted later on via depreciation.

Despite the recent tax reliefs due to the increased tax competition, Germany's overall tax rates are still among the highest within Europe (EUROPEAN COMMISSION 2001), impeding Germany's performance in the ongoing tax competition. The German corporate tax rate amounts to 38.7% (including the solidarity surcharge of 5.5% and the trade tax) while the EU average is 29.4% and the OECD average is just 29%. The following **Figure 1** (Source: BMF, 2004) shows that Germany, along with the United States, Canada and Japan are the countries which levy the highest tax burden on corporations.

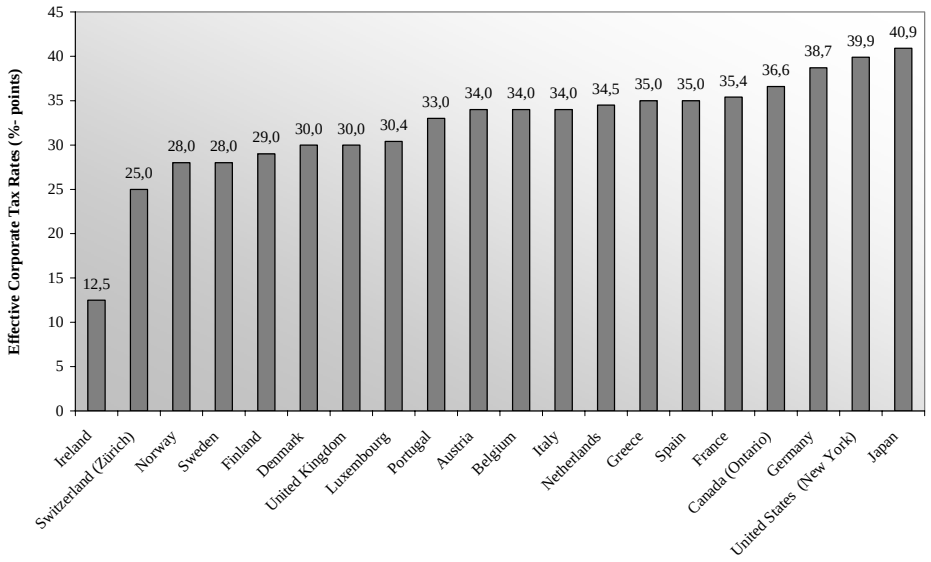

Figure1: *Effective Corporate Tax Rates Across Countries.*

To survive in the international tax competition Germany will have to lower its capital income tax rates further to prevent the mobile factor capital from fleeing to low tax countries. Hence, the DIT seems to be the prefect solution, since one of the main ideas of the dual income tax (as a step towards the Johansson-Samuelson tax) is to tax the international mobile factor capital less. According to theory, perfectly mobile capital has an infinitely elastic response to taxes levied on it by a small open economy. Then, the optimal policy would be to have a zero capital income tax rate such that the entire tax

Cash basis: difference between revenue arising from labour supply and the expenses needed to achieve this revenue.

incidence falls completely on labour. Moreover, the production efficiency theorem states that only consumption decisions are distorted by a wage tax, while a source tax on capital also distorts the international capital allocation and thus incurs a deadweight loss. These arguments are in favour of levying a lower tax rate on capital vis-a-vis labour. Furthermore, these arguments are also supported by several empirical findings, for instance by MENDOZA ET AL. (1994), DEVEREUX ET AL. (2002) or SØRENSEN (2000).[1]Thus, both theory and empirical evidence provide further arguments in favour of introducing a DIT.

Without a proper theoretical redesign of the German tax system, a discretionary reduction in some capital income taxes and an increase in the labour tax to maintain a sufficiently high tax revenue, will lead - as hitherto - to a very complicated and non-transparent system of taxation, which does not follow either the rules of a comprehensive nor of a schedular income tax system. Even if there exist some substantial reasons for deviating from a comprehensive income tax, each deviation will induce behavioral changes and therefore result in welfare losses. Therefore, one important prerequisite for eliminating the existing distortions and stimulating economic growth in Germany is a conceptual reorganization of the German tax system. The new tax system should ensure full neutrality with respect to the investment decision, the source of finance and the legal form, improve Germany's standing within Europe and also be in line with present EU-law.

2.1 The Experience of Nordic Countries

Looking for an adequate option for reforming the German tax system one notices that similar problems were solved in the Nordic Countries by introducing a DIT a decade ago. Several papers like SØRENSEN (2001), CNOSSEN (2000), and SØRENSEN/NIELSEN (1997) discuss the experiences these countries had with such a tax system. Starting with Denmark in 1987, followed by Sweden in 1991, and Norway and Finland in the subsequent years, all four countries changed their tax system from a comprehensive income tax to

[1]MENDOZA ET AL. construct time series of tax rates for seven OECD countries from 1965-1988 using national accounts and revenue statistics. Their findings suggest inter alia that there is a moderate shift of the tax burden towards labour. DEVEREUX ET AL. (2002) provide evidence for the international trend towards lower tax rates. Similar conclusions are derived by SØRENSEN (2000) who computes average effective tax rates on labour and capital respectively for 12 countries for the periods 1981-1985 and 1991-1995. His results show that while the tax burden on labour increased, the burden on capital declined or remained constant.

a schedular one. The modifications included a reduction in statutory capital income tax rates to 28 per cent in Norway (Norwegian Ministry of Finance 2004) and Finland for instance or 30 per cent in Denmark (Mennel/Förster 2003). Simultaneously the existing tax base was broadened, such that major losses in aggregate tax revenue were prevented. Additionally, a progressive tax schedule, ranging between 28 to 41.5 per cent in Norway, or 39.7 to 59 percent in Denmark was levied on labour income. Regarding the double taxation of distributed profits, Norway and Finland avoid this by applying full imputation. The double taxation of retained profits was abolished only in Norway. Furthermore, withholding or source taxes are installed at the company level or at the level of interest, royalty or other types of capital income paying entities, to guarantee the unique taxation of capital income.

2.2 The Concept of a Dual Income Tax

The dual income tax can be ascribed to the theoretical model of the Johansson-Samuelson tax which taxes the economic profit as 'Ertragswertzuwachs'. Such a tax is levied uniformly on all types of income which have been determined in an identical way in the country of residence. Since income cannot always be computed in the same way, different tax rates may be necessary to adjust the differences in the computation of the tax base. Therefore, there are reasons for having a schedular tax system, however, the precise difference between the two tax rates is still an open task. Accordingly, a pure DIT distinguishes between capital and labour income. Capital income - including business profits, dividends, capital gains, interest and rental income - is taxed at a low proportional tax rate, whereas progressive tax rates are levied on labour income. This separation between capital and labour income taxation has several advantages. On the one hand the proportional tax on capital income mostly assures the aspired neutrality concerning the investment and financial decisions, as well as the choice of the legal form of the firm. On the other hand, the uncoupled proportional taxation of capital income allows for sufficient flexibility to react and survive in the persisting tax competition without changing the whole tax system. Furthermore, the progressive taxation of labour income including wages (as well as the employer's calculatory salary), pension income, governmental transfers, and social security benefits, offers a solid base for redistribution, if desired. However, the difference

between the low, proportional tax rate on capital income and the higher top marginal tax rate on labour income should not be too large to prevent tax arbitrage. Without any functional mechanism to counteract income shifting, especially managers of non corporate firms are tempted to declare their fruits of labour income as capital income to avoid the higher progressive tax which is levied on labour income. Additionally it would be possible to accumulate the returns to debt-financed assets within a corporation subject to only a lower capital income tax and on the other hand deduct the interest payment against the higher personal tax rate. Moreover, a full imputation system should be installed to prevent the double taxation of distributed profits.

However, such a dual income tax has its disadvantages, too. According to WAGNER (2000), an often cited criticism regarding the dual income tax relates to the fact that it is a schedular tax. Nevertheless, such an allegation would only be meaningful if all types of income, irrespective of their source, were determined in the same way but taxed with different tax rates. In Germany however, capital and labour income are computed in different ways under the present tax law. Because of practicability reasons, one cannot give up the determination of labour income on a cash basis and therefore, the introduction of the dual income tax applying higher rates to labour income, can be interpreted as an attempt to adjust the taxation of capital and labour income.

A valid concern arising from the DIT applies to small enterprises, such as partnerships and proprietorships. They may suffer a severe disadvantage, if returns on business investments are taxed at the higher tax rate applying to labour income. To avoid this discrimination of small enterprises, one must impute a rate of return on equity and tax this calculated return as capital income at the lower capital income tax rate. Norway for instance solved this problem using a special method: Returns from capital are computed using a statutory interest factor, which is equal to the return on three-month Treasury Bills. Labour income is then determined residually as the difference between the owner's share of corporate profits and capital income (CNOSSEN 2000). Finnish tax law requires dividends paid by unlisted companies to be divided into two components. One is treated as capital income and subjected to the capital income tax rate and the other one is treated as earned income taxed at the progressive labour income tax (SØRENSEN 2001, 1994). According to SØRENSEN (1994), the Achilles' heel of this tax systems seem to be the fact that non-residents do not have to pay any taxes on withholding interest and royalties

and thus several tax loopholes are created, but this is only a worry for the foreign tax authorities.

3 The Model

Evaluating and quantifying the effects of a fundamental tax reform is a difficult task. Beside the more obvious first order effects, economy wide repercussions and second order effects have to be considered, too. Hence, it is advisable to base the analysis on a general equilibrium growth model to capture all kinds of effects. The growth model is in line with modern neoclassical growth theory. Savings and investment decisions are forward looking and allow therefore to consider important tax capitalization effects. Furthermore, the model mimics several important behavioral margins at the firm level, which are strongly sensitive to the effects of capital income taxation, like investment behavior, the financial decisions or the organizational form.

The applied computable general equilibrium (CGE) model, *IFOmod,* we use is a modification of the Swiss CGE-model developed by KEUSCHNIGG (2002). Compared to other well known CGE models - like *Multimode Mark III* developed by the IMF (LAXTON ET AL. 1998), *OECDTAX*, developed by SØRENSEN (2001), or the model developed by FEHR (1999) - our model contains a detailed modelling of the firm sector as well as an explicit welfare analysis using the traditional Ramsey model instead of an overlapping generation model.

3.1 Business Sector

This section presents an inter-temporal investment model with convex adjustment costs in the spirit of Tobin's q theory. We solve for optimal investment behavior under perfect foresight to explain the capital accumulation of the economy.

We rely on a basic neoclassical, linear homogenous production technology with capital and labour as production factors. The price of the output good is normalized to unity. Additionally, the firm incurs adjustment costs $J(I, K)$ which result from disruptions due to the firm's internal reorganization. Adjustment costs are introduced to obtain more

realistic dynamics in an open economy. The adjustment cost function is assumed to be linearly homogeneous in I and K and convex in investment. The steady state adjustment costs are zero such that they do not in influence the steady state solution.

Domestic firms hire labour and accumulate capital and debt to maximize their firm value. To model the distortionary effects of taxation on investments and therefore on capital accumulation we consider besides a tax on profits, denoted by t^U, a tax on dividends, t^D. According to the present German tax system dividends D, are first taxed on the firm level and then half of distributed dividends are once again taxed on the personal level. Capital gains are subject to the capital gains tax t^G, but effectively there is no capital gains tax in Germany. The variable, t^G, is carried along for reasons of completeness.

3.1.1 Financial Identities, Arbitrage and Optimization

Capital expands over time whenever gross investment, I_t, exceeds the depreciation of the existing capital, δK_t. Therefore capital accumulation can be written as:

$$GK_{t+1} = I_t + (1-\delta)K_t \ . \tag{1}$$

The growth factor G, which is equal to $(1+g)$, enters the model as we allow for an exogenous trend growth in labour productivity at rate g. Thus, in a balanced growth equilibrium the capital stock grows at the rate g.

Concerning debt policy, we assume that interest payment on debt includes an additional premium $m(b)$ which denotes the agency cost of debt depending on the debt asset ratio $b = B/K$ of the firm. The agency costs are increasing in b,[3] and therefore the firm's risk of bankruptcy will increase with rising indebtedness as the real cost of default increases. Debt accumulates according to:

$$GB_{t+1} = B_t + BN_t \ . \tag{2}$$

Thus, next period's stock of debt, B_{t+1}, is determined as the sum of the existing stock of debt, B_t, and new debt, BN_t. For notational convenience, we drop the time index t if all variables refer to the same current period t.

[3]The agency cost of debt, $m = m(b)$, are increasing in the debt equity ratio, $b = \frac{B}{K}$, since the first, $m'(b)$, and the second , $m''(b)$, derivative are positive.

Net of tax profits are given in equation (3), consisting of output less adjustment cost, wage payments, depreciation, interest payments on debt and the tax liability of the firm.

$$\begin{aligned} \pi &= Y - J - wL - \delta K - (i+m)B - T, \\ \text{with} \qquad T &= t^U[Y - J - wL - \delta K - (i+m)B - e(I - \delta K)] \ . \end{aligned} \tag{3}$$

The tax allowances for investments is represented by e.[4] The different opportunities of financing investment are either given by reducing the dividend payments D and financing therefore part of gross investment by retained earnings $\pi - D$,[5] by issuing new equity, VN, or externally via new debt, BN. Hence, the flow of funds equation states:

$$\pi + VN + BN = D + IN. \tag{4}$$

Solving (4) for D and inserting (3) and using the expression for net investments, one can derive an explicit expression determining dividends:

$$D = [Y - J - wL - \delta K - (i+m)B] - T + VN + BN - (I - \delta K). \tag{5}$$

Since we refer to a mature economy, characterized by mature firms, [6] we follow the 'New View' of dividend taxation and thus dividends are determined residually (Sinn (1985)). Keeping in mind the empirical evidence provided by Auerbach and Hasset (2003) who state that both views on the effects of dividend taxation are valid, we determine new share issues exogenously by $VN = \beta(1 - et^u)IN$ with $\beta = .05$. This approach is similar to Fehr (1999). New investments are largely financed by retained earnings and only a fixed fraction of 5 % is financed via new share issues.

The interest rate is determined endogenously in our model. Net of tax interest rates, $r_t = (1 - t^i) \cdot i_t$, equate across countries according to $r^{\text{home}} = r^{\text{foreign}}$. The variable i_t denotes the nominal market rate of interest. Since the source principle of interest taxation

[4] If $e = 0$ we have the case of true economic depreciation. If $e = 1$ we allow for a full immediate write-off and and t^U can be interpreted as a cash-flow tax.

[5] Further we assume that in our setting replacement investments are always financed internally.

[6] According to the nucleus theory the nucleus is incorporated in the first step and then a phase of internal growth sets in. During this phase, no dividends are paid, nor any new shares are issued, but all profits are retained to finance all profitable investments. After the nucleus has reached its stage of maturity, all profits are distributed as dividends. The dividend tax discriminates against the initial size of the nucleus, thus in the set up phase, the 'Old View' applies, but the dividend tax is neutral in the stage of maturity according to the 'New View' (Sinn 1991).

is applied, a reduction or an increase in the domestic interest rate affect foreign savings, too.

Following a basic non-arbitrage condition as written down in equation (6), we know that firm owners must invest their money either on the capital market, earning a net of tax return of r_t, or in firm equity which yields dividend payments of D_t/V_t and capital gains $[GV_{t+1} - V_t]/V_t$ per unit of wealth:

$$r_t V_t = (1 - t^D)D_t + (1 - t^G)\left[GV_{t+1} - V_t - VN_t\right] \ . \tag{6}$$

Ergo, the market value of a firm is equal to the present value of all future dividends and accruing capital gains less new share issues discounted at an appropriate discount rate.[7]

3.1.2 Investment and Financial Policies

Firms maximize their value by choosing optimal investment and financial policies. While the stock of capital and debt are historically determined - thus exogenously given at the beginning of a period - the future stock of capital and debt are endogenous. Using the *Bellman's Principle of Optimality*, optimal investment and financial behavior can be derived, as shown in the Appendix.

According to equation (7), optimal investment incorporates both the marginal advantage of decreasing adjustment cost and the marginal advantage of accelerated depreciation if $e > 0$. In the case depreciation conforms to true economic depreciation, $e = 0$ holds and thus the share of marginal investment financed by new share issues (here, fraction β) incur a cost of one. The other share financed through other sources (fraction $1 - \beta$), will then primarily be subject to the capital gains tax.

$$\begin{aligned} \tfrac{q_{t+1}}{(1+r^e_{t+1})} &= \tfrac{(1-t^D)(1-t^U)}{1-t^G} J_I + \beta \cdot (1 - et^U) + (1-\beta)(1-et^U) \cdot \tfrac{1-t^D}{1-t^G} \ , \\ \text{with} \quad r^e_{t+1} &= r_{t+1}/(1-t^G) \end{aligned} \tag{7}$$

Moreover, the shadow price of capital, q_t, is given by the envelope condition of the stock variable capital and represents the value of the induced marginal profit:

$$\begin{aligned} q_t &= \tfrac{(1-t^D)(1-t^U)}{1-t^G}\left[F_K - J_K + m'b^2\right] \\ &+ \left[\beta(1-et^U)(1-\tfrac{1-t^D}{1-t^G}) + \tfrac{1-t^D}{1-t^G} t^U(1-e)\right]\delta + q_{t+1}/(1+r^e_{t+1}) \ , \end{aligned} \tag{8}$$

[7] In our case, the appropriate discount rate is equal to $r^e = r_t/(1-t^G)$ as derived in the Appendix.

Adding one more unit of capital creates a marginal profit stream consisting of three different components: First, profits increase by the marginal product of capital; Second, due to lower adjustment costs future revenues increase; And third, the interest burden on debt is reduced, as the debt asset ratio is improved. Combining equations (7) and (8) we get an expression for the marginal product of capital:

$$F_K - \delta = (1 - t^i) i_t \frac{1 - et^U}{1 - t^U} \left[\beta \frac{1}{1 - t^D} + (1 - \beta) \frac{1}{1 - t^G} \right] - m' b^2. \tag{9}$$

The left hand side describes the value of the marginal product of capital less depreciation. The right hand side includes the cost of finance as a weighted average of the cost of equity finance and cost of debt finance. The cost of retained earnings decreases when the capital gains tax or profit tax decrease or whenever the tax on interest income increases.

Optimal debt policy is derived by following a similar procedure. Substituting the optimality condition for new debt into the envelope condition of the stock variable debt we get (cp. appendix):

$$\frac{(1 - t^i) \cdot i}{1 - t^G} = (1 - t^U)[i + m + m' b] \ . \tag{10}$$

The left hand side represents the cost of equity finance, while the right hand side denotes the cost of debt financing. According to equation (10) the optimal level of debt is achieved, if the cost of internal equity financing equals the cost of external debt financing.

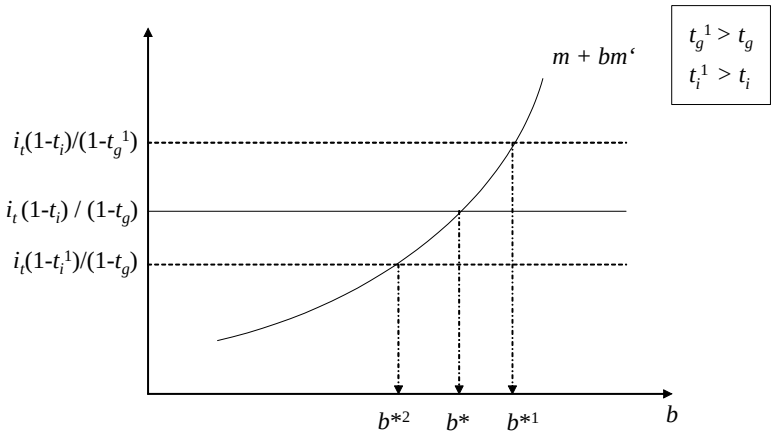

Figure 2: *The Optimal Debt Capital Ratio*

For example, an increase in the interest tax rate leads to a reduction in the cost of equity finance and thus lowers the attractiveness of debt finance. Accordingly, the debt

asset ratio will fall. The same is true for a decrease in the corporate tax rate. In contrast, a reduction in the capital gains tax reduces the cost of equity finance, leading to a decrease in the debt asset ratio. As we can see from the above figure, a higher capital gains tax rate ($t_g^1 > t_g$) raises ceteris paribus the optimal debt level while a higher tax rate on interest income lowers the optimal debt level.

3.2 The Household Sector

Since we mainly focus on the welfare implications rather than on the distributional issues of implementing a dual income tax, we model the household sector using the Ramsey model of an infinitely lived household. This Ramsey agent takes the discounted utility of future generations into account, where the subjective discount factor is denoted by $\rho < 1$, indicating the degree of relevance of future consumption. Accordingly, preferences can be described by:

$$U_t = u(Q_t) + \rho \cdot U_{t+1} = \sum_{s=t}^{\infty} \rho^{s-t} \cdot u(Q_t) \ , \tag{11}$$

with $Q_t = C_t - \varphi(L_t^S)$. Thus, utility depends on individual consumption C_t less the disutility of work, $\varphi(L_t^S)$, where L_t^S expresses labour supply. Households face therefore a trade-off between the utility stemming from consumption and the disutility of work, implying an endogenous labour supply in the model.[8]

Households consume out of total wealth, which can be split in two different components: Financial wealth, A_t, and human capital H_t. Financial wealth subsumes equity capital and all interest bearing assets, namely, business debt as well as domestic and foreign government debt. Human wealth consists of net of tax labour income, $(1 - t^L)w_t L_t^S$, and governmental lump sum transfers T_t^H. Hence, households' total wealth accumulates according to equation (12) and consists of the income from interest bearing assets, net of tax labour income, lump-sum transfers from the government, less consumption expenses, as given by:

$$GA_{t+1} = (1 + r_t)A_t + (1 - t^L)w_t L_t^S + T_t^H - (1 + t^C)C_t, \tag{12}$$

The household's optimization problem includes the optimal labour supply and optimal consumption behavior. Using once again dynamic programming, the optimality and

[8] This special form is chosen since we are only interested in the substitution effect and not the income effect.

envelope conditions for the households are derived.[9] Optimal individual labour supply depends on the current real wage, $\frac{(1-t^L)}{(1+t^C)}w_t$, which is corrected by a tax factor including the labour and consumption tax. Total labour supply is obtained upon aggregation of the individual labour supply. Thus, we can observe how changes in the labour income tax rate or in the VAT rate affect the individual labour supply. Applying a *CES* utility function, $u(Q) = \frac{Q^{1-1/\sigma}}{1-1/\sigma}$, where σ represents the intertemporal elasticity of substitution, a closed form solution of the optimal consumption profile can be derived. Accordingly, the Euler equation shows, how consumption and accordingly savings evolve over time:

$$\frac{u'(Q_t)}{1+t_t^C} = \frac{u'(Q_{t+1})}{1+t_{t+1}^C} \cdot \frac{\rho R_{t+1}}{G}. \tag{13}$$

We can see that the VAT also affects consumption. A rise in t^C leads to a decline in expected future income and thus current consumption declines and savings increase. Moreover, the decline in the net interest rate (as a result of the higher interest tax) also encourages savings through the income effect. To attain a given level of savings in the future, people need to save more given the lower return on savings. However, there is only a temporary change in the net interest rate since in the long run the interest rate is bound to fulfill $1 + r = \rho/G$ due to the assumptions underlying the Ramsey model .

As a measurement for welfare, we apply the equivalent variation:

$$TW(U^1, p^0) - TW(U^0, p^0) = EV \tag{14}$$

Therefore, we compare pre and after tax reform utility levels of the representative agent, which depend on her pre and after reform total wealth.

3.3 General Macroeconomic Equilibrium

Via taxation the domestic government introduces various distortions on the behavioral margins of the agents. On the corporate level the corporate tax is levied, whereas on the household level a tax on labour and consumption bites as well as a tax on interest and dividend income and on accrued capital gains. The accumulation of public debt has to cover public consumption, the primary deficit and the interest spending on public debt.

[9] The extended derivative can be found in the Appendix.

The primary deficit is defined as the difference between lump-sum transfers and total tax revenue.

The Rest of the World (ROW) is assumed to be a representative foreign agent, who closes the model. ROW is endowed with an *exogenous* income stream and chooses an optimal consumption stream to maximize life-time utility. Moreover, ROW can only save in terms of the internationally traded bonds. However, domestic investment does not stem only from domestic sources but also from foreign savings, resulting in a current account deficit or surplus depending on the policy experiment. The current account is thus given by:

$$GD^F_{t+1} - D^F = rD^F + TB_t, \tag{15}$$

and can also be interpreted as GNP less domestic absorption. Since we applied the source principle of interest taxation, an increase in the domestic net interest rate also affects foreign savings, however, since there is only a slight increase in the net interest rate, foreign government bonds held by domestic individuals decrease only to a low extent .

4 Comparative Statics & Simulation Results

4.1 Policy Scenarios

Starting from the prevailing German tax system, we just have one tax on the firm level, namely the profit tax which amounts to 38.6% (including the solidarity surcharge of 5.5% and the local trade tax). On the household level, the progressive labour tax rate reaches a top marginal tax rate of 44.3%, but since we just have one representative agent, we do not adopt the top marginal labour tax rate, but compute an average labour tax rate of 16.6%.[10] Taking an average annual income of about 20.814 € per year as given, the representative agent is according to the prevailing tax bracket liable to a marginal income tax of 28%, which also applies to interest income. Furthermore, income stemming from dividends is subject to a tax rate of 14% according to the German half income principle while capital gains are untaxed.

[10] From the labour income tax statistics we compute an average annual income of 20814 €. Then, using the prevailing marginal tax rate for the corresponding tax bracket we compute an average tax rate according to: $\frac{(20814-12740)\cdot 0{,}28+(12739-7665)\cdot 0{,}2}{20814} = 0.166$.

Now, the following three different policy scenarios are under consideration: *Scenario 1* takes the reform proposal made by the GCEA in their latest report. All tax rates applying to any kind of capital income are set at a flat rate of 30% while labour income is taxed progressively with a top marginal tax rate of 35%.[11] Again, we do not use the top marginal labour tax rate but compute an average tax rate of 12%. To avoid any double taxation of distributed profits the full imputation system is installed, implying a dividend tax rate of zero. Since no capital losses should be regarded, capital gains need also to be tax exempt implying a capital gains tax rate of zero.

Scenario 2 takes advantage of the 'New View' setting. As discussed above, the dividend tax is supposed to be neutral along the 'New View' and therefore the dividend tax has no impact on the investment decision of firms. Accordingly, Scenario 2 is identical to Scenario 1, but the dividend tax is set at a flat rate of 30%. In this model, the dividend tax is a well suited, non distorting instrument to raise additional tax revenue.

Last but not least, *Scenario 3* represents the "pure" dual income tax system, suggesting that all kinds of capital income are taxed at a flat rate. Thus, dividends and capital gains are also subject to taxation at a flat rate and labour income is taxed progressively. The applied tax rates of Scenario 3 are in line with the proposed tax rates of the GCEA report.

Table 1: *Tax Rates Before and After the Reform*

	Status Quo	Scenario 1	Scenario 2	Scenario 3
Profit Tax, t^U	0.386	0.3	0.3	0.3
Labour Tax, t^L	0.166	0.12	0.12	0.12
Tax on Interest Income, t^i	0.28	0.3	0.3	0.3
Dividend Tax, t^D	0.14	0	0.3	0.3
Capital Gains Tax, t^G	0	0	0	0.3
VAT, t^C	0.16	endogenous	endogenous	endogenous

Source: Bundesministerium der Finanzen (2004), Sachverständigenrat (2003)

Table 1 summarizes the current statutory tax rates of the German tax system in column "Status Quo", while the subsequent columns depict the scenarios one to three. Regarding the major loss in the tax revenue - which will arise due to the reduction in the statutory tax rates - there are only a few possible sources of financing the reform.

[11] The current local trade tax, the German 'Gewerbesteuer' is abolished in its existing form as an additional charge, and is embedded in the capital and labour income tax rate, respectively.

The GCEA report proposes a reduction of a bigger part of all legal tax reliefs, but it is rather arguable, whether this counteracting measures is sufficient. Since the tax revenue is determined endogenously in our model, we allow for an increase in the VAT rate to finance the proposed reform scenarios. Moreover, the increase in the VAT rate is the preferred alternative by political analysts in finding ways to finance different tax reforms.

4.2 Changes in the Investment Decision

By performing a comparative static analysis, basic insights about the economic effects arising from the different reform scenarios are derived. To see how changes in the tax rates affect the investment and financial behavior of a representative firm, we compute the effect of a marginal change in one tax rate on the marginal product of capital and the cost of equity, respectively.

Regarding the effects on investments, we derive the cost of capital equation by substituting the expression for optimal debt, equation (10), into the marginal product of capital derived in equation (9):

$$F_K - \delta = \underbrace{\frac{(1-t^i)i}{1-t^U}\left\{(1-et^U)\left[\frac{\beta}{1-t^D}+\frac{(1-\beta)}{1-t^G}\right]-\frac{1}{(1-t^G)}b\right\}}_{\text{cost of equity}} + \underbrace{(i+m)b}_{\text{cost of debt}}$$

Differentiating this expression with respect to the tax rate under consideration, we find, that reducing the corporate income tax, t^U, as well as the capital gains rate, t^G, has a positive impact on investment since in each case the cost of capital decline.

$$\frac{d(F_K-\delta)}{dt^U} = (1-t^i)i_t\frac{1-e}{(1-t^U)^2}\left[\frac{\beta}{1-t^D}+\frac{(1-\beta)}{1-t^G}\right] - 2bm'\frac{db}{dt^U} - \frac{dm'}{db}\frac{db}{dt^U} > 0\ .$$

The economic intuition concerning a reduction of the corporate tax rate is obvious. If the corporate tax rate is reduced, returns stemming from real investments are less heavily taxed compared to a financial investment which is not subject to the corporate tax rate but the personal income/interest tax. Hence, the decrease in the cost of capital leads to an increase in real investments.

$$\frac{d(F_K-\delta)}{dt^G}=(1-t^i)i_t\frac{1-et^U}{1-t^U}\frac{(1-\beta)}{(1-t^G)^2}-2bm'\frac{db}{dt^G}-\frac{dm'}{db}\frac{db}{dt^G}>0.$$

Analyzing the effect of a reduction of the capital gains tax we have to consider that profit retentions are favoured relative to debt financed investments if the capital gains tax decreases. Thus, real investments are stimulated to the extent that profit retentions are used as a marginal source of finance.

In contrast, a reduction of the interest rate will raise the cost of capital:

$$\frac{d(F_K-\delta)}{dt^i}=-i_t\frac{1-et^U}{1-t^U}\left[\frac{\beta}{1-t^D}+\frac{(1-\beta)}{1-t^G}\right]-2bm'\frac{db}{dt^i}-\frac{dm'}{db}\frac{db}{dt^i}<0.$$

Since the tax on interest income is increased, an alternative investment in the financial market becomes less attractive. A higher interest tax rate leads therefore to a preference for real investments relative to financial capital market investments. Hence, the tax wedge between the marginal product of capital and the market rate of interest decreases if the interest tax rate rises.

In the case of a *pure* 'New View' setting, new share issues do not exist as a source of finance. However, new share issues exist as a source of finance on a pro-rata basis of 5 % implying that we are close to the 'New View'.

$$\frac{d(F_K-\delta)}{dt^D}=(1-t^i)i_t\frac{1-et^U}{1-t^U}\beta\frac{1}{(1-t^D)^2}>0.$$

If there are no new shares issued, $\beta=0$, the first term in brackets of the cost of capital formula cancels out and the cost of capital formula is independent of the dividend tax.

To complete the analysis concerning the long-run investment incentives induced by the proposed reform scenarios, we also derive the King and Fullerton (1984) type formulae: The marginal effective tax rate is the difference between the pre-tax return of the corporation, denoted by u (= user cost of capital), and the after-tax return to the investor, denoted by $s=(1-t^i)i$. This marginal effective tax rate measures the overall distortion of taxation with respect to investment incentives. It is straightforward that taxes at the corporate and personal level drive a wedge between the required pre-tax return u and the net of tax return s to households. Using once again equation (9) we can define the user cost of capital as:

$$u = MRR - \delta = F_K - \delta + m'b^2.$$

The marginal effective tax rate is defined as the difference between the user cost of capital and the net of tax returns to private investor divided by the user cost of capital, $t^{eff} = \frac{u-s}{u}$. At present, the user cost of capital in Germany amount to about 4.7% and the after tax return for a representative investor is approximately 3%, implying an effective marginal tax rate of about 36.3%. Introducing scenario 1, the user cost of capital decreases to 4.4% while the after tax return stays constant at 3%. Thus, the effective marginal tax rate shrinks to about 31.5% if the proposed tax reform according to scenario 1 is introduced. Simulating scenario 2 and 3, an effective marginal tax rate of 33.5% and 45.5%, respectively, is achieved.

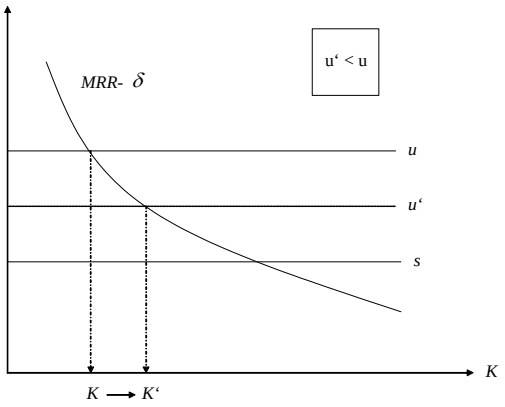

Figure 3: *The Marginal Effective Tax Rate*

Given decreasing returns to capital, the marginal rate of return curve will slope downward as shown in **Figure 3**. In a world without taxation, the user cost of capital, u, equals the after-tax return to private investors, s. Thus, the intersection of both curves denotes the long-run capital stock for the Germany economy in the absence of taxation. However, the corporate income tax at the firm level and the dividend and capital gains taxes at the personal level increase the cost of capital and thus have a negative effect on capital accumulation. For example, the proposed reform scenario 1 diminishes the tax wedge, by eliminating the dividend and the capital gains tax and by reducing the profit tax rate. In turn the user cost of capital, u, declines to u' and thus the distance to the after tax return to savers, s, dwindles and stimulates therefore the capital accumulation in the economy.

4.3 Changes in the Financial Behavior

To evaluate the effects of a marginal change in the tax rates on the financial decision of a representative firm, we analyze the change in the cost of equity stemming from a marginal change in the tax rate under consideration. The cost of equity is defined as the rate of return required on firm level. Taking equation (10), the optimal level of indebtedness of a firm is reached, if the marginal cost of equity finance equals the marginal cost of debt finance.

Since a change in the tax rates will alter the cost of equity finance, the firm's optimal debt level changes and hence the marginal source of finance. Similar to Dietz/Keuschnigg (2004) or Keuschnigg (1991), we compute the percentage change in the cost of equity analogous to: $\hat{r} \equiv dr/r$, where dr denotes the deviation from the initial value of r. The relative change in the particular tax rate is then defined as $\hat{t} \equiv dt/(1-t)$ to avoid division by zero. Therefore we have:

$$r = \frac{(1-t^I)i}{1-t^G} \qquad \Rightarrow \qquad \hat{r} = \hat{t}^G - \hat{t}^I \tag{16}$$

According to equation (16) we can see that on the one hand an increase in the interest tax rate lowers the cost of equity finance, $dr/dt^i < 0$. The opposite is true for an increase in the capital gains tax rate $dr/dt^G > 0$ since this effect increases the cost of equity finance in the form of retained earnings.

Due to an increase in the interest tax rate equity finance becomes more attractive compared to external finance since savers will earn a lower net interest rate on debt. As an implication of arbitrage they will also require a lower return on equity. This effect lowers the debt asset ratio such that retained earnings are increasingly used as a source of finance:

$$\frac{db}{dt^i} = -\frac{i\frac{1}{(1-t^G)(1-t^U)}}{[2m'(b)+m''(b)]} < 0 \ .$$

Moreover, a lower corporate income tax rate as well as a lower capital gains tax rate decrease the debt asset ratio. This reflects, that interest expenditures are deductible from the profit tax and thus a lower profit tax diminishes the advantage of debt finance:

$$\frac{db}{dt^U} = + \frac{i \frac{(1-t^i)}{(1-t^G)(1-t^U)^2}}{[2m'(b) + m''(b)]} > 0 \ ,$$

$$\frac{db}{dt^G} = + \frac{i \frac{(1-t^i)}{(1-t^G)^2(1-t^U)}}{[2m'(b) + m''(b)]} > 0 \ .$$

We start each simulation scenario from a calibrated equilibrium, where 55% of net investments are financed via retained earnings and 40 % via debt. New share issues are fixed at a rate of 5% and do not vary over time. In Scenario 1 and 2, the effect caused by the increase in the interest tax rate as well as the lowering of the tax rate on corporate profits, lead to a rise in the relevance of retained earnings as a source of finance . In the new long run equilibrium 58% of net investments will be financed via retained earnings while only 36% will be financed via debt.

In scenario 3 the increase in the interest tax rate decreases the cost of equity finance slightly. However, the introduction of a capital gains tax of 30% boosts the cost of equity finance once again while the decrease in the corporate tax rate increases the cost of debt finance. Starting from the initial equilibrium with 55% retained earning and 40% debt finance the new long run equilibrium will be characterized by an increase of 12% in the debt-asset ratio, implying that 50% of all net investments will be financed via retained earning while 45% will be financed via debt.

4.4 Calibration and Behavioral Parameters

Relying on the comparative static analysis we anticipate that the first two proposed reform scenarios will have a stimulating effect on capital accumulation and therefore on economic growth. However, this kind of examination just gives qualitative insights of the policy proposals. To achieve any quantitative results, we apply a CGE model calibrated to a stationary equilibrium along a balanced growth path of the German economy. The real growth rate of the German economy is approximated to be 1%, which is a quite fair estimation for Germany after re-unification. Depreciation is assumed to be 0.1 and the adjustment speed towards the new steady state is determined by half life of investments. According to a the study of CUMMINS ET AL. (1996) we take a value of 8.0, implying

that during the following 8 years after a policy shock half of the long run increase in the capital stock is accumulated.

A major advantage of using a CGE model is, that such a model incorporates all economy-wide repercussions and not only first order effects. However, these repercussions are strongly influenced by the behavioral parameters applied, and therefore special diligence is needed while calibrating the model. All behavioral parameters used in the model are standard results confirmed by the empirical literature. The most important ones are summarized in **Table 2**:

Table 2: *Behavioral Parameter Values*		
Elasticity of Capital Demand*)	(CHIRINKO 2002)	- 1.0
Half Life of Capital Accumulation (in years)	(CUMMINS et al. 1996)	8.0
Elasticity of Debt-Asset Ratio^)	(GRAHAM et al. 1998)	0.36
Intertemporal Elasticity of Substitution (FLAIG 1988)		0.4
Elasticity of Factor Substitution (GERMAN BUNDESBANK 1995)		0.8
Labour supply elasticity (weighted average of FENGE et al. 2002)		0.37
Elasticity with respect to: *) cost of capital; ^) profit tax		

The elasticity of capital demand can be interpreted as follows: A one percent increase in the user cost of capital leads to a decline in the long run capital stock by one percent. Concerning the elasticity of the debt-asset ratio, a decrease in the profit tax rate by 8.6 percentage points will lead to an increase in the debt asset ratio of $0.36 * 8.6 = 3.96$ percentage points.

The labour supply elasticity, representing an average over empirical estimates for different age and sex groups is actually a compensated supply elasticity, thus showing just the substitution effect between labour and leisure since this is the only effect we are interested in.

4.5 Quantitative Results

As mentioned above, half of the long run increase in the capital stock will be accumulated within the first 8 years after the shock appeared. Accordingly, 99.9% of the new steady state capital stock will be built up within 80 years. Due to he large reduction in the statutory corporate tax rate, from 38.6% to 30% , as well as the nonexistence of a capital gains tax leads to a major reduction in the user cost of capital. The cost of capital

decreases by 7.02% in scenario 1 and by 4.23% in scenario 2. This considerable decline in the cost of capital boosts investments and enhances economic growth. Thus, the capital stock increases from its initial value by about 3.62% in scenario 1 and 3.29% in scenario 2 leading in turn to an increase in GDP by 1.43% and 1.62%, respectively. Concerning scenario 3, the large increase in the cost of capital which amounts up to nearly 17%, the capital stock declines by 5.54% and thus GDP shrinks by 2.09% until the new steady state is asymptotically reached.

Regarding the source of finance, the debt asset ratio decreases in the scenarios 1 and 2, while it increases in scenario 3. Thus, scenario 1 and 2 lead to a strengthening of the equity position of the representative firm, implying a lower indebtedness in the new steady state. The reason for the huge increase in the debt asset ratio in scenario 3 rests on the existence of the capital gains tax. As discussed at length above, the capital gains tax of 30 % increases the cost of equity finance, implying that debt is now the most attractive source of finance.

Table 3: *Key Economic Figures* (Long Run Change in %)

	Scenario 1	*Scenario 2*	*Scenario 3*
Capital stock	3.62	3.29	- 5.54
User Cost of Capital	- 7.02	- 4.23	16.95
GDP	1.43	1.62	- 2.09
Debt Asset Ratio	- 8.61	- 8.61	11.96
Domestic Assets	4.79	- 8.29	6.18
Net Foreign Asset Position	- 23.18	- 20.76	37.19
Gross Wage	1.28	0.98	- 2.17
Disposable Income	6.43	6.55	2.64
Labour Supply	0.37	0.81	- 0.23
Domestic Consumption	0.63	1.14	- 0.80
VAT Rate (Change in %-points)	6.7	4.9	4.50
Welfare in % of Life Time Income	0.39	0.55	- 0.74
Welfare in % of GDP	0.21	0.29	- 0.39

Source: own calculations

Table 3 provides a rough overview of further important long run key economic figures. Until now, the simulation results of scenario 1 and 2 did not differ noticeably, thus the results concerning the change in domestic assets may surprise at first glance. The explanation is intuitive: While there is no dividend tax in scenario 1, firm values - which represent a major share of the financial wealth of households - increase due to reform

scenario 1 by 24%. In contrast, in scenario 2, where a dividend tax of 30% is levied, the firm value decreases by 10% from its initial value. Thus, the value of assets held by domestic households increases in scenario 1 although the net foreign asset position of domestic households deteriorates, while the value of assets held by domestic households decreases in scenario 2, due to lower firm values.

In all simulation scenarios labour income is taxed at a progressive rate with a top tax rate of 35% instead of the previous 44.3% (remember however that we compute the calculations with an effective tax rate of 12% after the reform and of 16.6% before the reform). The major tax relief on labour income reduces the distortion concerning the labour-leisure decision and households are willing to supply a larger amount of labour to the firm sector. Quantifying this effect, the reduction in the labour tax leads to a rise in disposable income by 6.43% in scenario 1 and by 6.55% in scenario 2. In turn, households increase their labour supply by 0.37% and 0.81%, respectively. However, this is not the only effect which determines labour supply. Due to the augmented capital accumulation the marginal product of labor, the complementary production factor, rises, also implying an increase in labour supply. According to economic theory, households use part of their higher income for consumption, which rises by 0.63% and 1.14%, respectively. Once again scenario 3 differs in its results: Since scenario 3 is not growth enhancing, capital decumulates and thus labor supply decreases by 0.23% and in turn consumption shrinks by 0.8%.

Since the reform scenarios have to be financed somehow, we allow for the VAT to adapt in order to balance the governmental budget without cutting lump-sum transfers to households.[12] Simulating scenario 1, the VAT instantaneously jumps by 6.9% -points from 16% to 22.9% thus assuring that the reform is revenue neutral. In the course of time, agents adjust their behavior to the new constellation of tax rates by increasing their labour supply and consumption, which leads to a broadening of the corresponding tax bases. During this adjustment process the VAT rate decreases slightly from initially 22.9% to a level of 22.7%, as shown in **Figure 4**. Hence, after all economy wide adjustment processes have taken place, especially the base broadening of the labour and consumption

[12] Applying the reform proposal made by the GCEA consistently would require that governmental transfers are also subject to the labour income tax. Thus, the next upcoming task is to include lump-sum transfers to households in the tax base for labour income.

tax base, an increase of 6.7% in the VAT rate is sufficient to balance the governmental budget, without any cut in expenditure. Analyzing scenario 2, there is an initial jump in the VAT rate to 26%, followed by a sharp decrease to 21%. Since the government can now draw also on the additional tax revenue from the dividend taxation, the required increase in the VAT rate amounts to 4.9% -points, thus about 2% less than in scenario 1. In scenario 3, the VAT rate rises to a level of about 20.8%, and there is an overall increase by 4.5% -points, compared to the initial (pre reform) value.

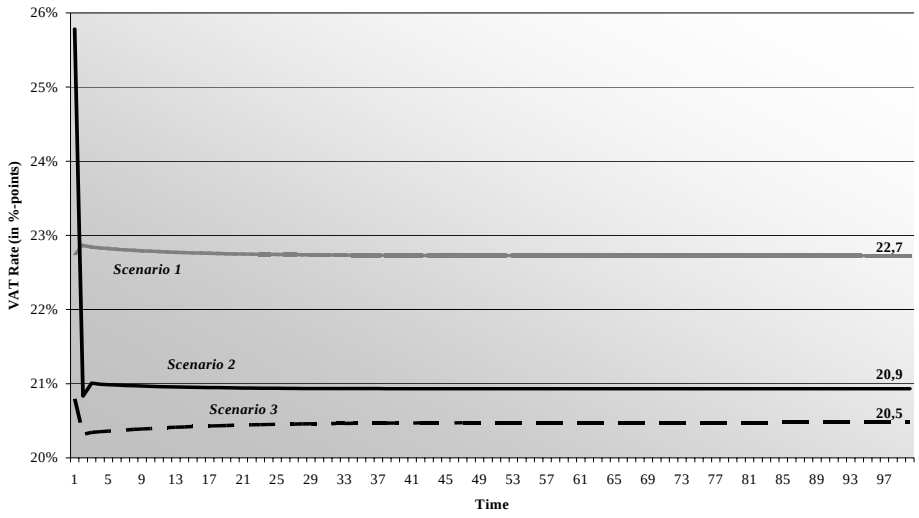

Figure 4: *Transition Path for VAT Rate*

To be able to evaluate the welfare implications of the three reform scenarios we rely on the equivalent variation to measure welfare. Therefore we compute pre and after reform utility levels of a representative individual and calculate how much money the agent would need before the reform to reach the same utility level which is achieved after the reform. The present value of this cash flow is then expressed in terms of total life time income of the representative agent and GDP. Scenario 2 yields not only the largest increase in GDP but also the largest increase in welfare. While welfare in terms of life time income increases by 0.55% - which is equivalent to a 0.29% increase in terms of GDP in Scenario 2 - in Scenario 1, welfare only amounts to 0.21% of GDP and there is even a decrease in welfare in terms of GDP of about 0.39% in scenario 3. The decline in welfare in scenario 3 is basically the result of the high capital gains taxation which leads to an increase in the cost of capital, decumulation of capital, decrease in wages and consumption.

4.6 Sensitivity Analysis

The large number of empirical papers which estimate different values for important behavioral parameters used in the model, offers us the opportunity to check the robustness of our results if different values for the key behavioral parameters are assumed. There are basically four different elasticities which are of interest in our context: the labour supply elasticity ε, the intertemporal elasticity of substitution σ^C, the elasticity of factor substitution σ^K , and the elasticity concerning the debt asset ratio σ^B .

Table 4: *Sensitivity Analysis* (Long Run Changes in %)

Scenario 1)*		$\varepsilon = 0.1$	$\sigma^C = 0.6$	$\sigma^K = 1.3$	$\sigma^B = 0.16$	$\sigma^B = 0.56$
$\widehat{K}$	**3.6**	3.3	3.6	5.8	3.5	3.7
$\widehat{LL}$	**0.37**	0.09	0.37	0.42	0.36	0.39
$\widehat{C}$	**0.6**	0.3	0.64	0.78	0.59	0.68
$\widehat{A}$	**4.8**	5	4.8	4.5	4.8	4.8
$\widehat{B}$	**−5.3**	−5.6	−5.3	−3.3	−0.4	−10.2
Scenario 2)*		$\varepsilon = 0.1$	$\sigma^C = 0.6$	$\sigma^K = 1.3$	$\sigma^B = 0.16$	$\sigma^B = 0.56$
$\widehat{K}$	**3.3**	2.7	3.3	5	3.2	3.4
$\widehat{LL}$	**0.8**	0.2	0.8	0.9	0.8	0.8
$\widehat{C}$	**1.1**	0.4	1.2	1.3	1.1	1.2
$\widehat{A}$	**−8.2**	−7.9	−8.3	−8.9	−7.8	−8.8
$\widehat{B}$	**−5.6**	−6.2	**−5.6**	−4.1	−6.7	−10.5
Scenario 3)*		$\varepsilon = 0.1$	$\sigma^C = 0.6$	$\sigma^K = 1.3$	$\sigma^B = 0.16$	$\sigma^B = 0.56$
$\widehat{K}$	**−5.5**	−5	−5.5	−8.8	−5.6	−5.5
$\widehat{LL}$	**−0.2**	0	−0.2	−0.3	−0.2	−0.3
$\widehat{C}$	**−0.8**	-0.6	−0.7	−1.1	−0.6	−1
$\widehat{A}$	**6.2**	5.9	6.2	6.7	6.2	6.2
$\widehat{B}$	**5.8**	5.9	5.8	2.2	−0.6	12.1

*)applied parameters: $\varepsilon = 0.37$; $\sigma^C = 0.4$; $\sigma^K = 0.8$; $\sigma^B = 0.36$; $\sigma^B = 0.36$

Source: own calculations.

Table 4 shows the results of the simulation exercise of scenario 1 to 3 with different values for the underlying elasticities. The basic scenario applies a labour supply elasticity of 0.37 which is a weighted average of compensated wage elasticities of labour supply for Germany estimated by Fenge et al. (2002).[13] If we set this elasticity close to zero,

[13]The authors compute four different elasticities for men and women aged 20-39 and 40-39, using data from the German Socio-Economic Panel We then compute a weighted average of 0.37, using these elasticities and the share of employed in each of these categories.

i.e. to 0.1, we model an almost fix labour supply. In this case, a higher marginal product of labour resulting from a higher capital intensity leads to hardly any increase in labour supply. In scenario 1 (2, 3) labour supply increases by only 0.09% (0.2%, 0%) and thus capital accumulation is impeded. In the long run the capital stock will increase by only 3.3% (2.7%) instead of 3.6% (3.3%) calculated in base scenario 1 (2). Accordingly, private consumption increases only to a smaller extent by 0.3% (0.4%).

Next, the values of the intertemporal elasticity of substitution, σ^C, reflects the change in the pattern of consumption and saving over time. We start with a value of 0.4 in the base scenario and then run a simulation with a higher value of 0.6. The model is largely resistant to the change in the intertemporal elasticity of substitution. The results change only slightly as depicted in the fourth column of table 4 due to the fact that the long-run interest rate is bound by the relationship $R = G/\rho$. According to theory, a higher intertemporal elasticity will have a stronger effect on the savings behavior of households. If the net interest rate decreases, savings will increase, since the income effect will dominate the substitution effect. On the one hand, the substitution effect arises since a lower interest rate increases the price of future periods consumption and thus we have a substitution of present consumption for future consumption. On the other hand, a lower interest rate leads to a positive income effect since the amount of savings needed, to attain a given consumption level tomorrow, is increased.

Another important parameter is the elasticity of substitution between capital and labour. This elasticity is like a capital demand elasticity in our model. The more elastic capital demand is, the higher is the reaction to a change in the tax rates. Accordingly, even a slight lowering of the pre-tax rate of return will stimulate capital creation. A higher elasticity means that in **Figure 2**, the MRR curve becomes flatter such that at a given pre-tax rate of return s the same decrease in the required pre-tax rate of return u is followed by a higher adjustment of the capital stock. The basic scenario employs a factor substitution elasticity of the CES production function of 0.8 . There are several estimates for this measure in the empirical literature, thus we simulate the proposed scenarios with a higher elasticity of 1.3. The higher elasticity leads to an even larger increase in the change of the long run capital stock compared to the base case.

The long run capital stock increases by 5.8% (5%) in scenario 1 (2) and it decreases to an even larger extent, by 8.8%, in scenario 3. Accordingly, the increased capital intensity

leads to a change in labour supply, which increases by 0.42% and 0.9% in scenario one and two. In turn the consumption level of households rises by 0.78% and 1.3%, respectively.

Regarding the debt elasticity, this measure shows how elastic firms react with their debt ratio to the different tax reform scenarios. In the baseline model the elasticity concerning the debt asset ratio is set to 0.36, while column six and seven of table 4 show the simulation results using a debt asset elasticity of 0.16 and 0.56 respectively. Firms choose the optimal debt level such that the costs of internal financing and external financing are equalized. If internal financing becomes cheaper, i.e. the required rate of return declines, enterprises will start financing more of their investments via retained earnings, until the costs of external financing will also decline due to the shrinking debt ratio. A reduced elasticity of i.e. 0.16 leads to a less elastic reaction of firms to cheaper internal financing.

5 Conclusion

Following the ongoing discussion of reforming the German tax system the paper takes up the reform proposal made by the German Council of Economic Advisors. This reform proposal suggests a dual income tax for Germany similar to the one already practiced in the Nordic Countries. Analyzing the economic effects of such a dual tax system we use a computable general equilibrium model and simulate three different scenarios. With quite realistic assumptions on behavioral parameters and marginal tax rates the reform leads to an increase in investments and therefore in capital accumulation and GDP as well as household consumption and welfare. This complete restructuring of the tax system leads in the long run to a welfare gain which is mainly based on the increase in life-time wealth as a result of the lower tax burden. Although some problems arise in the taxation of small and medium-sized firms, these can be partly solved as the experience of Nordic Countries shows.

One of the next upcoming tasks is to split the firm sector into a corporate and non-corporate sector to show the distortionary effects of capital income taxation on the organizational choice of a firms. Another important extension of the model will be to implement the residence principle instead of the source principle of taxation, to avoid the behavioral

adjustment of foreign investors due to a change in the domestic interest tax rate. Moreover, governmental transfers should be included in the labour income tax base to reflect this additional feature characterizing a dual income tax system.

Appendix

A: Firm's Optimization

Following a basic non-arbitrage condition, we know that firm owners must be indifferent between investing their money either on the capital market, earning a net of tax return of r_t, or in firm equity which yields dividend payments D_t/V_t and capital gains $[GV_{t+1} - V_t]/V_t$ per unit of wealth:

$$r_t V_t = (1 - t^D)D_t + (1 - t^G)\left[GV_{t+1} - V_t - VN_t\right]. \tag{A.1}$$

Using the two tax factors $\gamma^D \equiv \frac{(1-t^D)(1-t^U)}{1-t^G}$ and $\gamma^I \equiv (1 - \frac{1-t^D}{1-t^G})\beta(1 - et^U)$ and substituting the explicit expression determining dividends (equation (5)) we get:

$$[1 + \underbrace{\frac{r_t}{1-t^G}}_{r_t^e}]V_t = \underbrace{\frac{1-t^D}{1-t^G}D_t - VN_t}_{\chi_t} + GV_{t+1}\ , \tag{A.2}$$

with

$$\begin{aligned} \chi_t &= \gamma^D\left[Y - J - wL - (i+m)B\right] + \tfrac{1-t^D}{1-t^G}BN \\ &+ \left[\gamma^I + \tfrac{1-t^D}{1-t^G}(1-e)t^U\right]\delta K \\ &- \left[\gamma^I + \tfrac{1-t^D}{1-t^G}(1-et^U)\right] I\ . \end{aligned} \tag{A.3}$$

The market value of the firm is equal to the present value of all future dividends and accruing capital gains less new share issues. The appropriate discount factor is given by $r_t^e = r_t/(1-t^G)$. Since shareholders can only maximize end of period values we use the superscript e to indicate end of period values, according to: $V_t^e = (1 + r_{t+1}^e)V_t$. Hence, end of period values satisfy: $V_t^e = \chi_t + \frac{GV_{t+1}^e}{1+r_{t+2}^e}$. The fundamental value of capital is given by solving equation (A.2) forward.

At the beginning of a period the capital stock and the stock of debt are exogenously given, as they are determined historically. However, the future capital stock and debt are endogenous, as they result from the optimal investment and debt policy. Defining the value function $V(K_t, B_t)$ as a function of the accumulated stock variables K_t and B_t, the Bellman problem becomes:

$$V^e(K_t, B_t) = \max_{L,\ I,\ BN}\left[\chi_t + \frac{G\ V^e(K_{t+1}, B_{t+1})}{1 + r_{t+1}^e}\right] \text{s.t. (1) and (2).} \tag{A.4}$$

Further we use $q_t \equiv \frac{\partial V(K_t)}{\partial K_t}$ and $\lambda_t \equiv -\frac{\partial V(B_t)}{\partial B_t}$ as the shadow prices of capital and debt respectively. They determine the increase in the value of the objective function resulting from

an increase in capital or debt. The **optimality conditions** concerning the control variables labour, L, investment, I, and new debt, BN, are:

$$\begin{array}{llrcl} \text{(a)} & L_t: & w_t & = & F_{L,t}, \\ \text{(b)} & I_t: & q_{t+1} & = & [\gamma^D J_I + \gamma^I + \frac{1-t^D}{1-t^G}(1-et^U)](1+r^e_{t+1}) \ , \\ \text{(c)} & B^N: & \lambda_{t+1} & = & \frac{1-t^D}{1-t^G}(1+r^e_{t+1}) \ . \end{array} \tag{A.5}$$

The interpretation of (A.5a) is straight forward: To maximize the market value, firms should hire labour as long as the marginal product of labour is above its marginal cost, represented by the wage rate, w_t. Optimal investments must satisfy (A.5b). Substituting in the tax factor γ^I the expression simplifies to: $q_{t+1} = \gamma^D J_I + \beta(1-et^U)$. Thus, optimal investment incorporates the marginal advantage of decreasing adjustment cost and the marginal advantage of accelerated depreciation if $e > 0$.

Moreover, the **envelope conditions** concerning the stock variables are:

$$\begin{array}{llrcl} \text{(a)} & K: & q_t & = & \gamma^D[F_K - J_K + m'b^2] + [\gamma^I + \frac{1-t^D}{1-t^G}(1-e)t^U]\delta + \frac{q_{t+1}}{1+r^e_{t+1}} \ , \\ \text{(b)} & B: & -\lambda_t & = & -\gamma^D[i+m+m'b] - \frac{\lambda_{t+1}}{1+r^e_{t+1}} \ . \end{array} \tag{A.6}$$

The shadow price of capital given in equation (A.6a) represents the value of an induced marginal profit. Adding one more unit of capital creates a marginal profit stream consisting of three different components: first, profits increase by the marginal product of capital; second, due to lower adjustment cost future revenues increase; and third, the interest burden on debt is reduced, as the debt asset ratio is improved.

Combining equations (A.6a) and (29b) we get an expression for the marginal product of capital:

$$F_K - \delta = \frac{\tilde{r}_t\left[\gamma^I + \left(\frac{1-t^D}{1-t^G}\right)\left(1-et^U\right)\right]}{\gamma^D} - m'b^2 \ . \tag{A.7}$$

The left hand side describes the value of the marginal product of capital less depreciation. The right hand side includes the cost of finance as a weighted average of the cost equity finance and the cost of debt finance. The cost of retained earnings decreases whenever the capital gains tax or profit tax decrease or the tax on interest income is increased.

Optimal debt policy is obtained by substituting equation (A.5c) into (A.6b):

$$\frac{r_t}{1-t^G} = (1-t^U)[i+m+m'b] \ . \tag{A.8}$$

The left hand side represents the cost of equity finance while the right hand side denotes the cost of debt financing. The optimal debt level is achieved, if the cost of internal financing are equal to the cost of external financing.

B: Household Behavior and Welfare

The financial wealth of the representative household consists of domestic equity V and interest bearing assets, namely, business debt B, as well as domestic and foreign public debt, D^G and D^F, respectively. Thus, the portfolio identity states:

$$A = B + D^G + D^F + V \ . \tag{B.1}$$

The human capital endowment of the representative household is defined as the discounted sum of all future net of tax labour and governmental income. In addition, labour income is corrected for the disutility of work, $(1 + t_s^C)\varphi(L_s^S)$, and governmental income appears in terms of public lump sum transfers T_t^H. Accordingly, the get:

$$H_t \equiv \sum_{s=t}^{\infty} \left[(1 - t^L)w_s L_s^S - (1 + t_s^C)\varphi(L_s^S) + T_s^H\right] \cdot \prod_{u=t+1}^{s} \frac{G}{(1 + r_u)} \tag{B.2}$$

Referring to the text, total wealth of households accumulate through the interest earnings on owned assets, $(1 + r_t)A_t$, as well as after tax labour income, $(1 - t^L)w_t L_t^S$, and governmental transfers, T^H, less after tax consumption expenditures, $(1 + t^C)C_t$:

$$GA_{t+1} = (1 + r_t)A_t + (1 - t^L)w_t L_t^S + T_t^H - (1 + t^C)C_t \ . \tag{B.3}$$

The intertemporal budget constraint is derived by solving forward (B.3). As we know that total wealth, TW_t, consist of financial wealth and human capital. The equation for total wealth states:

$$TW_t = (1 - r_t)A_t + H_t = \sum_{s=t}^{\infty} \left\{(1 + t_s^C)\left[C_s - \varphi(L_s^S)\right]\right\} \cdot \prod_{u=t+1}^{s} \frac{G}{(1 + r_u)} \tag{B.4}$$

Preferences can be described by:

$$U_t = u\left(Q_t\right) + \rho \cdot U_{t+1} = \sum_{s=t}^{\infty} \rho^{s-t} \cdot u\left(Q_t\right) \ \text{, with} \quad Q_t = C_t - \varphi(L_t^S) \tag{B.5}$$

where Q_t denotes individual consumption, C_t, adjusted by the disutility of work, $\varphi(L_t^S)$. The optimization problem is once again solved by dynamic programming. Making use of the value function (B.5) and defining the shadow price of interest bearing assets, $\kappa_t = \frac{\partial U(A_t)}{\partial A_t}$, gives rise to Bellman problem:

$$U(A_{t+1}) = \max_{Q_t, L_t^S} \ \{u(Q_t) + \rho \cdot U(A_{t+1})\} \quad \text{s.t. (12).} \tag{B.6}$$

The **optimality conditions** with respect to the control variables Q_t, and labour supply L_t^S are:

$$\begin{array}{llcl} \text{(a)} & Q_t: & u\prime(Q_t) & = \ \rho \cdot \kappa_{t+1} \cdot (1 + t_t^C) \cdot \frac{1}{G} \\ \text{(b)} & L_t^S: & \varphi'(L_t^S) & = \ \frac{(1-t^L)}{(1+t^C)} w_t \end{array} \tag{B.7}$$

The **envelope condition** concerning the stock variable A_t states:

$$\kappa_t = \rho \cdot \kappa_{t+1} \cdot \frac{1 + r_t}{G} \ . \tag{B.8}$$

Applying a CES utility function, $u(Q) = \frac{Q^{1-1/\sigma}}{1-1/\sigma}$, where σ represents the intertemporal elasticity of substitution, the closed form solution of the consumption function can be derived:

$$(1+t_s^C)Q_s = \left[\frac{1+t_s^C}{1+t_t^C}\right]^{1-\sigma} \left(1+t_t^C\right) Q_t \cdot \prod_{u=t+1}^{s} \left[\frac{\rho R_u}{G}\right]^{\sigma} \quad . \tag{B.9}$$

Since this optimal consumption profile is unrestricted, we take the intertemporal budget constraint, equation (B.4), which refers to total wealth to constrain the optimal consumption level. Substituting in yields:

$$(1+t_t^C)Q_t = mpc_t \cdot TW_t \ , \tag{B.10}$$

where mpc_t denotes the marginal propensity to consume.

For the computations we need to introduce a new variable mc_t, defined as $mc_t = \left(1+t_t^C\right)^{1-\sigma} mpc_t$ such that the above equation becomes

$$\frac{mc_t}{\left(1+t_t^C\right)^{-\sigma}} \, Q_t \quad = \quad TW_t$$

C: Welfare Analysis

As a measurement for welfare, we apply the equivalent variation. Therefore, we compare pre and after tax reform consumption levels of the representative agent, which depend on her pre and after reform total wealth.

$$EV = TW(U^1, p^0) - TW(U^0, p^0) \tag{C.1}$$

In a first step we derive the functional form of the utility function by substituting the CES utility function, mentioned above, into the intertemporal utility function (B.5). Then we use optimal consumption profile derived in equation (B.9) and obtain:

$$U_t = \frac{-1}{1-\frac{1}{\sigma}} \frac{1}{1-\rho} + \frac{1}{1-1/\sigma} \cdot \sum_{s=t}^{\infty} \rho^{s-t} Q_s^{1-1/\sigma} \ . \tag{C.2}$$

Inverting the indirect utility function, we can derive an expression for total welfare as a function of indirect utility. From the above equation we infer that:

$$Q_t = \left[\left(\frac{\sigma-1}{\sigma} U_t + \frac{1}{1-\rho}\right) \cdot mpc_t\right]^{\frac{\sigma}{\sigma-1}} = \frac{mpc_t \cdot TW}{(1+t_t^C)} \ , \tag{C.3}$$

what results in:

$$\Rightarrow TW = (1+t_t^C) \cdot [mpc_t]^{-\frac{1}{1-\sigma}} \left(\frac{\sigma-1}{\sigma} U_t + \frac{1}{1-\rho}\right)^{\frac{\sigma}{\sigma-1}} \quad . \tag{C.4}$$

We can now compute the equivalent variation in wealth which is our welfare measure. Since we need to refer welfare to an interpretable measure, we convert this to an income stream of initial prices according to:

$$EV = y + y\left(\frac{G}{R}\right) + y\left(\frac{G}{R}\right)^2 + ... = y \cdot \frac{1}{1-\frac{G}{R}} = y \cdot \frac{1}{1-\rho} \ , \tag{C.5}$$

yielding:

$$\Rightarrow y^{EV} = (1-\rho)EV \ . \tag{C.6}$$

Accordingly, the welfare gain/loss in percent of GDP can be computed as:

$$\frac{y^{EV}}{GDP} = \frac{(1-\rho)EV}{GDP} \ . \tag{C.7}$$

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