601 LECTURE NOTES IN ECONOMICS AND MATHEMATICAL SYSTEMS

Doina Maria Radulescu

CGE Models and Capital Income Tax Reforms

The Case of a Dual Income Tax for Germany

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Lecture Notes in Economics and Mathematical Systems 601

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With 33 Figures and 34 Tables

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To my parents, Mariana and Andrei

Foreword

Capital income taxation is a complicated issue because of the general equilibrium implications these taxes have with regard to the intersectoral and intertemporal allocation of economic resources. Together with Michael Stimmelmayr (CES, Munich) and Christian Keuschnigg (IFF, St. Gallen), Doina Radulescu from the Ifo Institute for Economic Research has designed a complex and particularly elegant intertemporal general equilibrium model of the economy, called IfoMod. IfoMod makes it possible to calculate the welfare gains and losses from fundamental tax reforms in present value terms.

One of the tax reforms Doina Radulescu analyses is the move towards a dual income tax, as is used in some Scandinavian countries. She analyses this tax using German data, because it was recently proposed, among others, by the German Council of Economic Advisors. In the meantime, IfoMod has become a standard tool for the Ifo Institute. According to the Council of Economic Advisors, it is not only state-of-the-art, but one of the world's most developed and advanced CGE models for the purpose of analysing intertemporal allocation problems in growing economies.

Hans-Werner Sinn

Preface

This book was written during my time acting as a PhD candidate in the Public Finance Department at the Ifo Institute for Economic Research in Munich.

First and foremost I would like to thank my supervisor Hans-Werner Sinn, University of Munich and President of the Ifo Institute. He was the first one to raise my interest in capital income taxation and continued to stimulate my proccupation for this topic over the last years. I am particularly grateful to him for all the things I've learnt.

I am also very much indebted to my second supervisor, Christian Keuschnigg from the University of St. Gallen who led me to the field of CGE modelling and kindly accompanied my work step-by-step with very competent advice and patience. I enjoyed working with both professors and feel very lucky to have had the opportunity to have conducted a thesis on such an interesting and up-to-date policy issue.

Just as much I would like to thank Assaf Razin for the insightful comments which he provided during my research visit at Tel Aviv University. Furthermore, I am also particularly thankful to Peter Birch Sørensen from the University of Copenhagen, who made crucial suggestions for enhancing the quality of my work especially during the final phase of my thesis.

I also benefited from the helpful comments made by Wolfgang Wiegard, Søren Bo Nielsen and Bernd Genser, while visiting various seminars and international conferences.

I should not forget to mention my colleague Michael Stimmelmayr at CES whose continuous motivation was of particular support.

The realization of this project would not have been possible without the kind support of my colleagues and friends at Ifo to which I am particularly grateful especially to Chang Woon Nam and Rüdiger Parsche.

Last but not least I would like to thank my parents at home in Romania. Without their support and encouragement it would have been simply impossible to complete this thesis. This is the reason why I would like to dedicate this thesis to them.

München, August 2007 *Doina-Maria Rădulescu*

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1

Introduction

Tax policy reform has always been an important task and an up-to-date policy issue not only in Germany but all over the world. Especially in times like now when the economic slowdown is accompanied by a situation of high and persistent unemployment, public discussions about tax reforms and concrete reform proposals are inevitable. Germany, once the country of the 'Economic Miracle' and the leader of European growth statistics has now fallen behind all other European countries in terms of growth, such that a tax reform is unavoidable. Accordingly, it is not surprising to observe the attention that has been lately paid to this topic both by the media and by economists and politicians. In this context, a fundamental restructuring of the tax system seems to be an immediate need, in order to enhance Germany's standing as an investment location and thus as a step towards overcoming the economic slump. It is not astonishing that even though the last step of the German Tax Reform 2000 has just been implemented, new tax reform proposals are once again on the agenda of the federal government and nearly all political parties. They range from more basic reform proposals such as reducing the corporate tax rate from the present 25 per cent to 19 per cent as suggested by the federal government, to more complicated and comprehensive tax reforms such as a fully integrated tax system for business and personal income (Kirchhof, 2003), a consumption based income tax (Rose, 2003) or the introduction of a dual income tax (DIT) as suggested by Sinn (2003a) and the German Council of Economic Experts (GCEA, 2003).

Without a conceptional change of the German tax system, the arbitrary reduction of some rates appears to lead to a more complicated and non-transparent tax system that follows neither the principles of a comprehensive income tax nor those of a schedular tax system. The new tax system has to ensure an increased neutrality with regard to the investment and financing decision as well as to the choice of legal form. A competitive tax system has to be simple, reliable, efficient and growth enhancing. Neglecting, postponing or even abandoning the idea of a comprehensive tax reform does not represent an alternative in the light of the increased international tax competition. Defer-

ring such a reform would cause losses in tax revenue since domestic investment activity would continuously decline. As opposed to this, a comprehensive tax cut accompanied by the scrapping of tax loopholes would be likely to reduce the revenue shortfalls.

Due to their wide-spread and considerable effects on the whole economy, a thorough analysis of the consequences of implementing a comprehensive tax reform is thus essential. Such an examination can be performed by using a computable general equilibrium (CGE) model which allows to evaluate and quantify not only the more obvious first order effects but also the economy-wide repercussions and second-order effects of a tax reform.

The major aim of this study is to examine the effects of introducing a dual income tax in Germany as suggested by Sinn (2003a) and by the GCEA (2003). To evaluate the consequences of implementing such a tax system, the study applies *IFOMod* a dynamic CGE model which was developed to analyze the incidence of taxes and tax reforms on the economy in a systematic way. The superiority of *IFOMod* is extensively illustrated below.

The purpose of any comprehensive tax reform and accordingly also of introducing a DIT, should be to enhance economic growth, to ensure an increased efficiency and neutrality of the tax system, to provide the basis to survive in the international tax competition and last but not least to cover the government's revenue needs. Therefore, the simulations performed in this study will assume that the reform is financed either via a reduction in public transfers or by an endogenous increase in the VAT rate.

The contents of the study are as follows:

Prior to the examination of the effects of introducing a dual income tax, Chapter 2 suggests the reasons why a reform of the German capital income tax system is needed in the first place and what the Tax Reform 2000 has already achieved. This chapter also includes basic theoretical and empirical arguments for an overhaul of the German tax system in general and for the necessity to apply lower capital income tax rates in particular. In addition to a brief description of the German corporate income taxation system and its change due to the German Tax Reform 2000, some further economic arguments such as Germany's recent poor economic performance, the fierce international tax competition and the lack of structure of the tax system are illustrated to support the idea of introducing a dual income tax.

Chapter 3 discusses in detail the dual income tax as a possible reform option. Following the description, the origins and the theoretical foundations of such a tax system, the main advantages of this tax are highlighted. This chapter also critically assesses the experiences of the Nordic countries with this schedular tax and presents two concrete reform proposals made by the GCEA (2003) and Sinn (2003a) for Germany.

The GCEA proposal features a proportional capital income tax of 30 per cent, which also equals the tax rate on corporate profits, and progressive labor income taxes up to 35 per cent. To avoid the double taxation of retained or

distributed profits, no dividend or capital gains taxes apply. The Sinn (2003a) reform scenario combines a dual income tax with an allowance for corporate and non-corporate equity. Corporate and non-corporate profits are taxed at 35 per cent and the half income principle of dividend taxation applies such that distributed profits are subject to 46 per cent taxation. Interest income as well as the imputed return on equity are taxed at a flat rate savings tax of 20 per cent. Labor income is subject to progressive taxation ranging from 15 to 35 per cent.

Chapter 4 describes the *IFOMod* applied general equilibrium model which is used to evaluate and quantify the economic and fiscal effects of introducing a dual income tax.

IFOMod contains a detailed modelling of the firm sector and features the traditional Ramsey model on the household side. This, in turn, permits to analyze the welfare change of the representative individual caused by a tax reform. Additionally, *IFOMod* is in line with neoclassical growth theory and savings and investment decisions are forward looking, thus permitting a consideration of important tax capitalization effects. Moreover, the model contains an endogenous investment financing policy of firms and labor supply as well as international portfolio investments. Therefore, by introducing both a corporate and a non-corporate sector, the effects of changes in different tax rates can be individually described for corporate and non-corporate firms. The overall effect will depend on the magnitude of each sector within the economy.

The model does not only describe the economy's new steady state solution under the new tax rules but also offers additional results in the form of adjustment paths of the macroeconomic variables such as capital stock, GDP, foreign debt, labor supply and consumption. For the ultimate evaluation of a tax reform, the model also allows for the computation of welfare variations expressed as changes in the equivalent variation in consumption.

Chapter 5 provides a detailed description of two simulation scenarios which both consider introducing a dual income tax in Germany.

The most significant outcomes include the fact that both reforms have positive overall macroeconomic effects but their scope depends on the way the different proposals are financed, namely via a reduction in transfers or by allowing for an endogenous increase in the VAT rate. The two reform alternatives lead both to a reduction in the cost of capital from 10.6 per cent for corporate firms and 9.9 per cent for non-corporate ones to 9.4 and 8.6 per cent, respectively, under the GCEA proposal and to 9.2 and 8.1 per cent under the Sinn reform scenario. The Sinn proposal appears to be more substantial in this regard. Welfare in terms of life-time income increases by 2.0 and 2.3 per cent, respectively, in the two scenarios if the reform is financed by a reduction in transfers and by 0.8 and 1.2 per cent if the government budget is balanced by an increase in the VAT rate. Accordingly, the Sinn (2003a) reform proposal achieves better welfare improving results. This effect mainly owes to the fact that under Sinn's scenario a long-run increase of only four

percentage points compared to a 6.5 percentage point rise in the VAT rate in the GCEA proposal is sufficient to balance the government budget.

The transition paths of capital and GDP under the Sinn (2003a) proposal lie above those under the GCEA(2003) reform alternative due to the larger reduction in the cost of capital under the former.

As shown above, under both scenarios the representative individual is better off since welfare in terms of life-time income or GDP increases. However, a more considerable improvement is achieved by implementing Sinn's tax reform proposal.

The final chapter summarizes the major findings of the study in a systematic way and provides some future research suggestions.

2

Why Does Germany Need a Reform of Capital Income Taxation?

After the reform is before the reform. This statement can surely be applied to the present discussions in Germany. Although the final step of the German Tax Reform 2000 has just been implemented, new tax reform proposals are again on the agenda of the federal government and opposition parties. They range from a fully integrated tax system for business and personal income (Kirchhof, 2003) or a consumption based income tax (Rose, 2003) to the introduction of a dual income tax (DIT) as suggested by Sinn (2003a) and the German Council of Economic Experts (GCEA, 2003).

The purpose of a comprehensive tax reform should be to enhance economic growth, to ensure an increased efficiency and neutrality of the tax system, to provide the basis to survive in the international tax competition and to cover the government's revenue needs, aspects which will all be discussed in detail below. Prior to the examination of the effects of introducing a DIT we have to first ask ourselves why a reform of the German capital income tax system is needed in the first place and what the Tax Reform 2000 has already achieved. This Chapter is structured as follows: Firstly, I briefly describe the German system of corporate income taxation, and discuss the German Tax Reform 2000 to see what has already been accomplished and further to determine future desirable reform strategies. Then theoretical and empirical arguments for an overhaul of the German tax system in general and for the need to apply lower capital income tax rates in particular are presented. Finally, additional arguments such as Germany's recent poor economic performance, the fierce international tax competition and the lack of structure of the tax system are illustrated, to support the idea of a tax reform.

2.1 The German Tax System of Corporate Taxation

The evolution of the German corporate income tax system starts in 1891 when the Prussian Minister of Finance, Johannes von Miquel, introduced the modern income tax. In this context, natural as well as legal persons such as

stock companies were subject to the income tax. The separation of personal and corporate income taxation was introduced 30 years later, namely in 1920 (Reiss, 2003). Until 1977, the classical system of capital income taxation which resulted in a double taxation of shareholder income was applied. The full imputation system[1] entered into force in 1977 and was applied until the German Tax Reform 2000 was enacted, which introduced a partial imputation system by means of the half-income taxation of dividends.

The German profit tax system distinguishes between the taxation of corporate firms which are subject to corporate income taxes and non-corporate firms to which personal income taxes apply.

Until 2001, for more than 15 years, corporate firms were liable to a split-rate system with separate taxes on retentions and distributions. These rates declined drastically in the course of time, for example, from 56 per cent for retained earnings and 36 per cent for distributed profits in 1987 to 40 and 30 per cent, respectively, in 2000 (Harhoff and Ramb, 2001).

Nowadays, there is a uniform taxation of corporate profits amounting to 25 per cent.

This tax, as well as the solidarity surcharge, which was designed to finance the costs of German unification, are levied on various types of entities such as stock companies (Aktiengesellschaft-AG), limited liability companies (Gesellschaft mit beschränkter Haftung - GmbH) as well as partnerships limited by shares (Kommanditgesellschaft auf Aktien - KGaA).

Additionally, enterprises are also liable to the so-called local trade tax (Gewerbesteuer) which is determined by levying the basic federal rate (Steuermesszahl) of five per cent on the assessed business income. Then a multiplier (Hebesatz) of about 400 per cent, which is fixed by the municipalities, is applied to this resulting basic tax amount (Steuermeßbetrag).

The overall profit tax burden including the local trade tax and the solidarity surcharge for retentions thus amounts to 38.3 per cent in 2005 (see Appendix A for the computations)[2].

The usual depreciation methods for movable assets are the straight-line or the declining-balance methods. A switch from declining balance to straight-line depreciation is allowed and the annual geometric-degressive depreciation rate is limited to twice the allowable straight-line rate with an overall maximum of 20 per cent.

Non-corporate firms are liable to the personal income tax and the solidarity surcharge. They are, however, allowed to credit the local trade tax multiplied by a weight factor of 1.8 against their income tax liability. Thus, at present,

[1] Under the full imputation system distributed profits are taxed in the hands of an individual shareholder; however, the imputed tax can be credited against the personal income tax liability of the shareholder. Therefore, dividends are just subject to the personal income tax (Sinn, 1987).

[2] There are discussions to reduce the statutory corporate tax rate to 19 per cent from 2006, which would result in an overall burden of about 33 per cent.

the effective statutory tax rate applying to firms in the non-corporate sector amounts to 45.4 per cent[3] (see the Appendix A for the computations).

2.2 The German Tax Reform 2000

In spite of a series of reform efforts made in previous years, the level of taxation has remained relatively high in an international comparison. Thus, the German federal government has tried to counter the international tax competition by enacting the German Tax Reform 2000. It was acknowledged as a step in the right direction but its effect was unlikely to be significant enough. Therefore, the question to be asked is what was actually achieved by this last tax reform especially with regard to the implementation of future reform measures.

The reform envisaged, on the one hand, a substantial reduction in personal income tax rates: in only six years, the top marginal tax rate was reduced from 51 to 42 per cent by nine percentage points (see Table 2.1).

Table 2.1. Personal Income Tax Rates Before and After the Reform

	2000	2001	2005
Minimum tax rate	22.9 %	19.9 %	15%
Top rate	51 %	48.5 %	42%
Basic personal allowance	6.902 €	7.206 €	7.664 €

Source: German Ministry of Finance 2004 b,c.

On the other hand, the tax reform also brought about a new system of taxing corporations. Before 2001, retained earnings were taxed at 40 per cent while distributions were only subject to 30 per cent taxation. After the reform, this split-rate system was replaced by a uniform tax on corporate profits amounting to 25 per cent (see Table 2.2), and the full imputation system was changed to a half-income system of dividend taxation (meaning that one half of distributed dividends is subject to the personal income tax rate). Moreover, non-corporate firms now have an extra benefit since they can credit 1.8 of the local trade tax against their personal income tax liability. Since the reform also envisaged a tightening of thin capitalization rules[4] for foreign companies

[3] Starting 2006, this rate could decrease by about one percentage point to 44.5 per cent if the amount of credited local trade tax would be increased to two as proposed.

[4] Thin capitalization rules mean that loan interest is under certain conditions classified as a hidden distribution of profits and thus subject to the corporate income tax (§8a of the Corporate Income Tax Act).

and a substantial reduction in depreciation allowances[5], it can be attributed to the tax-cut-cum-base-broadening type of reforms (Devereux et al., 2002).

Table 2.2. Effective Statutory Tax Rates Before and After the Reform

	2000	2001	2005
Tax rate on corporations	40	25	25
Incl. local trade tax and solidarity surcharge	51.6	38.3	38.3
Tax rate on non-corporate firms	51	48.5	42
Incl. local trade tax and solidarity surcharge	61.3	51.1	45.4

Note: The statutory effective tax rates apply to an investment financed out of retained earnings
Source: German Ministry of Finance 2004c, own calculations.

While the German Tax Reform 2000 envisaged lower statutory tax rates, the second reform goal, namely the realization of a more neutral tax system regarding the legal choice of the firm (Bundestagdrucksache, 2000), was not achieved. Although the tax reform reduced the tax burden of non-corporate firms, the effect on corporate firms is two-fold. Corporations which finance new investments by retained earnings are at an advantage, followed by non-corporate firms; the highest burden is levied on corporations using new share issues as a marginal source of finance (see Table 2.3). The tax rate differential between non-corporate and corporate firms has widened and no neutrality is attained with regard to the choice of legal form (Scientific Advisory Council attached to the Ministry of Finance (SAC), 2004). This partial tax discrimination against corporate firms has even increased in recent years due to the steady reduction of marginal personal income taxes (Spengel and Wiegard, 2004). Accordingly, the difference in the taxation of distributed earnings between corporate and non-corporate firms increased from four percentage points in 2003 to 6.6 percentage points in 2005 (see Table 2.3).

[5] The maximum rate of declining balance depreciation was reduced from 30 to 20 per cent for movable assets and for buildings, the straight-line depreciation rate was reduced from four to three per cent (German Ministry of finance 2004 b).

Table 2.3. Statutory Tax Rates for Corporate and Non-corporate Firms

	Corporate firm	**Non-corporate firm**
	Retained Earnings	
2003	39.6	51.1
2004	38.3	48
2005	38.3	45.4
	Distributed Earnings	
2003	55.1	51.1
2004	53	48
2005	52	45.4

Notes: The top marginal income tax rate applies. Corporate firms are subject to corporate tax rate, solidarity surcharge and local trade tax. Non-corporate firms are subject to personal income tax, solidarity surcharge and local trade tax where the local trade tax can be partly credited against the personal income tax. Half of distributed profits by corporate firms are subject to personal income tax and solidarity surcharge.
Source: German Ministry of Finance 2004c, own calculations, see Appendix A.

The federal government's intention to lower the tax burden of non-corporate firms was motivated by the fact that most small and medium-sized enterprises[6] (SMEs) in Germany are organized as non-corporate firms. However, even though 83 per cent of SMEs are organized as sole proprietorships or partnerships (German Ministry of finance 2004a), only 35 per cent of all employees work in the non-corporate sector, while about 65 per cent are employed in corporations (own calculations using data of the Institut für Arbeitsmarkt und Berufsforschung (IAB)). Thus, if a tax reform is to improve the economic situation of German enterprises, it has to include corporate firms as well. Nevertheless, the most efficient tax reform would envisage that both legal forms are subject to the same effective tax rates and there is no discrimination against any of them. Such a reform would be a dual income tax as proposed by Sinn (2003a) and GCEA (2003) as well as by the Scientific Advisory Council at the Ministry of Finance (2004) who consider the dual income tax as an optional model for reforming the tax system. Such a tax system can ensure an increased neutrality with regard not only to the sources and uses of finance but also to the choice of organizational form, as has again been reiterated lately as a necessary component of an efficient tax system.

[6] SMEs are defined as those having less than 500 employees and an annual turnover not exceeding € 500,000 for small firms and € 50 Mill. for medium-sized firms (german ministry of finance, 2004a).

2.3 Theoretical and Empirical Arguments for Lower Capital Income Taxation

Arguments for reforming the German tax system or lowering capital income tax rates respectively, are provided by the theory of capital income taxation and by empirical evidence. According to Sinn (1987), in a small open economy, perfectly mobile capital has an infinitely elastic reaction to taxes levied on it. Hence, the optimal policy would envisage a zero tax rate on capital but under such circumstances the whole tax incidence would fall on labor. Since the forces of tax competition hinder the effective implementation of capital income taxes, it might be inefficient to try to tax labor and capital at the same rate as required by the principles of a comprehensive income tax[7].

An additional reason for applying lower capital income taxes, relates to the intertemporal distortions which are linked to the saving-consumption decision. These distortions are the result of a double taxation phenomenon: Savings stem from after-tax earned income and interest on savings is taxed once again when it is paid (Sinn, 2003a). To avoid this additional burden on future consumption, no capital income tax should exist. However, this is not always feasible and thus a lower capital income tax rate compared to the labor income tax rate is desirable (Boadway, 2004). Moreover, the production efficiency theorem[8] states that a wage tax solely distorts the consumption decision, while a source tax on capital also distorts the international capital allocation, resulting in a deadweight loss. This line of argument favors levying a lower tax rate on capital than on labor. Above all, this reasoning is supported by several empirical findings, for instance by Mendoza et al. (1994), Devereux et al. (2002) or Sørensen (2000).[9]

Additionally, there is a wide range of empirical papers dealing with the negative effects of taxation on investment. One typical study was performed by Cummins, Hasset and Hubbard (1994) for the U.S. using data between 1981-1992. The authors find a long-run elasticity of the capital stock with respect to the cost of capital between -0.5 and -1.0. Chirinko, Fazzari and Meyer (1999) estimate a user cost elasticity of capital of around -0.25. The most relevant study for Germany was performed by Harhoff and Ramb (2001) who, using the corporate balance sheet data of the German Central

[7] The comprehensive or global income tax system applies a progressive global income tax to the entire income of the taxpayer, irrespective of its source.

[8] See Diamond and Mirrlees (1971).

[9] 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 labor. 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 labor and capital respectively for 12 countries for the periods 1981-1985 and 1991-1995. His results show that, while the tax burden on labor increased, the burden on capital declined or remained constant.

Bank for the years 1987-1997 find an implied long-run elasticity of the capital stock with respect to the user cost of about -0.45. Thus again, taxes which induce a higher cost of capital have a negative impact on investments.

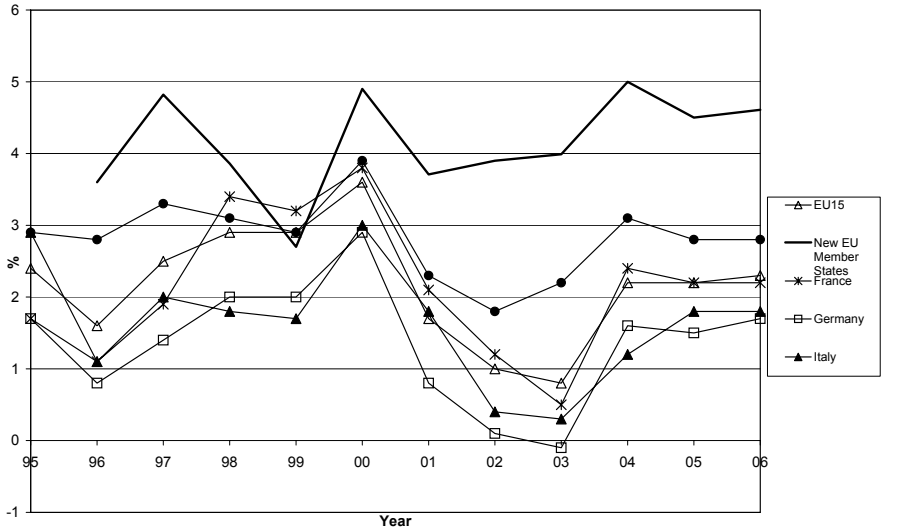
A further argument for the need to apply lower capital income taxes is provided by Sinn (2003a) and is related to Germany's demographic structure and the resultant problems. Nowadays, in Germany the pay-as-you go pension system applies, according to which today's workforce pays the pensions of today's retirees. However, in the years to come, there will be an increasing number of retirees whereas the number of contributors will continuously decrease. To counteract this problem, an alternative would be the introduction of a funded system. Under such a system, the workforce invests in financial or real capital and future pensions are paid out of the proceeds of these investments (interest income, etc.). A high capital income tax hinders the capital accumulation and the build-up of wealth and is thus not in the spirit of a pension reform.

2.4 Germany's Declining Economy and the Increasing Tax Competition in the EU

One of the most important reasons for the urgency to reform the German tax system, besides the above mentioned efficiency aspect, is the increasing international tax competition. High German tax rates cause capital exports as companies shift their tax base and active production abroad, to the country's detriment.

Germany, once the country of the 'Economic Miracle' and the leader of European growth statistics has now fallen behind all other European countries in terms of growth. The newly acceded EU countries present record growth rates, e.g. about four per cent in the Czech Republic and Hungary and even six per cent in the Baltic republics. The forecasted average growth rate of about 4.5 per cent in these countries in 2005 is thus much higher than the growth rates of the UK and France with 2.8 and 2.2 per cent respectively. Germany represents the worst picture with growth of only 1.7 per cent forecasted for 2005 (see Fig. 2.1).

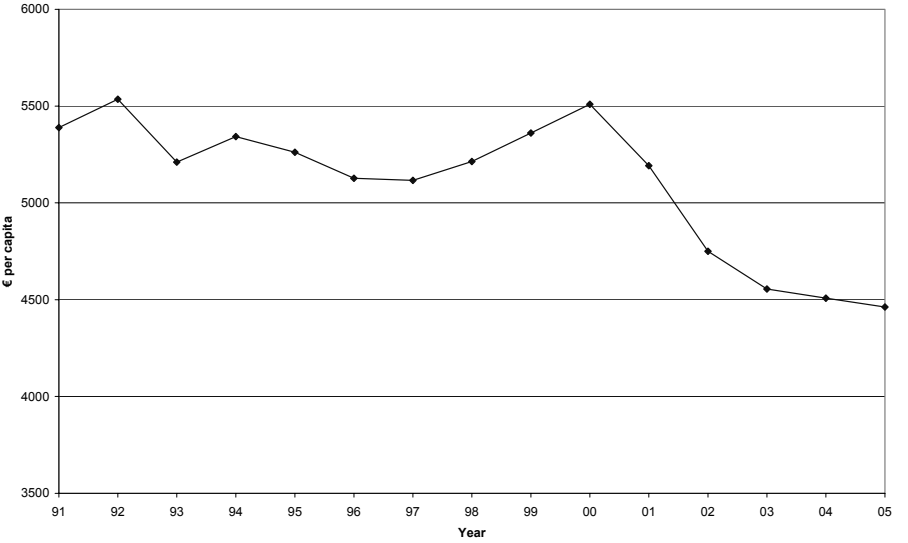
Fig. 2.1. GDP Growth Rates in Selected EU Countries



Note: The numbers for 2005 and 2006 are forecasts.
Source: Eurostat 2005.

Among other things, this poor economic performance can be attributed to the abuse of German tax policy as a discretionary instrument for short-run cyclical interventions. According to the GCEA(2003), the tangled mess of partly proposed, partly enforced tax reliefs and modifications in the tax system have hardly led to any improvements but induced a severe loss of credibility resulting in decreasing investment. As one can see from Fig. 2.2, per capita investment declined by around 20 per cent from € 5540 to € 4474 between 2000 and 2005.

Fig. 2.2. GDP German Gross Investment in Plant and Machinery



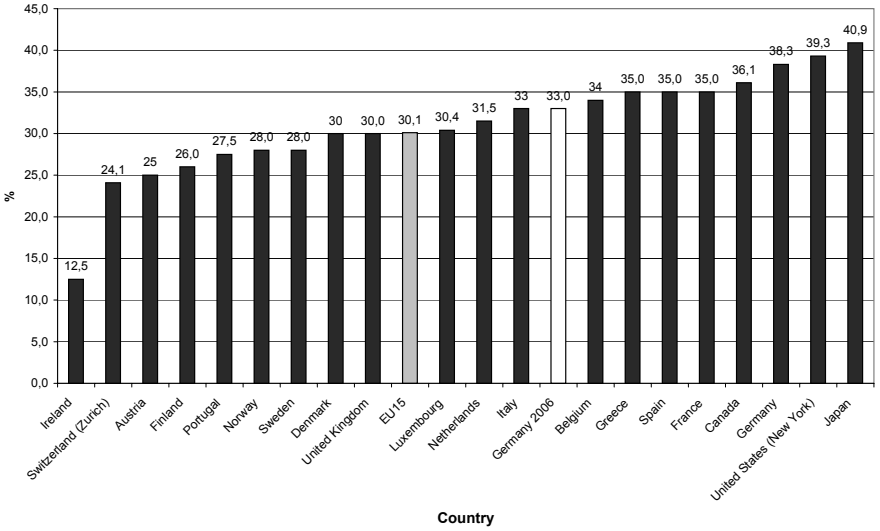
Source: German Statistical Office 2004a.

The decline in investment which also has negative consequences for employment and growth, is also due to increasing international tax competition. Therefore, at present, the measures that aim at improving Germany's standing as an investment location are of vital importance as a step towards overcoming the economic slump. If investment in Germany becomes relatively 'cheaper' from a tax point of view, net returns to investors will increase. These may in turn consider to invest more in Germany, a situation which would have positive employment effects and consequently improve also the economic situation of the employees (Scientific Advisory Council attached to the Ministry of Finance, 2004).

Despite recent tax relief, Germany's effective corporate tax rate is still the highest in Europe. The German corporate tax rate amounts to 38.3 per cent (including the solidarity surcharge of 5.5 per cent and the local trade tax) in 2005[10] and is thus about nine percentage points higher than in Denmark or in the UK. The EU 15 average is 30.1 per cent (see Fig. 2.3).

[10] If the corporate tax rate is lowered to 19 per cent starting with 2006, the effective statutory corporate tax rate will amount to 33 per cent including the local trade tax and solidarity surcharge.

Fig. 2.3. Cross-Country Comparison of Statutory Effective Tax Rates (2005)



Note: The figures for Greece, Japan and the United States are for 2004.
Source: OECD Tax Database, 2004 and 2005.

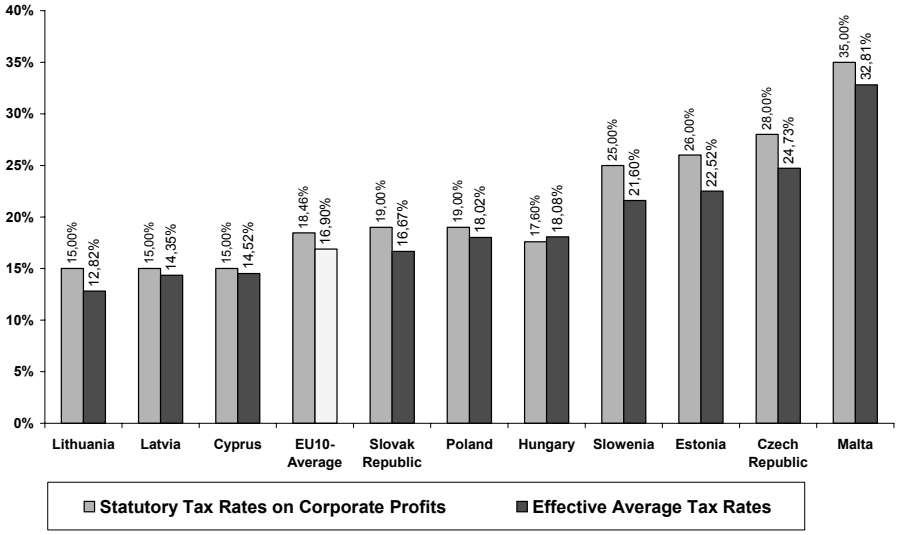
But Fig. 2.3 does not show the whole picture, since it does not include the rates prevailing in the new EU Member States. These countries offer more advantageous investment opportunities due to extremely low statutory tax rates. Estonia, for instance, does not levy any corporate tax rate on retained profits and in Hungary the statutory tax rate is just 18.08 per cent[11].

The lowest statutory tax rate of only 15 per cent is applied in Cyprus, Latvia and Lithuania, and the average among the New EU Member States amounts to only 18.5 per cent. The average effective tax rates (EATR)[12] are even lower. Here the average is about 16 per cent, with most countries levying rates between 13 and 25 per cent (see Fig. 2.4). Consequently, the German statutory tax rate which is at the upper end of the international range, is about eight percentage points higher than the EU-15 average and even 20 percentage points higher than that of the new EU Member States - a clearly unsustainable situation. Thus, tax competition is extremely high and will even

[11] See Ernst and Young and ZEW, 2004.

[12] The average effective tax rates are calculated as the weighted average of the effective marginal tax rate (EMTR) and the statutory corporate income tax. The weights are determined by the proportion of the pre-tax return covered by the cost of capital (defined as the minimum required rate of return before taxes) and is assumed to be 20 per cent in the ZEW calculations. The EMTR is computed as the difference between the cost of capital and the market interest rate divided by the cost of capital.

Fig. 2.4. Statutory Tax Rates on Corporate Profits and Effective Average Tax Rates in the New EU Member States (2004)



Source: Ernst&Young and ZEW (2004).

increase if one considers the future tax law changes which will be adopted by these countries.[13]

This development has to be seen in connection with the effects it induces on investment by German firms. An empirical study by Büttner and Ruf (2004) shows that a reduction in a country's statutory tax rate by 10 percentage points increases the odds of direct investment by German enterprises in that country by 20 per cent. Accordingly, one can easily compute the amount of German direct investment in the Czech Republic, Austria or Cyprus in the light of the recent tax relief adopted in these countries.

This type of capital flight effect has been exacerbated since 1999 because due to the introduction of the euro, Germany can no longer attract investors by offering lower interest rates, thus compensating for the disadvantage of being a high tax country, since the European Monetary Union has led to a convergence of interest rates in the Euro area (Sinn, 1997). Accordingly, an increasing number of investors decide to relocate their production elsewhere. A survey of the Association of German Chambers of Industry and Commerce among 10,000 enterprises (DIHK, 2003) showed that 18 per cent of industrial

[13] The Czech Republic, for instance, has lowered the tax rate to 26 per cent in 2005 and will even lower it to 24 per cent in 2006. A reduction of five percentage points was undertaken in Cyprus as well, where a rate of 10 per cent instead of the previous 15 per cent applies from 2005 onwards. In the same year the corporate tax rate was reduced from 34 to 25 per cent in Austria and from 28 to 26 per cent in Finland.

firms have decided to locate their production outside Germany during the last three years and almost 25 per cent of this kind of firms plan to do the same in the years to come. Moreover, according to German Central Bank statistics, direct investment abroad by German firms increased by about € 536 billion and the number of foreign subsidiaries increased by more than 14,000 in the period 1990-2002 (GCEA, 2004). These developments are not only the result of German firms' strategy to open up new markets but can also be attributed to the country's unattractive location characteristics and implicitly to the present tax system.

The negative effects of high German or low foreign corporate tax rates are especially evident when the source principle[14] of capital income taxation applies. In that case, lower foreign corporate taxes lead to higher after-tax returns for investors, such that more capital is driven from Germany to other countries (Sinn, 1987). Yet, for returns on financial investment, one could assert that since the residence principle applies, high national tax rates do not lead to capital flight because returns on investment abroad are taxed in the same way as returns on domestic investment. Nevertheless, it should be borne in mind that even this situation can be counteracted by moving the private or company residence abroad or by creating letter-box firms.

Moreover, since due to the Tax Reform 2000, the foreign dividends of share owners also benefit from the shareholder relief system, it is easier for German investors to take advantage of international differences in corporate tax rates (Schreiber, 2000).

In the light of these developments and due to the fact that the EU plans to harmonize the corporate income tax base, tax competition is likely to become even fiercer. A reform of German corporate income taxation is therefore urgently required.

2.5 The Non-Transparent and Complicated German Tax System

An additional argument for the need to reform the German tax system is related to the lack of structure and clarity which characterizes the tax system. A redesign of the German tax system is imperativ, for the present tax law is criticized to be rather complicated, non-transparent and inefficient. For instance, a recent study by the World Economic Forum (2005), ranks Germany last among 104 surveyed countries regarding the 'efficiency of the tax system' and on position 99 regarding the tax burden which includes all associated costs such as tax rates, administrative costs, time lost and penalties. Double taxation and legal tax loopholes have created severe distortions

[14] According to the source principle of capital income taxation, all income is taxed in the country where it is realized. The residence principle, however, provides that a corporation is liable to taxation on its world-wide income in the country where its headquarters are located (Frenkel et al., 1991).

concerning investment and financial decisions of firms resulting in major welfare losses due to the inefficient allocation of resources. There is an on-going discussion about flat-rate savings taxes and the closure of tax loopholes. On the one hand the tax amnesty law[15] has recently been passed and on the other hand the present ruling coalition[16] is debating the introduction of a tax on millionairs. Investors, however, need a clear guideline and not this seesaw of discussions[17] for their future investment decisions, for which the expected tax burden plays a decisive role.

Although the German income tax is labelled a comprehensive tax system[18], in reality it systematically deviates from such a principle. For instance, according to the half-income principle of dividend taxation, distributed profits are taxed differently from earnings from other sources. Additional anomalies arise due to the multitude of tax exemptions, including returns on institutional savings, returns on appropriately designed life insurance policies or the tax exemption of capital gains. Further deviations from this principle derive from the generous tax allowances. For example, married couples benefit from the rule which provides that the first € 2842 of capital income are tax-free. Thus, if we assume a real interest rate of five per cent, only those households owning financial assets worth more than € 56,840 are liable to capital income taxation. Therefore, many German savers can avoid capital income taxes by making use of these allowances (Fuest and Huber, 2000). Moreover, profits of or dividends distributed by foreign affiliates are not subject to domestic but to foreign taxation as a result of double taxation treaties (GCEA, 2003).

Another incompatibility consists in the different methods of determining the respective tax base of labor and capital income. According to Wagner (2000), while the capital income tax base is determined on the *accrual* basis (i.e. the difference in wealth between the beginning and the end of each tax period), the labor tax base is calculated on a *cash* basis (i.e. the difference between the income arising from labor supplied and the expenses needed to achieve this income). Thus, income stemming from labor enjoys tax privi-

[15] By the 'Act To Promote Tax Honesty' the state offers people, who evaded taxes between the years 1993 and 2002, an opportunity to escape punishment by declaring their concealed income up to 2005. This offer applies to the corporate tax, income tax, turnover tax, trade tax, wealth tax, inheritance tax, gift tax and tax deductions pursuant to the Income Tax Act. Amnesty participants must pay a reduced tax rate of 25 per cent on declared income within ten days after the declaration. Regarding the corporate and income tax bases, this is reduced to 60 per cent. Thus the law grants the tax evaders a tax rate of 15 per cent (Kellner, 2005).

[16] This coalition consists of the Social Democratic Party (SPD) and the Green Party.

[17] The present federal government has changed the tax law 29 times in the past three years (Wirtschaftsrat der CDU e.V., 2004).

[18] According to the comprehensive income (defined as the increment in the taxpayer's wealth in the course of a taxable year) tax system, individual capital income is also fully subject to income taxation.

leges, because expenses linked to human capital investment are immediately deductible, whereas those required for capital investment can only be deducted later on via depreciation (Wagner 2000).

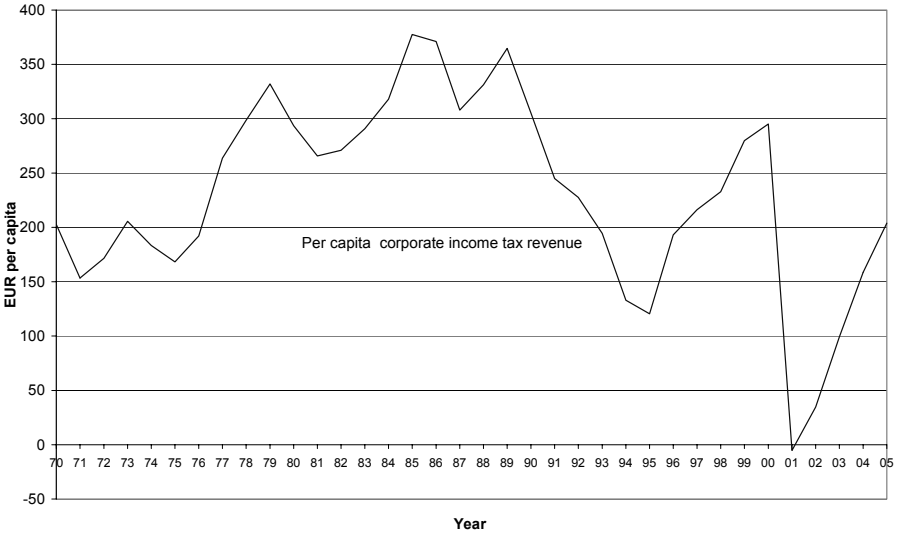
Moreover, the estimation of asset value also poses a challenge for the correct application of a comprehensive income taxation system. The determination of asset values requires the exact knowledge of the price or market value of the asset. However, this is not always possible, and the capital owner has an incentive to undervalue his assets and thus lower his tax burden. The asset owner can do this by creating hidden reserves or different kinds of provisions which are even anchored in the German tax code by the so-called minimum value principle ('Niedrigstwertprinzip'). According to this principle which follows some kind of worst case accounting, assets have to be valued at their lowest price. As opposed to the correct value required by the exact application of the comprehensive income tax, these measures allow the undervaluation of increments to wealth. A further violation of the correct measurement arises if the nominal value principle is applied. According to this principle, depreciation allowances are based on the historical acquisition cost and losses can be carried forward for several periods even in inflationary periods. For these reasons, applying nominal values for past periods distorts asset valuation (Genser, 2001).

Consequently, there are several arguments for departing from the system of comprehensive income taxation if this principle is inconsistently applied.

2.6 Decreasing Revenues From Corporate Taxes

Furthermore, the continuous decline in tax revenue from corporate income taxes provides an additional reason for the need to reform the German tax system. Looking at the evolution of corporate tax revenue, we can see that even though the corporate tax rate still stands at 25 per cent, per capita tax revenue follows a declining trend. A cut in the corporate tax rate has been accompanied by a reduction in tax revenue. A type of built-in flexibility can no longer be anticipated. Accordingly, the revenue declined from about € 295 per capita in 2000 to about € 159 per capita in 2004 (see Fig. 2.5), which implies a decline of about 46 per cent.

Fig. 2.5. Evolution of per Capita Corporate Tax Revenue



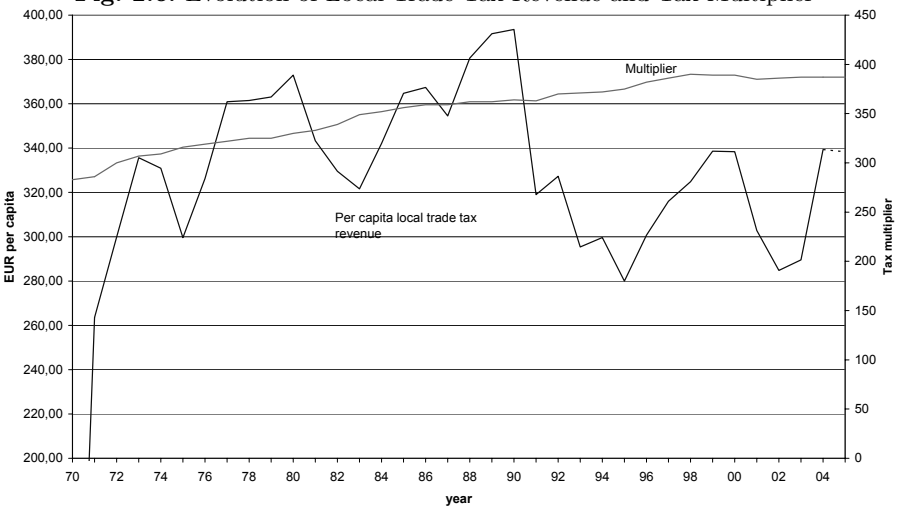
Source: German Ministry of Finance 2005a, German Statistical Office 2004a, own calculations.

The sharp decline in corporate tax revenue in 2001 (a negative € 426 million) is mostly the result of the gift received by the German shareholders due to the distribution fiction present in the German tax system. Thus, companies are required to distribute first the most highly taxed stocks of previously retained earnings. Therefore, distributing new earnings (now taxed at 25 per cent) via old equity (previously taxed at 45 per cent before 1999), companies were able to reduce taxes on the entire capital stock they had retained since 1977 (Sinn, 2002).

A similar picture is given by the revenue from local trade taxes. Here a decline of 14 per cent in only four years was recorded. In 2000, tax revenue

per capita amounted to € 338 while in 2003 it just amounted to about € 289 (Fig. 2.6).

Fig. 2.6. Evolution of Local Trade Tax Revenue and Tax Multiplier



Source: German Ministry of Finance 2005a, German Statistical Office 2004a, own calculations.

Fig. 2.6 also illustrates the shrinking of the tax base over time accompanied by a higher marginal tax burden. The decline of revenue from local trade taxes can also be ascribed to the high cyclical sensitivity of this tax, for it is a pure profit tax (RÄDLER, 2003). Thus, the economic slowdown in 2001 led to low or even negative company profits and accordingly to a collapse in revenue from this tax. In this context, one can again have doubts about whether the prevailing tax rates as well as the system of corporate taxation are still sustainable in their present form. Accordingly, a reform which would envisage a further reduction of the tax burden on investments would increase investments and thus the profit tax revenue due to the larger tax base. Moreover, since lower capital income taxes provide an increased incentive to tax capital income in Germany as opposed to low-tax countries, this would also lead to a rise in tax revenue.

Without a conceptional change of the German tax system, the arbitrary reduction of some rates appears to lead to a more complicated and non-transparent tax system that follows neither the principles of a comprehensive income tax nor those of a schedular tax system. A fundamental restructuring of the tax system is therefore necessary. A new tax system has to ensure greater neutrality with regard to the investment and financing decision as well as to the choice of legal form. A competitive tax system has to be simple, reliable, efficient and growth enhancing. Neglecting, postponing or even

abandoning the idea of comprehensive tax reform does not represent an alternative in the light of increased international tax competition. Postponing such a reform would cause losses in tax revenue since domestic investment activity would continuously decline. However, a comprehensive tax cut accompanied by the scrapping of tax loopholes would be unlikely to further worsen the revenue shortfalls.

Therefore, the introduction of a dual income tax would be an option for Germany that provides a tax-cut-cum-base broadening type of reform. The dual income tax system could also better fulfill the above mentioned requirements for an efficient tax system.

2.7 Summary

Although the final step of the German Tax Reform 2000 has just been implemented, new tax reform proposals are once again on the agenda of the federal government and nearly all other political parties. They range from more basic reform proposals such as reducing the corporate tax rate from the present 25 per cent to 19 per cent as suggested by the federal government, to more complicated and comprehensive tax reforms such as the introduction of a dual income tax (DIT) as recommended by Sinn(2003a) and the German Council of Economic Experts (GCEA, 2003).

It is true that the German Tax Reform 2000 has led to lower capital costs and thus lower effective marginal tax rates, the second reform goal, namely the realization of a more neutral tax system regarding the legal choice of the firm, was not yet accomplished. While the tax reform reduced the tax burden of non-corporate firms, the effect on corporate firms is two-fold. Corporations which finance new investment out of retained earnings are at an advantage, followed by non-corporate firms, and finally by corporations using new share issues as a marginal source of finance. In general, the tax rate differential between non-corporate and corporate firms has widened and no neutrality is attained with regard to the choice of legal form. Thus, while the difference in the taxation of distributed earnings by corporate and non-corporate firms was four percentage points in 2003, it even increased to 6.6 percentage points in 2005.

One of the main reasons for the need to reform the German tax system is the country's poor economic performance. Germany, once the country of the 'Economic Miracle' and the leader of European growth statistics is now lagging behind all other European countries in terms of growth. At only 1.7 per cent growth in 2005, the country lies far behind other EU countries in terms of growth, and most notably behind the new EU Member States, which are displaying an average growth rate of about 4.5 per cent in 2005. This poor economic performance can also be attributed, among other things, to the high German profit tax rates which result in declining investment. At present, the statutory effective tax rate on retained corporate profits amounts to 38.3 per

cent (including the solidarity surcharge of 5.5 per cent and the local trade tax), and is thus about eight percentage points higher than the EU-15 average of 30.1 per cent and even around 20 percentage points higher than the average of the new EU Member States. As a result, capital flight is motivated by tax considerations, and companies shift their tax base and production abroad. This declining investment, which also has negative consequences for employment and growth, is also triggered by increasing international tax competition. Therefore, at present, the measures which aim at improving Germany's standing as an investment location are of vital importance as a step towards overcoming the economic slump.

An additional argument for the need to reform the German tax system is the lack of structure and clarity which characterizes the current tax system. A redesign of the German tax system is imperative, as the present tax law is complicated, non-transparent and inefficient. For example, a recent study by the World Economic Forum (2005), ranks Germany last among 104 surveyed countries regarding the 'efficiency of the tax system'. Double taxation and legal tax loopholes create severe distortions concerning the investment and financial decisions of firms resulting in major welfare losses due to the inefficient allocation of resources.

Besides international tax competition, the complexity of the German tax system and the non-neutrality and inefficiency of the present tax rules, the low tax revenue from corporate income taxes provides an additional reason for the need to reform the German tax system.

Looking at the evolution of tax revenue from corporate taxes, we can see that per capita tax revenue follows a declining trend. Accordingly, the revenue declined from € 295 per capita in 2000 by about 46 per cent to € 159 per capita in 2004. A similar picture is given by the revenue from local trade taxes. Here a decline of 14 per cent in only four years was recorded. In 2000, tax revenue per capita amounted to € 338, while in 2003 it just amounted to about € 289.

Finally, a third line of argument for reforming the German tax system or lowering capital income tax rates respectively, is provided by the theory of capital income taxation and by empirical evidence. Thus, in a small open economy, perfectly mobile capital has an infinitely elastic reaction to taxes levied on it. Hence, the optimal policy would envisage a zero tax rate on capital, but under such circumstances the whole tax incidence would fall on labor. Moreover, the intertemporal distortions which are linked to the saving-consumption decision offer additional support for low capital income taxes. These distortions are the result of a double taxation phenomenon: Savings derive from after-tax earned income, and returns on savings are taxed once again when they occur. To avoid this additional burden on future consumption, there should be no capital income tax at all. However, as this is not always feasible, a lower capital income tax rate compared to the labor income tax rate is desirable.

3

The Dual Income Tax

After having presented arguments for the need to comprehensively reform the German tax system, this chapter discusses in detail the dual income tax (DIT) as a possible reform option. Details of this proposal as well as its simulation with an earlier version of *IFOMod* can also be found in Radulescu and Stimmelmayr (2005). Following the description of the origins of the DIT and the theoretical foundations of such a tax system in Section 3.1, the main features of such a tax system are described and compared with those of more common global income taxation in Section 3.2. This Section also examines the arguments for the DIT as the proper reform measure for the German tax system regarding equity and efficiency considerations. Sections 3.3 and 3.4 provide an overview of the experiences of each of the Nordic countries with this schedular tax. Finally the last Section presents two concrete reform proposals made by the GCEA (2003) and Sinn (2003a).

3.1 Definition and Main Features of the Dual Income Tax

The concept of the dual income tax has its origin in Denmark. According to Sørensen (1994), Niels Christian Nielsen, a member of a Danish committee on tax reform, was the first to advance the proposal of a dual income tax at the beginning of the 1980s. However, the advantage of having a separate flat tax on capital income - which is one of the basic features of the DIT - was already mentioned by King (1977). The theoretical foundations of such a tax are initially provided by the Johansson-Samuelson theorem according to which, under certain circumstances, the present value of returns on an investment is not affected by a uniform tax applied to all kinds of capital income, and thus investment neutrality is ensured. The major assumptions underlying this theorem are the equality between tax and economic depreciation and deductibility of debt interest (Sinn, 1987).

This type of tax reform, which was first performed in Denmark in 1987, followed by Sweden, Norway and Finland at the beginning of the 1990s, was also carried out in Belgium and Austria but in a rather rudimentary form (Sørensen, 2001b).

In these countries, the motivation for implementing such a tax system was the desire to diminish the scope of tax arbitrage, to stimulate private savings, to alleviate the distortions caused by progressive capital income taxation in inflationary phases and to reduce the revenue loss resulting from the possibility to deduct nominal interest rates against the high marginal income tax rates (Nielsen and Sørensen, 1997). In other words, the policy shift towards a DIT was basically led by the recognition that the old policy regime had induced increased tax-motivated investment characterized by only low social rates of return. The new tax policy was therefore aimed at equating before-tax rates of return on investment across different sources of finance and asset types (Andersson et al., 1998) and at reducing the difference between the social cost of capital, given by the international real pre-tax interest rate in the case of a small open economy, and the private cost of corporate capital.

A pure dual income tax, which basically combines a proportional capital income tax equal to the corporate income tax rate with progressive labor taxation, displays the following distinctive characteristics Sørensen, 1998, 2001, 2003, Cnossen, 2000):

- The separation of income into a capital income component consisting of business profits, interest, dividends and capital gains, and a labor income component including salaries, wages, pension income, social security and fringe benefits.
- Taxation of capital income at a proportional rate and labor income at progressive rates.
- The flat capital income tax rate is usually equal to the lowest labor income tax rate in order to prevent tax arbitrage and ensure that capital and labor income are taxed at similar rates.[1]
- Avoidance of full double taxation at the shareholder and company levels by applying a full imputation system.
- The separation of taxable profits arising in proprietorships and closely held companies (CHC)[2] into a capital income and a labor income component. The first is computed by assigning a special rate of return to the value

[1] Nevertheless, the effective labor tax rate is usually higher than the effective capital income tax rate since labor income is also subject to indirect consumption taxes and social security contributions. In addition, in inflationary phases the effective capital income tax rate also tends to be higher since the capital income tax is not typically levied on the real but on the nominal capital return (Nielsen et al, 1997 and Sørensen 1997).

[2] A CHC is a corporate business with one or only a few active owners (Lindhe et al, 2003).

of the business's gross or net capital. The difference between profits and capital income determines labor income.
- Avoidance of special deductions like accelerated depreciation in a way that business profits and pure economic profits become comparable.
- Opportunity to choose between joint or separate taxation of capital and labor income. The first alternative allows for the offset of negative capital income against positive labor income while the second alternative permits the imposition of proportional taxes on the different types of capital income and thus ensures single taxation of income from capital by withholding taxes at the company level.

3.2 The Case for a Dual Income Tax

To properly evaluate the benefits of a switch from a global to a dual income tax one should first compare the DIT system to the most common comprehensive income tax system[3].

The comprehensive income tax system applies a progressive tax rate to the entire income of the taxpayer, irrespective of its source (Genser, 2001, Cnossen 2000, Sørensen 1994). This income is determined on an accrual basis, meaning that the tax base is defined as the change in financial and real wealth during a fiscal year, without allowing for any deduction of expenses linked to acquiring these assets. Such a system conforms on theoretical grounds to the horizontal equity principle,[4] since all individuals with equal income and tax base are subject to the same tax burden irrespective of the income source.

However, given the fact that governments are hardly able to tax all forms of income uniformly, a departure from the principle of comprehensive income taxation appears to be desirable. For instance, most OECD countries do not impose a tax on returns on institutionalized pension savings based on the governments' argument that they need to stimulate private saving. Under the global income tax, the yearly returns on pension savings of an individual should also be subject to taxation at his personal marginal tax rate. However, most governments do not follow this rule. Moreover, due to the expenditure tax treatment of pension savings by institutional investors, the returns on savings are again taxed at lower rates than labor income. According to this

[3] As described by Sinn (1987), the theoretical foundations of this income concept, according to which income is determined as the increase in the individual's personal wealth in the course of a taxable year were first laid by Schanz (1896), Haig (1921) and Simons (1938). This is the reason why a comprehensive income tax is also labelled as a Schanz-Haig-Simons tax.

[4] According to this principle, individuals with the same economic ability, i.e same income, should suffer from the same income reduction and have the same after-tax income. In other words, people who earn the same before-tax income are subject to an equal tax treatment.

principle, pension contributions are tax deductible and the returns on savings are taxed. If the taxpayer's marginal tax rate is higher when he contributes than the rate at the time when he receives the pension, this leads to a subsidy on savings (SØRENSEN, 2001b). Moreover, the returns on savings which accumulate within a corporation and arise in the form of capital gains are mostly either tax exempt or subject to very low taxation. Finally, in most countries the imputed rent or the capital gains and losses on owner occupied housing are not subject to taxation (SØRENSEN, 2001b). Consequently, mismatches of the principles underlying global income taxation in some areas such as the taxation of returns from different savings forms, have caused violations in other areas such as interest taxation. As a result, the principles underlying the comprehensive income tax system are even more inconsistently applied.

Therefore, the dual income tax which can be ascribed to the schedular taxation forms due to the separation of taxable income (SØRENSEN,1994), can be considered a proper reform measure. Compared to other types of reforms where, as the result of increased tax competition, lower capital income tax rates are applied to *some* forms of capital income, *all* forms of capital income are subject to a uniform proportional tax under a dual income tax system.

Finally, as stated by BOADWAY (2004), the structure of the DIT can offer additional advantages in a federal country like Germany. This is so because lower levels of government such as the Länder may be entitled to share revenue from direct taxes on labor with the central government while leaving the responsibility for capital income taxes only with the central government.

3.2.1 The DIT and the Basic Principles of Taxation: Efficiency and Equity

When evaluating the features of a tax system, taxation theory applies two basic yardsticks: the equity and the efficiency principles.

Equity Aspects

The first principle takes into consideration the taxpayer's ability to pay taxes, which is determined by either his income or consumption. Thus, the discussion focuses on whether proportional or progressive taxes are better suited to meet the purpose of achieving equity. In the following, I will present several arguments for proportional versus progressive income taxation.

In the case of capital income taxation, the DIT advocates a uniform proportional tax rate. Since, under a DIT, the individual's tax bill depends both on overall income and on this income's division into a capital and a labor income component, it is rather difficult to apply the standard measures of horizontal equity to this kind of tax (SØRENSEN, 1994). Moreover, if wealth taxes or taxes on bequests and inheritances are in place, the issue of inequality in endowed wealth is ultimately addressed by these kinds of taxes, such that the case for progressive capital income taxation is eroded (BOADWAY,

2004). Regarding the vertical equity[5] of such a tax system, supporters of the DIT consider a flat capital income tax to be an appropriate solution to the unduly high taxation of unrealized capital gains. This extra burden could induce taxpayers to refuse the sale of their equity and thus lead to a lock-in effect. As a result, profits are prevented from being directed to more productive investments resulting in an inefficient outcome (SØRENSEN,1994 and 2001b). Critics of the DIT have raised doubts about whether such a proportional tax system would not favor high income earners since capital income is usually attributed to income earners in the top tax bracket. Nevertheless, there seem to exist better instruments such as wealth taxes which can be applied if the main purpose of a tax system is to avoid the excessive wealth concentration among high-income earners. Yet, most probably the strongest arguments in favor of proportional instead of progressive capital income taxes relates to the fact that different forms of tax arbitrage can be avoided. Hence, under conventional income taxation, it would be possible, on the one hand, to accumulate the returns to debt-financed assets within a corporation subject to a lower corporate income tax and, on the other hand, to deduct the interest payment against the higher personal tax rate. Moreover, if different taxpayers face different marginal tax rates, they can make use of tax differences to avoid taxation (SØRENSEN, 1994).[6] A flat capital income tax equal to the corporate tax rate prevents such arbitrage opportunities.

Intertemporal aspects

As mentioned at the end of the previous Chapter, one argument for having lower capital income taxes relates to the intertemporal aspect of taxation.[7] For those individuals with a high intertemporal elasticity of substitution in consumption, who accordingly prefer future to present consumption, taxing capital income under the income tax puts them at a disadvantage. If no capital income tax were in place, such distortions and inequities among individuals with different rates of time preference would not arise. The global income tax, however, infringes upon the principle of intertemporal horizontal equity, because the individual with higher savings who receives his life-time income earlier, has to pay more taxes (GENSER, 2001). A double taxation of savings out of current income occurs because income is first taxed when it is earned and then later the return on saving is taxed again, making future consumption more expensive relative to present consumption (BOADWAY, 2004). Consequently, a DIT which applies lower capital income tax rates helps alleviate these distortions as well (SØRENSEN,1994, SINN, 2003a). This is illustrated

[5] This principle requires that people with different incomes should pay different amounts of tax.

[6] For example via wealth transfers among family members.

[7] GORDON (2000) even asserts that the capital income tax rate should be zero on equity grounds.

in Table 3.1. The Table shows an 'early' vs. a 'late' consumer who earn both the same wage income of € 1000 in both periods (Per.1 and 2). Only the patient consumer who prefers to save today and postpone his consumption has to pay a tax on his interest on savings. The present value of life-time income is the same for both consumers. However, the present value of life-time taxes is higher for the late consumer, although they both earn the same wages in both periods. Thus, under the global income tax scheme, the patient consumer will have to pay € 1000 of taxes in present value terms as compared to the tax payment of only € 976.2 of the impatient consumer. The DIT helps to alleviate this distortion. By taxing capital income and accordingly interest income at a flat rate of 20 per cent, the present value of taxes would be almost the same for both individuals, namely € 969 for the early consumer and € 972 for the late one. Therefore, the DIT does not discriminate against returns on savings as is the case with the global income tax.

Table 3.1. Treatment of Patient vs. Impatient Consumers Under the Global and Under the Dual Income Tax (in €)

	Early Consumer		Late Consumer	
	Per.1	Per.2	Per.1	Per.2
Wage Income	1000	1000	1000	1000
Wage Tax (50%)	500	500	500	500
Savings	0	0	500	-500
Gross Interest Income (10%)	0	0	0	50
Present value of life-time income[a]	2100		2100	
Global Income Tax (GIT)				
Tax on Interest Income	0	0	0	25
Consumption	500	500	0	1025
Present value of tax payments[b]	976.2		1000	
Dual Income Tax				
Tax on Interest Income at 20%[c]	0	0	0	10
Consumption	500	500	0	1040
Present value of tax payments[b]	969		972	

Notes: [a]The present value is calculated using the gross interest
[b] rate of 10%. The PV of tax revenue is computed using the net of tax interest rate of 5% in the case of the GIT since the applied tax is 50%, and 8% for the DIT scenario since in this case the interest tax amounts to 20%.
[c] This rate corresponds to the Sinn (2003a)proposal.
Source: Sørensen (1994), GCEA (2003).

An additional argument for a preferential treatment of capital income relates to households' savings for retirement. Since individuals might undersave or a transition from a pay-as-you-go to a funded system is necessary, lower capital income taxes which stimulate households' incentive to save seem to be more appropriate (Boadway, 2004).

Investment in human versus physical capital

A further argument for separate taxation of capital versus labor income and for proportional capital income taxes versus progressive labor income taxes relates to investment in human versus physical capital. The global income tax favors investment in human capital because it offers consumption tax treatment of human capital investment. This emerges since the cost of acquiring human capital during education in the form of foregone wages can be immediately deducted from taxable income, as wages are taxed when they are earned (on a so-called cash basis[8]). By contrast, the costs of acquiring physical capital can only be deducted over time via depreciation (Sørensen, 1994, Wagner, 2000). This methodical incompatibility in determining the respective tax base of labor and capital income leads to a preferential treatment of income received from labor. This is illustrated in Table 3.2.

Table 3.2. Investment in Human versus Physical Under the Dual Income Tax (in €)

	Human capital investor		Physical capital investor	
	Period 1	Period 2	Period 1	Period 2
Potential wage income	2000	4200[a]	2000	2000
Actual wage income	0	4200	2000	2000
Interest Income	0	0	0	100
Tax at 50%		2100	1000	1050
Physical investment	0	0	1000	-1000
Consumption	0	2100	0	2050

Note: For both human and physical capital the rate of return is assumed to be 10%. [a] A person who invested in education will earn the € 2000 which an uneducated person earns and the return to education equal to 1.1 x 2000 € = 2200 €.
Source: Sørensen (1994).

In the first period, both individuals earn the same potential income of € 2000 since they have the same skills. The actual income diverges since the first person decides to invest in education and thus foregoes the € 2000 while the second person decides to work and invest his net-of-tax income in physical capital. At the end of the second period the second individual will

[8] See Chapter 2 for the definition of *cash* versus *accrual* basis. Human capital investment is actually taxed on a cash-flow basis since wages are taxed when they are paid. This means that the tax diminishes the opportunity cost of education in the form of foregone wages by the same amount as the additional future labor income resulting from education. In the case of investment in physical capital, however, a proportional tax creates a wedge between the private return and the social return given by the before tax world market interest rate (Nielsen et al., 1997).

again earn a wage of € 2000 and the interest income of € 100 less € 1050 taxes. The entire amount of € 2050, available for consumption at the end of the second period will be less than the € 2100 amount available to the person who invested in human capital. This situation arises since the global income tax favors investment in human capital by adopting a consumption tax treatment of this type of investment. This means that the cost of human capital investment can be immediately deducted from taxable income, which is not the case for investment in physical capital. Moreover, increases in physical capital in the form of capital gains can be assessed and taxed, while increases in human capital do not contribute to overall income growth and are thus not subject to taxation.

A comprehensive income tax of the Schanz-Haig-Simons (SHS) type would require all types of income to be determined on the accrual basis and would tax the individual's consumption *and* additions to his stock of human capital and real net wealth.

Since in practice it is impossible to measure changes in the human capital stock, an approximation of the SHS type of tax can be achieved by taxing labor income at a higher rate than capital, as is the case with the DIT (Sørensen 1994, Wagner 2000). Here, we find a theoretical argument of horizontal equity which can be applied to the combination of proportional capital income taxation with progressive labor taxation. A progressive labor income tax reduces the return to human capital investment and consequently diminishes the advantage a proportional tax creates for such investments.

Inflation

An additional advantage of the DIT concerns the taxation of returns in inflationary phases. Under a comprehensive income tax regime, excessive taxation may occur since inflation adjustment is not always undertaken in the case of capital income (Gordon, 2000).[9] In most cases, the tax is levied on the taxpayer's *nominal* instead of the *real* capital income. In contrast, the DIT imposes a lower rate on capital income and thus alleviates this problem. This argument does not only apply to high inflation countries. Assuming that one wishes to tax the real return of three per cent at 50 per cent, even with a two per cent inflation rate and a five per cent nominal interest rate, the nominal interest rate has to be taxed at a much lower rate of only 30 per cent. Therefore, even in the presence of low inflation, the argument is still valid (Sørensen, 2001b).

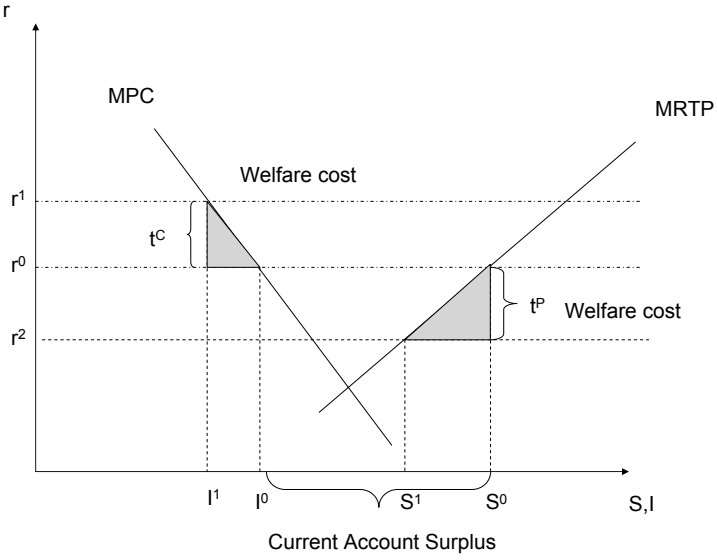
Efficiency Aspects

After having discussed the aspects of horizontal and vertical equity, we now turn to the second basic principle of a tax system, the efficiency aspect.

[9] The distinct taxation of labor income is based on the fact that labor earnings are automatically indexed for inflation and accordingly also the labor tax.

If efficiency is regarded as maximizing the representative consumer's utility, different taxation of labor and capital income would be efficient. The studies by Atkinson and Sandmo (1980) and King (1980) show that if, as a result of changes in after-tax factor prices, the substitution effects in labor supply are relatively small compared to those on savings, the second-best optimal solution would envisage a higher taxation of labor relative to capital income. Moreover, as emphasized by Razin and Sadka (1989) and Gordon (1986), in a small open economy with perfectly mobile capital (which is thus in perfectly elastic supply), the optimal solution is to apply a zero source corporate income tax such that the whole burden falls completely on labor (see also Gordon (2000) and Haufler (2001)).[10] Accordingly, a high corporate tax leads to capital flight, to decreasing capital intensity and a resulting decline in the marginal productivity of labor. Domestic real wages go down such that, in the end, the burden of the corporate tax is finally borne by labor. The capital tax thus leads to inefficient production and to too little capital in the economy since the gross return on capital is larger than the opportunity cost of capital in the world market (Haufler, 2001). Therefore, taxing labor income explicitly is more efficient than imposing high corporate tax rates in the presence of tax competition and high capital mobility (Andersson et al., 1998 and Sinn,1987).

Fig. 3.1. Tax Wedge and Welfare Costs: The Case of a Small Open Economy



[10] This outcome primarily occurs if capital invested abroad is difficult to assess; stated differently, this situation emerges if it is difficult to enforce resident taxation on income from portfolio investment realized abroad.

Fig. 3.1 depicts the effect of levying a corporate or a capital income tax in a small open economy with a current account surplus (since saving S^0 is larger than investment I^0). The equilibrium level of investment is determined by the intersection of the downward sloping marginal product of capital MPC curve, which illustrates the relationship between the demand for capital and the market interest rate r. The equilibrium level of saving is determined by the equality between the marginal rate of time preference $MRTP$ and the market rate of interest. The $MRTP$ curve is upward sloping since a higher interest rate leads to an increased supply of savings.[11] First,introducing a corporate income tax drives a wedge between the fixed world market interest rate and the marginal product of capital equal to the corporate tax rate t^C. Accordingly, less investment will be undertaken in the economy and the current account surplus will increase. The corporate income tax rate does not affect domestic saving. The negative effect on investment is, however, stronger than in a closed economy due to the infinitely elastic supply of world savings at the world market interest rate. In a closed economy the market interest rate would decline thus alleviating the effect of the rise in the corporate tax rate. Hence, the effect of tax competition on a small open economy which applies high corporate taxes is quite striking.

Second, Fig. 3.1 also shows the effects of introducing a personal tax on capital income (in this case on the return on savings) t^P. This tax does not affect the level of investment but introduces a wedge between the world market interest rate and the marginal rate of time preference. The current account surplus will be reduced since this tax creates a disincentive to save. As is the case above, the higher the degree of a country's openness, the larger this effect will be.

Since applying zero capital income taxes is not always feasible, adopting a low proportional capital income tax compared to labor income might be desirable (Boadway, 2004). Additional arguments for positive corporate tax rates are the avoidance of income shifting from highly taxed labor income to capital income and the existence of country-specific rents. If pure economic profits cannot be subjected to non-distorting instruments, then efficiency arguments would call for a positive source tax on capital (Haufler, 2001).

A further argument for the uncoupled proportional taxation of capital income is the fact that it provides sufficient flexibility to react and overcome the persisting tax competition without changing the entire tax system (Cnossen, 2000, Sørensen, 1994). This effect has been reenforced in Germany as well as in other high-tax countries by the aggressive tax policies adopted by the new EU Member States (see Chapter 2) which, in turn, make an on-going amendment of corporate income taxation unavoidable (Scientific Council attached to the Ministry of Finance, 2004).

[11] The MRTP curve is strictly speaking upward sloping only in the short run in the Ramsey model. In the long run, since the rate of time preference equals the interest rate, the curve will be flat.

Thus, a dual income tax system that applies lower capital income taxes is in line with the traditional theory of capital income taxation and seems to be an appropriate reform measure in the light of increasing international tax competition.

Neutrality Considerations

The most relevant efficiency aspect concerns the neutrality of the tax system.

The inconsistent application of a comprehensive income tax runs counter to a neutral tax system with respect to the financial and investment decision of the firm as well as to the choice of legal form. Progressive capital taxes, which apply under the global income tax, subject different taxpayers to different tax rates thus leading to an inefficient allocation of savings across time as well as between the corporate and the non-corporate sector.

This neutrality consideration is violated by the present German tax system. Firstly, since the German tax system (as described in the previous Chapter) distinguishes between corporate firms subject to the corporate income tax and non-corporate firms subject to personal income taxation, no neutrality exists regarding the taxation of these two legal forms. Secondly, the possibility of deducting debt interest against the high personal income tax distorts the financing decision of the firm. Thirdly, due to the special treatment of certain types of investment such as housing, the allocation of aggregate savings is also disturbed.

Therefore, a DIT which taxes all kinds of capital income irrespective of the firm's legal form, source and use of finance at a proportional tax rate would diminish the existing distortions and ensure a more efficient tax system.

3.2.2 Administrative Simplicity

The DIT is a quite appealing tax due to its administrative simplicity. Since the present German income tax law is too complicated, any tax reform should try to simplify tax laws such that laymen are also able to understand the tax code. In this context, a tax system is considered to be simple when the compliance and resource costs of filing tax returns and collecting taxes are low (Spengel and Wiegard, 2004). A DIT, which leaves no scope for arbitrage and avoids reoptimization of firms' decisions in the presence of taxation, offers such administrative simplicity. Additionally, if the DIT applies a uniform proportional tax rate on all types of capital income, which is levied as a source tax, it is easier to administer since an assessment of capital income is not necessary anymore. Thus, from the 25 million individuals subject to taxation in Germany, about 1.5 million people have capital income and have to be assessed under the current tax code (German Statistical Office, 2004b). The assessment of taxable self-employed persons is also simplified since the filing of capital income and the prepaid taxes on it are dropped. Furthermore, a separate source tax on dividends and capital gains need not be levied, if the

tax rate on corporate profits and the capital income tax rate are equal (as required by the dual income tax) and thus the profit payout is already taxed at firm level. Such a final taxation by means of the corporate income tax is already in place in Finland, Norway and Sweden (Genser, 2001).

A proportional capital income tax would also facilitate the administration within the banking sector, for it mostly avoids the supervision of tax allowances and other exemptions. By applying a uniform source tax one does not need any minimum threshold for small savers and the tax burden is reduced by levying just a low flat tax rate (Genser, 2001).

3.2.3 Revenue Aspects

An additional argument for higher labor income taxes rests upon the need to raise government revenue. Under the present tax law, due to several exemptions such as the return to pension savings or to owner-occupied housing, personal income taxes on capital have led to declining tax revenues. Hence, lower capital income tax rates applied uniformly to all kinds of capital income can be a practical way to counter the revenue loss resulting from the preferential treatment of certain investment returns and from the possibility to deduct debt interest against high personal income taxes.

In the light of increased international tax competition, capital exports as a result of high domestic taxation also lead to a shrinking domestic tax base. Thus, measures such as low capital income taxes designed to prevent capital flight are necessary to maintain tax revenues (Sørensen, 1994).

Moreover, progressive labor taxes are a main revenue raising instrument for the government and do not cause problems of horizontal equity when a social insurance system is in place which safeguards the most unfortunate workers against specific risks. Therefore, the DIT which combines higher progressive labor taxes with low proportional capital income taxes seems to be a good compromise between the government's revenue needs (requiring high taxes) and the competition for mobile production factors (requiring low taxes on these factors) (Scientific Council Attached to the Ministry of Finance, 2004).

Summing up, the following statement can be interpreted as a good appraisal of the DIT:

"*The DIT aims to strike a balance between equity concerns and revenue needs on the one hand and efficiency and neutrality on the other. As capital income tends to be concentrated in the upper income brackets the DIT may be conflicting both with horizontal and vertical equity objectives. However, in a comprehensive income tax system, interest expenditure (e.g. stemming from mortgage loans) is normally deductible against the top marginal personal income tax rate, whereas this is deductible against the (low) capital income tax rate in a DIT. As a result, in effective terms the DIT may be as equitable as a comprehensive tax system. The application of lower rates on capital as*

opposed to labor also contributes to efficiency, as capital is more mobile internationally, its supply more elastic and the real return more sensitive to inflation. In addition, a proportional rate reduces distortions with respect to the choice between present and deferred consumption inherent in comprehensive tax systems, in particular if taxation is heavy, and also promotes tax neutrality between different sources of capital income." (OECD Committee on Taxation, 2001, p. 29)

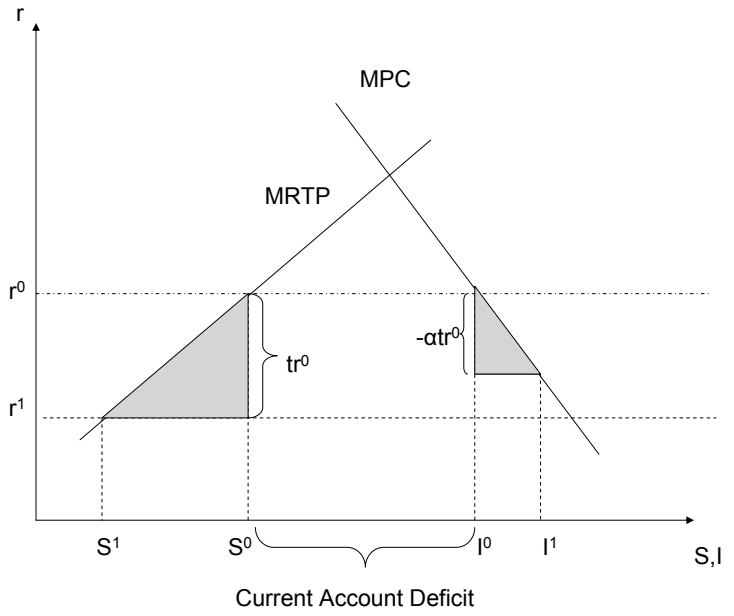
3.3 The Experience of Nordic Countries

Given all the considerations examined extensively above, the Nordic countries decided to implement the DIT system at the beginning of the nineties. The reforms basically pursued the principles of tax-cut-cum-base-broadening reforms of the type carried out in the U.S. in 1986. Firstly, all types of income such as fringe benefits or capital gains were to be included in the tax base and accelerated depreciation brought in line with economic depreciation. Secondly, tax rates were substantially reduced to make the reform politically feasible.

Fig. 3.2 shows the effects of a tax-cut-cum-base-broadening reform on savings and investment for a small open economy running a current account deficit. The uniform capital income tax drives a wedge between the $MRTP$ and the world market interest rate thus causing savings to decline. At the new equilibrium, $MPC = F_K - \delta = r^0(1 - \alpha t)$, where α denotes accelerated depreciation and δ economic depreciation. The higher the tax rate t, the larger the difference between the marginal product of capital and the interest rate will be and the more investments in physical capital will be undertaken. Since a uniform tax is neutral only when $F_K - \delta = r^0$, allowing for accelerated depreciation such that $\alpha > \delta$ leads to the so-called *taxation paradox*[12] (Sinn, 1987). It is called a 'paradox' since a higher tax rate can lead to higher investment in case accelerated depreciation exceeds true economic depreciation. The increasing investment and the decreasing saving also result in a larger current account deficit than at the starting point ($S^1 I^1 > S^0 I^0$).

[12] The term was first introduced by Schneider (1969,1974) and the phenomenon also described by Nachtkamp and Schneider (1970), Strobel (1970) and Sinn (1987).

Fig. 3.2. Tax-Cut-Cum-Base-Broadening Reform for a Country Running a Current Account Deficit



A tax-cut-cum-base-broadening reform such as the one brought about by implementing a dual income tax system reduces the prevailing distortions and is consequently welfare enhancing. Firstly, a reduced capital income tax rate diminishes the distortion in the consumption-savings decision (the left triangle which depicts this welfare loss becomes smaller). Secondly, through the base broadening, accelerated depreciation loses further attractiveness, thus reducing investments (the right triangle also shrinks).

The literature on dual income taxation (Cnossen, 2000 Sørensen, 1994) emphasizes the same line of argument as described in Section 3.2 - namely among other things that such a reform was necessary in the light of increasing tax competition and high capital mobility. Moreover, due to the fact that governments were usually not able to impose a uniform tax on all forms of income, as required by the principles of a comprehensive income tax, deviation from such a system was advisable.

Before the reform, Nordic countries did not treat all kinds of capital income in a similar way but allowed for several exemptions, especially in the treatment of interest or capital gains for taxation purposes. Specific investments like owner-occupied housing benefited from considerable subsidies like tax exemption of capital gains and generous rules for deductibility of debt interest. This situation caused huge public revenue losses in all countries un-

der consideration. Consequently, the erosion of the tax base led to a rise in marginal labor income tax rates.

Table 3.3. Marginal Income Tax Rates in the Nordic Countries Before and After the First Major Tax Reforms (in %)

	Denmark	Sweden	Norway	Finland
Year of introduction	1987	1991	1992	1993
Marginal tax rate on personal income				
Before tax reform	48-73	36-72	26.5-50	25-57
After tax reform	50-68	31-51	28-41.7	25-57
Marginal tax rate on capital income				
Before tax reform	48-73	36-72	26.5-40.5	25-57
After tax reform	50-56	30	28	25
Corporate income tax rate				
Before tax reform	40	52	50.8	37
After tax reform	50	30	28	25

Note: The above after reform tax rates are those prevailing immediately after the reform
Source: Sørensen (1994).

As can be seen from Table 3.3, there was a wide dispersion of marginal tax rates on capital income before the reforms were enacted in the respective countries. By and large, marginal tax rates for capital income were mostly equal to those of labor income, which is well in accordance with the principles of the global income tax (Cnossen, 2000).

The comparison of post reform tax rates with the ones that prevailed prior to the reform clearly shows the drastic reduction that took place. Since the tax reform also encompassed a broadening of the tax base, there was no general loss in government revenue (Cnossen, 2000).

Meanwhile, the tax rates and structures have changed in these countries. Table 3.4 provides a summary of the basic features of the tax system at present.

Table 3.4. Statutory Tax Rates and Taxation Rules in the Nordic Countries 2004 (in %)

	Denmark	Sweden	Norway	Finland
a. Capital income				
-corporate	30	28	28	29[e]
-other	28/43[a]	30	28	29[e]
b. Labor income	38.1-59	31-56.5[b]	28-55.3[d]	29-52
Elimination of double taxation of corporate profits				
a. Distributions	No	No	Yes	Yes[f]
b. Retentions	No	No	Yes	No
Withholding taxes on non-residents				
a. Dividends	Yes	Yes[c]	Yes	Yes[f]
b. Interest	No	No	No	No
Income splitting				
a. Proprietorships	Yes	Yes	Yes	Yes
b. Closely held companies[g]	No	Yes	Yes	Yes

Notes: [a] The 28 per cent constitute a final withholding tax for distributions up to 41,100 DKK. Above this threshold dividend income is taxed at 43 per cent and credited against personal income tax. Interest income is subject to personal income taxation with a top rate of 59 per cent.
[b] Including communal taxes.
[c] Under most double taxation treaties the rate is reduced from 30 to 15 per cent.
[d] 55.3 excluding employer's social security contributions(64.7 per cent including these contributions).
[e] From 2005 the corporate rate is reduced to 26 per cent and the tax rate on capital income to 28 per cent.
[f] From 2005 the imputation system will be replaced and 70 per cent of distributed profits from public listed companies.
[g] Will be subject to personal taxes. A closely held corporation defines a corporation with an active owner, meaning an owner who is both manager and shareholder.
Source: German MoF (2005b), GCEA(2003), Cnossen(2000), Schratzenstaller(2004), Danish Ministry of Taxation (2005), Finnish, Norwegian, Swedish Ministry of Finance (2005).

As indicated in Table 3.4, the lowest marginal labor tax rate is usually as high as the capital income tax rate (which is usually also equal to the corporate income tax rate) thus meeting one of the principles required by the dual income tax.

In Finland, Sweden and Norway, interest income of residents is taxed at source by applying relatively low final withholding taxes (Schratzenstaller, 2004). There are no source taxes for non-residents except in Norway. Double taxation is avoided by a shareholder relief system taxing dividends at a reduced tax rate in Denmark and by applying a full imputation system in Norway and Finland.

3.3.1 Denmark

Even though Denmark can be regarded as the cradle of the dual income tax, it is the country that departs most from the principles underlying such a tax. The 1987 reform proposal actually advanced the idea of a 50 per cent tax on capital income and corporate profits. However, due to the opposition's reluctancy to abandon the idea of progressive capital income taxation, a special surtax of six per cent was introduced, such that the marginal capital income tax rate amounted to 56 per cent. A further move away from the basic principles of a DIT was undertaken with the 1993 tax bill which lowered labor income tax rates. Therefore, from 1994 onwards, personal income and positive net capital income above a certain threshold were subject to the same marginal tax rates (Sørensen 1994).

Nowadays, a proportional tax rate of 30 per cent on corporate profits is in place, however other capital income such as interest income (Schratzenstaller 2004) is subject to higher progressive rates. Regarding the taxation of inbound dividends, 66 per cent of them are taxed at the corporate tax rate. Tax exemption is provided only if 20 per cent of the company shares have been held for more than 12 months. This rule applies also to outbound dividends if the shareholder is domiciled in an EU country or in a country which has concluded a double tax treaty with Denmark. However, in general, outbound dividends are generally subject to a withholding tax of 28 per cent which can nevertheless be reduced according to a tax treaty. Capital gains are taxed at the corporate tax rate if the shares have been held for less than three years.

The effects of this Danish Tax Reform were evaluated by Knudsen et al. (1998)[13]. Applying a dynamic computable general equilibrium (CGE) model, the authors find a limited macroeconomic effect. There is a long-run increase in private consumption which is mainly due to wealth accumulation in the private sector as a result of higher savings. The reduction in labor taxes has a positive effect on the labor cost but total labor demand is unlikely to change. This is due to the fact that the reduced capital stock (stemming from higher capital gains taxes) leads to a reduction in marginal labor productivity which counteracts the effect of lower labor costs. Although each individual reform component does have a significant effect on the economy, they tend to act in opposite directions, such that the overall welfare effect of the reform is moderate.

3.3.2 Finland

The last Scandinavian country which implemented such a tax system is Finland. Before the reform, statutory corporate income tax rates in Finland were very high but collected taxes were considerably lower due to a large number

[13] This model features overlapping generations (OLG) of agents. However, it also incorporates the effects of introducing green taxes as revenue raising instruments.

of allowances and special provisions. Regarding personal taxation, statutory marginal tax rates of over 50 per cent prevailed, nevertheless, they rarely applied to capital income as investments in non-taxed assets prevailed. In addition, the tax base from capital income eroded further since tax-exempt ceilings on personal capital income existed at that time. The possibility to deduct a certain level of interest expenses when computing the personal income tax base led to an even negative average effective interest income tax rate. Corporate investments in real assets were mainly financed by bank loans and retained earnings, thus leading to a high debt ratio of companies and little profit distributions by firms.

Accordingly, a reform became a high priority when the government decided to make the system more competitive in the international environment and to come closer to the ideal of a neutral[14] tax system. The gradual reform was carried out between 1987 and 1993.

Nowadays, the progressive tax rates on earned income range from 14 to 37 per cent.[15] In 2005, capital income is taxed at a flat rate of 28 per cent while corporate income is subject to a 26 per cent tax. Moreover, starting in 2005, the present full imputation system is replaced by partial double taxation of dividends, and no tax exemption of capital gains is in place. The taxpayer is also entitled to offset negative income from capital against his income tax on earned income, the credit amounting to 29 per cent of the deficit. Withholding taxes apply to dividends, interest and royalties (Finnish Ministry of Finance, 2005).

Welfare estimations of the reform, performed by Valkonen (1999) using a dynamic CGE model with overlapping generations on the household side, suggest opposing effects: present households face a gain of 7.1 per cent of GDP, while future generations lose about 11.3 per cent in terms of GDP. This loss is mainly due to lower real wages and lower after-tax rates of return on savings. The reform also entailed a positive revenue effect. Even though tax rates were reduced, computed revenue from corporate income taxation increased from 4.7 per cent to 11.8 per cent of GDP between 1990 and 2000 (GCEA, 2003).

3.3.3 Norway

The main reasons behind the 1992 reform of the Norwegian tax system are clearly described by van den Noord (2000). During the late 1980s, the Norwegian tax system was characterized by a large number of exemptions and allowances like the preferential tax treatment of certain regions or sectors as well as rather high statutory tax rates for labor and capital (Christiansen

[14] A neutral capital income tax system is one characterized by the equality between the interest rate and the social rate of return to real investment. Thus, we have a uniform taxation of all forms of capital because the effective tax rate on financial capital equals the one on real capital (Holmoy and Vennemo, 1995).

[15] These numbers apply if the communal tax which also applies to the individuals' earned income and ranges between 15 and 19.75 per cent is not considered.

2004 and VAN DEN NOORD 2000). The preferential treatment had its underpinnings in the government's objective to continue to provide a high level of public goods and preserve a high level of employment and social standards in the whole country in order to keep remote areas populated, too. However, all these exemptions led to tax distortions. For instance, households took advantage of the deductibility of debt interest which induced negative after tax real interest rates. Such a situation led to a housing bubble and to an increase in debt-financed consumption. Therefore, a reform of the tax system became vital. Accordingly, the 1988 appointed Aarbake Committee proposed the dual income tax including lower tax rates and a broadening of the tax base.

Prior to the reform, the top marginal tax rate on labor income reached 50 per cent. After 1992, this rate was first reduced to 41.7 per cent and then again raised to 55.3 per cent in 2000. The pre-reform corporate tax rate amounted to 50.8 per cent compared to the post-reform rate of 28 per cent. The reduction in tax rates was also accompanied by a tax base broadening since tax depreciation became less generous and brought in line with economic depreciation, special deductions and tax credits were abolished, and realized capital gains became subject to taxation (SØRENSEN, 2003).

Although the reform tried to reduce the distortion of overinvestment in the housing sector, it did not really accomplish this goal. Due mainly to political considerations, the tax rate on owner occupied housing was set at very low levels such that the reform did not succeed in reducing the tax benefit for this investment type.

The present Norwegian tax system distinguishes between general income and personal income. The first includes all income from work, business and capital. Tax allowances and reliefs like interest payments on debt and a basic allowance on wage and pension income are deductible in the computation of this income (at the 28 per cent tax rate) but not from the personal income tax base. The latter consists of employment and pension income.

The flat rate on capital income and that on labor income below NOK 380,000 are the same as the corporate rate of 28 per cent (Table 2.4). labor income above NOK 380,000 is subject to a two-bracket progressive surtax (NORWEGIAN MINISTRY OF FINANCE, 2005).

A full imputation system is in place and thus the double taxation of profits is avoided. There is also no double taxation of retained profits. No withholding taxes apply to interest and royalty payments, but dividends to non-resident companies and individuals are also subject to a 25 per cent withholding tax (CNOSSEN, 2000, SØRENSEN, 2001b, CHRISTIANSEN, 2004, NORWEGIAN MINISTRY OF FINANCE, 2005).

An additional positive outcome of the reform was the neutrality of the tax system with regard to the three main sources of capital income for individuals, namely dividends, interest income and capital gains. The neutrality argument according to which, for a given after-tax rate of return, the same pre-tax rate of return has to result from different savings and investment alternatives is underlined by VAN DEN NOORD (2000). His computations show that

the marginal effective tax wedge in the manufacturing sector is always 1.3, irrespective of whether investments are financed by retained earnings, debt or new equity.[16] This result arises since under the current system dividends and capital gains are taxed in an equal manner (van den Noord, 2000).

Estimates of the welfare gain of the reform using a CGE model with OLG households suggest an increase in welfare by 0.75 per cent in terms of the equivalent increase in private consumption (Holmoy and Vennemo, 1995). Additionally, households' savings rate and the before-tax return on business investment increased (Christiansen, 2004). The reform also generated more revenue from corporate taxes and from indirect taxes as a result of increased private consumption. The first increased from 9 per cent to 15.2 per cent of GDP between 1990 and 2000 (GCEA, 2003). If welfare is expressed as the amount of lump-sum taxes required for financing the reform, the Norwegian reform proves to be very successful, for the required lump-sum tax revenue decreases (Holmoy and Vennemo, 1995).

The 1992 reform was followed 11 years later by a new reform proposal submitted by the Skauge Committee[17] in 2003, which mainly focused on information and enforcement problems inherent in the tax system. Especially the deficiencies of the income splitting model were addressed by designing a so-called shareholder tax (Christiansen, 2004). This tax consisted of a personal tax on share returns above the post-tax interest rate on government bonds. Following the proposal, the tax rate on returns on investment in shares would rise from 28 per cent to 48.16 per cent and the top marginal labor income tax rate would decline from 64.7 per cent (55.3 per cent) to 54.3 per cent (46.8 per cent) with (without) social security contributions (Norwegian Finance Ministry, 2005). Such an amendment would bring the combined corporate and personal capital tax in line with the labor income tax, thus limiting the scope for tax arbitrage by active[18] firm owners (Sørensen, 2003).

3.3.4 Sweden

When introducing the dual income tax in Sweden, legislators had particularly in mind to set a ceiling for the tax reduction offered by the possibility to deduct interest payments from the tax base - a situation that was previously common

[16] The applied measure shows the extent to which corporate and personal taxes increase the real rate of return offered by an investment project if the alternative is a 5 per cent real rate of return on a demand deposit. To avoid the double taxation of retained profits, only capital gains exceeding the increase in the company's stock of retained earnings are taxed. This is the so-called RISK method (van den Noord, 2000).

[17] Named after the former Minister of Finance Arne Skauge (Sørensen, 2003).

[18] In general, an active owner is defined as a corporation's manager who is also a stockholder. Norwegian tax law defines an active owner as one that owns at least two thirds of the firm and works for a minimum number of hours per year in the firm (Christiansen, 2004).

to all Nordic countries. At present, capital income including capital gains, rental income, dividends and interest income is separated from earned income. Offsetting negative labor income against positive capital income is permitted. The capital income tax rate of 30 per cent on nominal interest was set at this level to roughly compensate for the need of indexation and was computed in the following way: assuming a 10 per cent nominal interest rate and 4 per cent inflation, a 30 per cent tax rate on nominal interest would be equal to a 50 per cent rate on real interest. The latter value corresponded approximately to the top rate on earned income (20 per cent central government tax and 30 per cent local government tax at that time) (Muten, 1996). Regarding the taxation of distributed profits, these are subject to the classical system, although a reduced tax rate applies at the personal level.

An evaluation of the Swedish tax reform was performed by Agell et al. (1996). The authors conclude that the reform succeeded in reducing the number of tax-induced economic activities such as investment in owner-occupied housing triggered by tax concessions, thus leading to a more efficient allocation of the capital stock. The marginal excess burden per krona of tax revenue declined for different types of workers. However, the reform also incurred costs. Due to the savings shift from real assets such as housing, to financial assets, effective demand decreased.

Moreover, corporate tax revenue increased from 3.1 to 7.5 per cent of GDP between 1990 and 2000, even though tax rates were reduced (GCEA, 2003).

An interesting feature of the tax systems described above is that they usually apply methods to avoid the double taxation of distributed profits to residents, while they still apply withholding taxes on dividends distributed to non-residents. According to Andersson et al. (1998) such a policy achieves the effect of reducing the cost of equity finance to a lesser extent than originally desired (assuming that the majority of a country's shares are held by non-residents). Just reducing the tax burden for domestic shareholders does neither render domestic shares relatively more attractive for foreign investors nor does it lead to an increase in the domestic share price which results in a lower cost of equity. Even if there could be arguments stating that such a tax relief would benefit small companies whose shares are not traded on international stock exchanges, the results appear to be unclear and therefore the authors suggest that reducing taxes at the corporate level is more effective than attempting to alleviate the double taxation by reducing taxes at the personal level. This argument is also well in line with the new view of dividend taxation according to which the dividend tax is neutral with respect to investment decisions and therefore a reduction or even abolishment of this tax would not be meaningful.

As also postulated by the OECD Committee on Taxation (2001): "*The Nordic countries seem to have fared relatively well with the DIT system. As small, open economies with a particular preference for redistribution and relatively large public sectors, they have been facing the challenge of raising revenue from a mobile source in an environment with relatively high marginal tax*

rates. Under these circumstances, the DIT has served as a pragmatic middle course between pure comprehensive income and consumption taxation, while lowering overall distortions in the tax system." (p. 29)

3.4 Problems Related to the DIT Implementation

3.4.1 Difficulties Arising from the Separation of Labor and Capital Income

A valid concern arising from the DIT applies to small enterprises, such as partnerships, proprietorships and to corporations with active owners. They may suffer a relative disadvantage if returns on business investments are taxed at the higher tax rate applying to labor income which is reenforced by the fact that social security taxes are only levied on labor income. This problem arises because self-employed persons derive income both from their work effort and from the invested savings. Therefore, one must determine a labor and a capital income component, each being in part very complicated to assess. The easier way is to determine the capital income component first by imputing a rate of return on equity and tax this calculated return as capital income at the lower capital income tax rate. However, this is quite often a cumbersome task. It is difficult to define which assets have an imputed rate of return, especially for those assets used for both business and private purposes. Additionally, it is important to decide whether the value of all assets less debts should be used as the basis for computing net taxable capital income (the so-called net method), or whether the imputed rate of return should be applied to the value of all assets (the so-called gross method) (Cnossen, 2000). Moreover, the method of valuation of special assets such as intangibles and the proper rate of return may pose additional problems.

3.4.2 Solutions Applied by the Nordic Countries

To combat tax shifting incentives from labor to capital income, for instance, the so-called closely held corporations (CHC)[19] in Sweden are required to split dividend income into a labor and a capital income component. This rule is applied in the case that dividends are paid out or a capital gain is realized by an active shareholder. An imputed rate of return[20] on the acquisition price of shares is computed, and dividends are subject to the same tax as capital income if they are less or equal to this imputed return. If dividends are higher, the difference is taxed as labor income. In the case of capital gains, half are treated as capital and the other half as labor income. This method can also be applied to sole proprietorships (Lindhe et al., 2003). The procedure described above is also applied in Finland with the difference that the return

[19] According to Swedish tax law, a closely-held corporation is a firm where one or a few individuals hold a minimum of 50 per cent of the shares. In order to make law firms and medical offices also fall under this category, active shareholders can be regarded as one person (Muten, 1996).

[20] Equal to the interest rate on 10 year government bonds plus a risk premium of five percentage points (Lindhe et al 2003).

is computed on net or gross business assets but not on the acquisition price of shares (Lindhe et al., 2001).

In Norway, partnerships, sole proprietorships or corporations with active owners have to undertake the income splitting rule annually, regardless whether dividends are paid or not. First of all, capital income is computed by calculating an imputed rate of return equal to the interest rate on five-year government bonds and a four per cent risk premium, amounting to 10 per cent in 2003 (Christiansen, 2004, Sørensen 2003). Labor income is then determined residually as the difference between the owner's share of corporate profits and capital income (Cnossen 2000, Sørensen 2001c). However, residual profit above a certain threshold is still taxed as capital income since a high return is likely to represent rather a return on capital than wage income (Sørensen, 2003).

To avoid the difficulty of defining *active* versus *passive* shareholders, which is inherent in Norwegian tax law, the Finnish tax code requires dividends paid by unlisted companies to be differentiated in two components. One part is treated as capital income and subject to capital income tax and the other is regarded as earned income on which the progressive labor income tax is imposed (Sørensen 2001b and 1994).

The above mentioned weakness of the DIT regarding income splitting has indeed proved to be a problem in the Nordic countries. In Norway, for instance, the share of enterprises which are subject to income splitting declined from 55 to 32 per cent between 1992 and 2000. The owners of these firms found several methods of circumventing high personal income taxes, for instance by inviting more passive owners into the enterprise such that their share decreased below 66 per cent (Christiansen, 2004). This result is also emphasized by the empirical findings of Fjaerli and Lund (2001), who using data on Norwegian corporations, find that choosing the type of payout (earned income or capital income) by active owners is strongly affected by the desire to minimize tax payments.

Regarding the introduction of a DIT in Germany (see further below), neither the GCEA(2003) nor Sinn (2003a) offer any concrete solutios to these problems. The GCEA (2003) suggests that one of the above mentioned splitting methods should be applied for German sole proprietorships or partnerships to avoid tax arbitrage. An alternative would be a so-called shareholder tax as advocated by Keuschnigg and Dietz (2004) as a component of the Swiss Dual Income Tax (SDIT) proposal (see the Appendix to this Chapter). According to this concept, the shareholder tax is chosen to combat any tax arbitrage incentives by owners of non-corporate firms. The rule, according to which the shareholder tax t^S is computed, states that $(1-t^U)(1-t^S) = 1-t^W$ where t^U is the tax rate on corporate profits and t^W the tax rate on labor income. In line with this rule, the owners would not have an incentive to declare their wages as capital income. On the one hand, if the entrepreneur declares his income as wage income, this income will just be subject to the wage tax

and not to the profit tax. On the other hand, if the firm's owner decides to declare his income as capital income, this income will then be taxed at the profit tax rate and the shareholder tax because it can be interpreted as an abnormal profit. Keuschnigg and Dietz (2004) compute for Switzerland a shareholder tax of 18.3 per cent when the corporate tax amounts to 23.2 per cent and the wage tax to 37 per cent.[21]

3.5 Concrete Proposals for Germany

Given the arguments for introducing a DIT, analyzed at length in Section 3.2 of this Chapter and the reasoning for the need to reform the German tax system, presented in Chapter 2, I now introduce two concrete reform proposals advanced by the GCEA(2003) and by Sinn (2003a) which consider implementing such a tax system in Germany.

3.5.1 Main Features of a DIT System as Proposed by the GCEA (2003)

The GCEA has recognized the deficiencies inherent in the present German tax system and presented the DIT as a possible reform option in its 2003 economic report.

The council's proposal features the following key characteristics (GCEA 2003, Spengel and Wiegard, 2004):

- Income is divided into a capital and a labor component.
- Capital income should include corporate business profits, dividends, capital gains, royalties, interest income and rental income.
- Earned income should cover income from employment, income arising in non-corporate firms, pensions and compulsory old-age pensions.
- Capital income is taxed at a uniform flat rate of 30 per cent. This rate also equals the corporate tax rate. The local trade tax can be included in the corporate tax or abolished.
- Earned income is taxed at progressive rates between 15 and 35 per cent with a basic tax allowance of € 7664 . The top marginal tax rate on earned income should not be too high compared to the capital income tax rate to prevent tax arbitrage. The proposal does not provide any exact rules for income splitting of closely held corporations, sole proprietorships or partnership, but income shifting incentives are prevented by applying tax rates on capital and labor that do not diverge too much. [22]

[21] For illustrative computations which show how such a tax avoids tax arbitrage opportunities see Keuschnigg (2004).

[22] It should be noted however that social security contributions are also levied on labor income such that in the end the overall burden on labor will be higher.

- To avoid double taxation of distributed and retained profits, dividends and realized capital gains should be tax-exempt, either by applying a full imputation system or a general tax exemption.
- Profits of foreign corporations accruing to domestic shareholders are tax exempt.
- There is income splitting of income arising in non-corporate firms. Specific splitting rules can be designed based on the regulations prevailing in the Nordic countries (see Section 3.4 of this Chapter).[23]
- There is separate or joint taxation of labor and capital income, with the GCEA favoring separate taxation that also allows a tax credit for negative net capital income to be offset against the tax bill on labor income. This can be determined by multiplying the tax rate with the income loss and allowing for a tax credit of this amount to be deducted from positive labor income.

The German Institute for Economic Research (DIW 2004) computed the revenue effects of this reform proposal. Accordingly, at € 1.5 billion loss in tax revenue, the DIT is the 'cheapest' reform proposal compared to other proposals which are now on the agenda of the federal government and other political parties.

3.5.2 The DIT Proposal of Sinn (2003a)

Another explicit reform proposal was advanced by Sinn (2003a). The main thrust of the proposal allows for the deduction of interest and of an imputed rate of return from the income tax base of all types of firms and to subject this income to a flat-rate savings tax of 20 per cent. His recommendations include:

- There is a final withholding tax on interest income at the rate of 20 per cent.[24] Provision to deduct debt interest against this proportional tax. Deduction of an imputed rate of return in determining taxable income for both corporate and non-corporate firms.
- There is a progressive tax schedule of 15, 25 and 35 per cent. The bottom marginal rate is applied to incomes between € 7,500 and € 17,500 . Income between € 17,500 and € 35,000 is subject to 25 per cent taxation and thereafter the top rate of 35 per cent applies. The present solidarity surcharge is already included in these numbers.

[23] Introducing in this case a shareholder tax as suggested by Keuschnigg (2004) to avoid arbitrage opportunities would result in a tax amounting to 7.1 per cent (in case the wage tax is 35 per cent and the profit tax rate 30 per cent).

[24] Tax reforms carried out in Austria, Belgium and Italy do not implement a fully fledged DIT but final withholding taxes on dividends and interest and are thus o similar to the Sinn proposal (Eggert and Genser, 2005 and Bordignon et al., 2001).

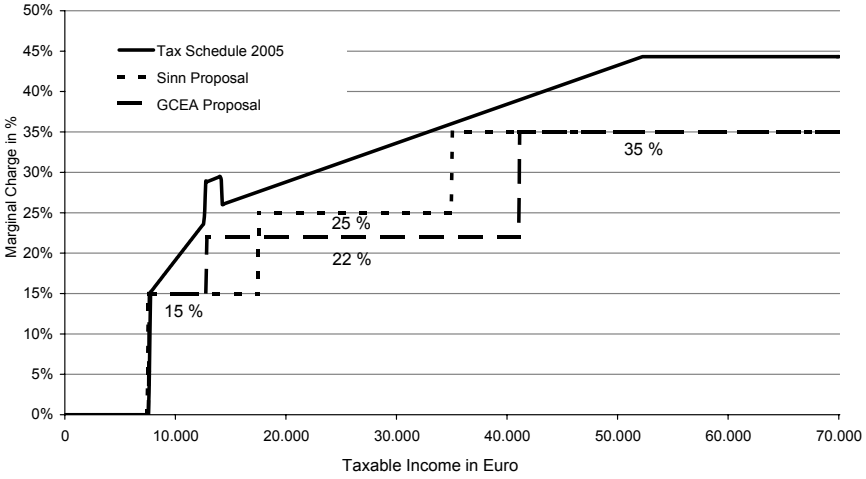
- Retained profits are taxed at 35 per cent (25 per cent corporate income tax plus 10 per cent local trade tax).
- Non-corporate firms are liable to the progressive earned income tax schedule with a top rate of 35 per cent.
- To address the income shifting problem arising in sole proprietorships and partnerships, an imputed rate of return is first computed and then subjected to the 20 per cent final withholding tax.[25] The imputed rate of return is computed equal to the long-term capital market real interest rate. The residual income is then taxed as labor income under the progressive tax schedule.
- The half-income taxation of dividends applies. Accordingly, distributed profits above the imputed return, will be subject to a top rate of 46 per cent (25 per cent profit tax plus 10 per cent local trade tax plus 11 per cent[26] personal income tax).

[25] In case this proposal is applied, the shareholder tax as designed by KEUSCHNIGG (2004) could be zero, since both the tax rate on retained earnings and the top marginal labour income tax rate equal 35 per cent.

[26] Assuming 100 profit units, we substract 35 units corporate and local tax and multiply a half of profit units by the top marginal personal income tax rate of 35 per cent i.e. ((1-0.35)/2·0.35)=0.11.

As an example, Fig. 3.3 depicts three marginal personal income tax schedules. The highest tax rates apply under the current law with the top marginal tax rate including solidarity surcharges amounting to 44.3 per cent. The two reform alternatives are insofar quite similar, as they both display a graduated scale of taxes and apply a basic tax rate of 15 per cent up to a certain threshold and a top marginal tax rate of 35 per cent. It is however important to notice that the GCEA proposal has not specified the thresholds; these are set here as in the DIW(2004) study. Moreover, the proposal does not specify a specific tax rate applying to the average income class such that I will also assume the average individual is subject to 25 per cent income tax as in the Sinn proposal. Nevertheless, the message is clear: Both reform alternatives offer a tax relief compared to the present situation, as the marginal tax burden is drastically reduced.

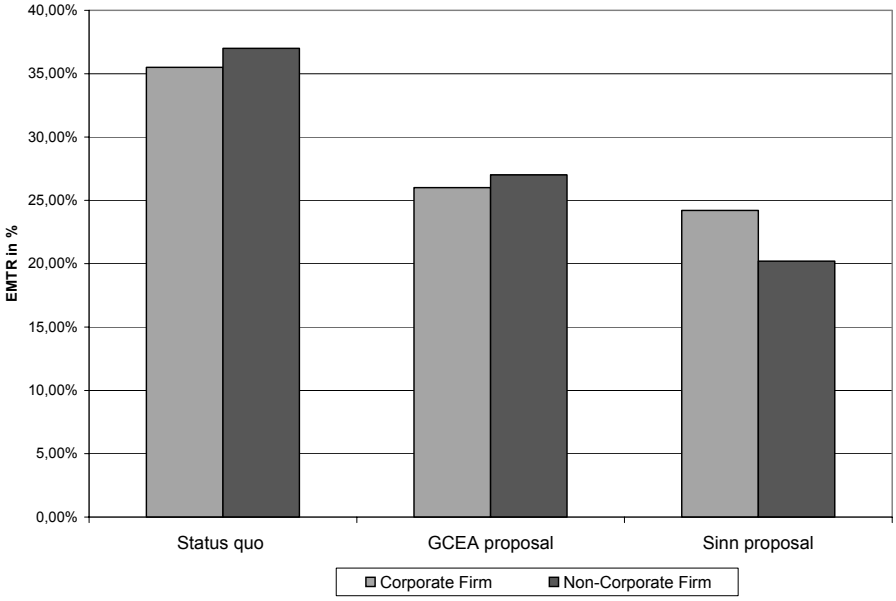
Fig. 3.3. Personal Income Tax Schedule 2005 versus Reform Proposals; Marginal Rates



Source: Sinn (2003a), GCEA(2003), DIW(2004), own calculations.

Fig. 3.4 depicts the effective marginal tax rates (EMTR) which apply to the current tax system and which would result after implementing the GCEA (2003) or the Sinn (2003a) proposal. The EMTRs are among the most important measures that influence investors' decisions. As we can see, both proposals lead to a visible reduction in EMTR's. The lower effective tax rates applying under the Sinn proposal are due to the additional introduction of an allowance for corporate and non-corporate equity under this tax regime. Nevertheless, the message is clear: Implementing a DIT leads to a considerable improvement in Germany's position in the international tax competition and increases the country's attractiveness for investment.

Fig. 3.4. EMTRs Before the Reform and After Implementing the GCEA (2003) or Sinn (2003a) Proposal



Source: Own calculations.

3.6 Summary

The line of argument favoring a dual income tax presented in the literature considers basically the desire to create a type of tax imposed on all kinds of income in a uniform manner. Since this is, however, politically difficult, it can be meaningful to introduce such a fiscal change in a stepwise process, by considering first the imposition of lower flat taxes on all types of capital income. Focussing on capital income first is a rather pragmatic approach and has to be viewed in the light of increased capital mobility. Further arguments are related to the fact that the present tax systems prevailing in many European countries, although labelled comprehensive income tax systems, systematically deviate from the principles of such a tax system.

The major motivations for such a tax cut-cum-base-broadening reform were the desire to diminish the scope for tax arbitrage, to stimulate private savings, to alleviate the distortions caused by progressive capital income taxation in inflationary phases and to diminish the revenue loss resulting from the possibility to deduct nominal interest rates against the high marginal income tax rates.

Finland, Sweden and Norway have already implemented tax systems that apply a low flat uniform tax rate on *all* kinds of capital such as dividends, corporate profits, interest income, capital gains and progressive labor taxes

on earned income including wages and salaries, pensions and social security transfers.

Accordingly, both equity and efficiency considerations favor the introduction of such a tax system. A low proportional capital income tax helps alleviate the intertemporal distortions resulting from taxing the returns to savings and at the same time, diminishes the disadvantage of physical versus human capital investment. Moreover, a uniform tax on various forms of capital hinders arbitrage opportunities. As opposed to this, under conventional income taxation, it would be possible, on the one hand, to accumulate the returns to debt-financed assets within a corporation subject to only a lower corporate income tax and, on the other hand, deduct the interest payment against the higher personal tax rate.

Additionally, the uncoupled proportional taxation of capital income allows for sufficient flexibility to react to the persisting tax competition without changing the entire tax system. This situation is exacerbated for Germany versus the rest of the world, notably the new EU members.

In the light of the mentioned considerations, a DIT which follows the proposals of the GCEA (2003) or Sinn (2003a) is a valid alternative.

Appendix - A Reform Proposal for Switzerland

Keuschnigg (2004) describes and analyzes the so-called Swiss Dual Income Tax (SDIT). This tax reform proposal which is inspired by the findings of the optimal taxation literature is primarily aimed at removing tax obstacles to growth. A small open economy has to design a tax system which fulfills several criteria such as providing an attractive investment climate and covering the government's revenue needs. The optimal tax system, which maximizes social welfare and meets the mentioned requirements, would envisage a zero source tax on profits if labor and residence-based interest income taxation also apply.[27] Such a system might reduce the level of employed capital in case of low employment, however, the capital labor ratio will remain unchanged and production efficiency will thus not be distorted. Since the core idea of the optimal tax system is actually to abolish the tax wedge between the marginal product of capital and the gross interest rate, this may also be achieved by positive profit taxes but at the same time by providing for an immediate investment write-off (leading effectively to a cash-flow tax) or if an allowance for corporate equity is given.[28] Moreover, residence-based taxation of capital income which leads to the equalization of gross interest rates is also advisable. The gross interest rate is the one which enterprises will adopt when discounting future investment projects in order to be able to grant the shareholders the required rate of return (Keuschnigg, 2005a).

The SDIT is actually a combination of an allowance for corporate equity with a dual income tax. The main idea behind this reform proposal is to apply a flat tax on capital income at the personal level and to exempt these profits at the company level which can be interpreted as a normal return to capital. Basically this means that a zero source tax on profits and a positive savings tax apply. Particularly, the SDIT displays the following main features (Keuschnigg and Dietz 2004, Keuschnigg 2004):

- A flat profit tax rate t^U of 23.2 per cent applying to both corporate and non-corporate firms.
- A progressive tax schedule for wage income with a top marginal rate t^W of 37 per cent.
- Provision to deduct a normal return on equity which equals the long-run risk-free return on government bonds.
- All types of capital income such as dividends, interest and realized capital gains are subject to a proportional tax, a so-called shareholder tax t^S of

[27] Regarding taxes on labor and capital income, if the savings elasticity with regard to the net interest rate is high, labor income should be more highly taxed and the other way around, if labor supply is highly reactive to the net wage rate, capital income should be more heavily taxed.

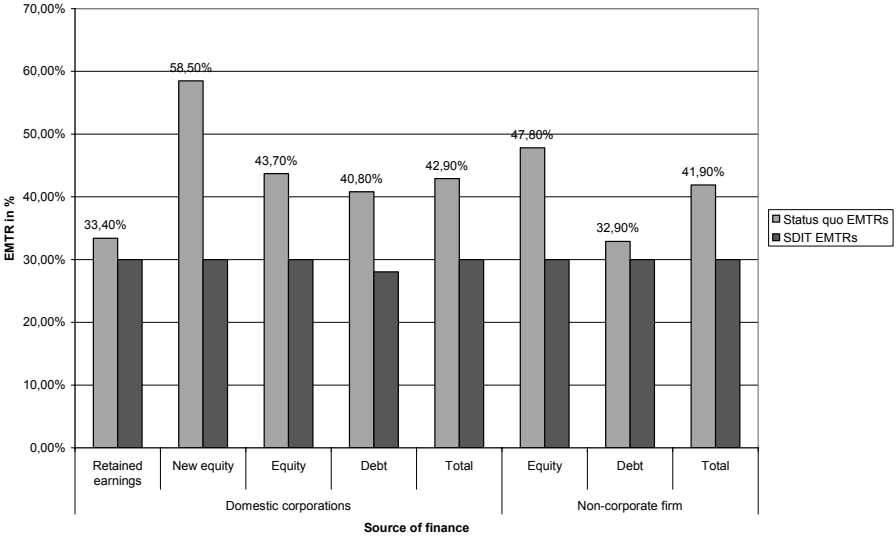
[28] A positive source tax on capital might be required, for instance, if these taxes also contribute to raising government revenue (Huizinga, 1995). Moreover, if it is desired to tax rents or monopolistic profits as well, applying a profit tax is also advisable (Keuschnigg, 2005).

18.3 per cent. To avoid tax arbitrage by misdeclaration of owners' wages as capital income, the shareholder tax has to satisfy $(1-t^U)(1-t^S) = 1-t^W$. Moreover, the SDIT also provides for full loss offset.

If such a drastic tax reform is implemented, it will lead to large revenue losses which can be financed, according to Keuschnigg (2004) by an endogenously determined increase in the value added tax.

Quantifying the effects of introducing such a tax system in Switzerland, Keuschnigg (2004) finds that the effective marginal tax rates (EMTR) are visibly reduced and an increased neutrality with respect to the source of finance and the choice of legal form is achieved. Fig. 3.5 illustrates the EMTRs prevailing in Switzerland both before and after introducing the SDIT. Before the reform, the Swiss capital income tax system distorts the decision regarding the source of finance or the firm's legal form. After introducing the SDIT, the EMTRs are equalized across sources of finance and legal forms such that tax distortions are eliminated. Moreover, the decline of the overall level of EMTRs makes investment in Switzerland more attractive.

Fig. 3.5. EMTR Before and After Introducing the SDIT



Source: Keuschnigg and Dietz (2004).

4

The Model

4.1 Overview of Different CGE Models and Their Characteristics

Evaluating and quantifying the effects of a comprehensive 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 use a general equilibrium model to capture a wide range of effects. This type of general equilibrium approach for analyzing the incidence of taxes was first developed by Harberger (1962,1966). His model depicts an economy where two sectors, namely the corporate and the non-corporate sector employ capital and labor supplied by a representative household to produce their output. The representative household uses its income from factor supply to buy the output good. The classical Harberger argument states that firms in the corporate sector are liable to a corporate income tax which does not apply to the non-corporate sector. Accordingly, too much capital will be accumulated within the non-corporate sector and too little in the corporate sector thus leading to a reduction in aggregate output. This analytical framework has provided the basis for the future, more developed computable general equilibrium (CGE) models.

Simulation models have been used as a method for an empirical evaluation of tax reforms. They can be applied for economic experiments which quantify the complex effects of different kinds of reforms in order to make a decision on the best alternative. These simulation models try to replicate the economic system and evaluate the effects of different fiscal instruments starting from the existing institutional framework. They enable policymakers to assess reform scenarios with regard to their distributional, fiscal and allocative effects.

We can distinguish between macro and micro models, with CGE models being a branch of macro models. CGE models allow us to evaluate numerically specific policy proposals (Peichl, 2005). They are derived from general equilibrium theory. Consequently, factor, goods and labor markets are integrated

into the model which displays the economy as a whole. The three main components are equations describing the supply and the demand side behavior, equations illustrating the income distributions of agents and finally equilibrium conditions for goods and factor markets. The decisions of households and firms follow from optimization rules which are derived from maximizing the individual's utility and the firm's value. The government's decisions satisfy its intertemporal budget constraint. The price mechanism coordinates the individual decision making process until an equilibrium is achieved. To evaluate a reform numerically, the model should be calibrated to replicate the economy at the moment under consideration.

CGE models can be static or dynamic. Static models, such as those developed by Shoven and Whalley (1972) just represent a one point in time description of the impact of taxes for a specific year. Hence, the main deficiency of this kind of models is the fact that the intertemporal dimension of tax incidence can not be analyzed since the capital stock is assumed to be fixed. Dynamic models take the capital accumulation process into consideration and can thus show how taxes affect investment and savings decisions (Fehr, 1999). The models in the second category assume rational expectations by all agents.

The four main building blocks of such models are firms, households, the government and the rest of the world. Firms derive their investment decision from an intertemporal optimization process of firm values. Households can be modelled on the one hand as OLG households where different generations with finite life horizons overlap. On the other hand, if households are modelled as a Ramsey agent, then a representative individual living forever is assumed. This kind of modelling is particularly useful for evaluating the intersectoral and intertemporal efficiency of tax reforms (as it is the case with the here applied model *IFOMod*), while OLG models are mainly appropriate if the overall purpose is to consider intergenerational redistribution issues.[1]

The government has to satisfy its intertemporal budget constraint which means that the present value of future tax revenue has to be equal to the present value of future government expenditures plus the present debt level. The foreign economy can either be modeled in case of a small open economy just by the exogenously given real interest rate or in case of a large economy by a symmetric modelling of the foreign economy to the domestic economy where the interest rate is determined endogenously on the world capital market.

There are various types of CGE models developed by different institutions, each of them displaying one or the other characteristic mentioned above. For instance, *Multimode Mark III* developed by the IMF (Laxton et al. 1998) is a multi-country dynamic OLG model which simulates the macroeconomic effects of industrial country policies on the world economy. Another noteworthy CGE model is OECDTAX recently developed by Sørensen (Sørensen

[1] Auerbach et al. (1987) for instance apply both features in their CGE model analysis.

2001a) for the OECD countries. The model is intended to describe the international cross-border effects of national tax policies via the world capital market and may be used to examine the effects of various forms of international tax coordination. OECDTAX is, however, static describing a stationary long-run equilibrium and does not include either an endogenous dividend policy or the firms' choice regarding their organizational form.[2] In the context of this study, the *IFOMod,* an applied CGE model is developed, which is a modification of the Swiss CGE model called *IFF Tax Model* elaborated by KEUSCHNIGG (2002 and 2005b). The *IFF Tax Model* is a dynamic CGE model with OLG households. It encompasses features like the two distinct firm sectors, namely the corporate and the non-corporate sector, an endogenous dividend, debt policy and labor supply, in- and outward FDI by multinationals, taxes at the personal and business level and last but not least international portfolio investments with home bias.

Compared to other well-known CGE models, *IFOMod* contains a detailed modelling of the firm sector as well as an explicit welfare analysis. In addition, it distinguishes itself from other models, since I apply the traditional Ramsey model instead of an overlapping generation model, which allows to analyze the way the welfare of the representative individual changes as a result of a tax reform. Additionally, *IFOMod* is in line with neoclassical growth theory. Savings and investment decisions are forward looking and thus permit a consideration of important tax capitalization effects. Moreover, the model contains an endogenous investment financing policy and labor supply as well as international portfolio investments. Furthermore, the model mimics several important behavioral margins at the firm level that are strongly sensitive to the effects of capital income taxation like the investment behavior and the financial decision. All these features enable a realistic modelling of the economy and are important for the quantitative evaluation of tax reforms. Therefore, by introducing both a corporate and a non-corporate sector, the effects of changes in different tax rates can be described for corporate and non-corporate firms since some tax policies might benefit the first and put the latter at a disadvantage or vice versa. Thus, I can simulate the effects for each sector in particular but also for the whole economy where the overall effect will depend on the magnitude of each sector within the economy. An endogenous investment and financial policy delivers empirically refined results. Since firms can react to each tax rate change by adjusting their source of finance and use of funds, this will influence the cost of capital and also the accumulation of capital and debt within each sector and within the economy. Therefore, all the above mentioned features enable an accurate examination of capital income tax reforms.

As it can be seen, each model's key features mostly depend on the model's applications. For instance, since the Dutch CGE model *MIMIC* particularly

[2] This model was applied by SØRENSEN to model the effects of the German Business Tax Reform 2000 on the German economy (Sø RENSEN, 2002).

aims at analyzing the effect of the tax and social security system on labor markets, the main focus is on the detailed description of the household sector while the modelling of the firm sector is less elaborate.

Table 4.1 provides an overview of the most common CGE models and their application.

Table 4.1. Overview of Different CGE Models and Their Features

General Features of	**IfoMod**	**OECD TAX**	**IFF Mod**	**MIMIC Mark III**	**MULTI MOD**	**Auerbach Kotlikoff**
Multi-Country Model	- (GER)	+	- (CH)	- (NL)	+	- (USA)
Dynamic Model	+	−	+	−	+	+
HH Structure	Ramsey	−	OLG	−	OLG	OLG
Individual Optim.	+	+	+	+	+	+
Welfare Analysis	+	+	−	−	−	+
Firm Sector						
External Financing	+	+	+	−	−	−
Endog. Dividend Policy	+	+	+	−	−	−
Different Legal Forms	+	−	+	−	−	−
Internat. Capital Flows	+	+	+	−	+	−
Household Sector						
Endog. Lab. Supply	+	−	+	+	−	+
Unemployment	−	+	−	+	−	−
Heterog. HH	−	−	+	+	+	+
Public Sector						
Pers. Income Tax	+	+	+	+	+	+
Corp. Income Tax	+	+	+	+	+	+
Dividend Tax	+	+	+	−	−	−
Capital Gains Tax	+	+	+	−	−	−
Public Transfers	+	+	+	+	−	+
Social Sec. Contrib.	−	−	−	+	−	+

Note: The + denotes the model features the respective characteristic;
The − shows a missing feature.
Source: Altig et al.(2001), Laxton et al. (1998), Keuschnigg (2002 and 2005b), , Sørensen (2001a) Graafland et al. (1998).

Additional CGE models developed to analyze especially different kind of reforms in Germany include the model developed by Fehr (1999), the MEA-PENSIM model of Börsch-Supan et al. (2003) and the model of the Zentrum für Europäische Wirtschaftsforschung (ZEW) by Böhringer et al. (2004). The MEA-PENSIM model applied, for instance, to analyze international capital flows as a result of population aging and pension reform, is a multi-country OLG model. The model used by Böhringer et al. (2004) is a static multi-sector general equilibrium model for an open economy. Again, also in the case of this model, the focus is to study policy reforms which affect the labor market and, therefore, the household sector is modelled much

more in detail than the firm sector. Therefore, the model does not distinguish between corporate and non-corporate firms nor does it allow for an endogenous portfolio choice. *IFOMod* features these characteristics and is thus more adequate for analyzing capital income tax reforms.

Accordingly, one can see that CGE models have increasingly become a standard tool for quantitative policy analysis, since they provide an appropriate framework to analyze the effects of different policy reforms on the whole economy.

4.2 The Model

The main features of *IFOMod* are

- open economy with international capital flows
- international portfolio investment with home bias
- domestic corporate and non-corporate sector
- sectoral investment dynamics
- endogenous business debt
- 'New View' of dividend taxation
- personal and business taxes
- level and composition of savings, endogenous labor supply

The model does not only describe the economy's new steady state solution under the new tax rules but also offers additional results in the form of adjustment paths of the macroeconomic variables such as capital stock, GDP, foreign debt, labor supply and consumption. For the ultimate evaluation of a tax reform, the model also provides a platform for the computation of welfare variations expressed as changes in the equivalent variation in consumption. Last but not least, the model enables to compute the marginal excess burden of each particular tax which provides an important device in designing an efficient tax system.

4.2.1 Business Sector

This section presents an inter-temporal investment model with convex adjustment costs $J^f\ (I^f, K^f)$[3] to highlight the main transmission channels: The price of the output good is normalized to unity. Investment decisions follow Tobin's (1969) Q theory of investment which states that firms will undertake investments as long as the stock market value of the assets exceeds the replacement cost. This result is consistent with the investment decision which is derived from maximizing the firm's market value when capital formation is subject to adjustment costs (Hayashi 1982). These adjustment costs which

[3] $J_I > 0, \quad J_{II} > 0, \quad J_K < 0$

are caused by disruptions due to the firm's internal reorganization, are included in the model to obtain more realistic dynamics in an open economy. In the absence of adjustment costs, the firm's optimal investment policy would envisage so much investment that the difference between the replacement cost and the market value of assets would become zero. As a consequence, adjustment costs motivate a 'smoothing' of investments over time (Auerbach 1987).

I distinguish between a corporate and a non-corporate sector, denoted by the superscript $f \in \{C, N\}$. Domestic firms hire labor L^f and accumulate capital K^f and debt B^f to maximize their firm value V^f.

Because I model an imperfect asset substitution in investor's portfolio choices, net rates of return are not equalized and an imperfect financial arbitrage exists (see for further details the Section on Optimal Portfolio Choice). Households thus choose the shares of foreign and domestic assets in financial wealth depending on the relative rates of return (Goulder and Eichengreen, 1992). The domestic gross interest rate on government bonds is denoted by i^H, while that on firm bonds is i^{BH}. Hence, the net domestic interest rate on government and firm bonds is $r^H = (1-\tau^i)i^H$ and $r^{BH} = (1-\tau^i)i^{BH}$ respectively, where τ^i denotes the tax rate on interest income. The interest rate prevailing in the foreign country is denoted by i^F. Domestic firms issue equity and pay a return on equity denoted by r^V. This return is higher than the return on firm bonds, for instance, as it includes an equity premium. As the residence principle of taxation applies, the gross domestic and foreign interest rates are equalized such that $i^H = i^F$.

Production and Investment

The economy is endowed with corporate and non-corporate firms. All firms within one sector are homogeneous so it will be sufficient to consider one representative firm for each sector and examine its optimizing behavior.

The linear homogenous production function Y^f includes not only labor and capital as production factors but also a sector specific fixed factor E^f.[4](For details regarding the specific form of the production function and its calibration see the Appendix C2). Hence

$$Y^f = F(K^f, L^f, E^f) = F_K^f \cdot K + F_L^f \cdot L + F_E^f \cdot E \tag{4.1}$$

where F_K^f, F_L^f, F_E^f denote the marginal products of capital, labor and of the fixed factor respectively.[5]

Capital expands over time whenever gross investment, I_t^f, exceeds the depreciation of the existing capital stock, δK_t^f. Therefore capital accumulation

[4] This factor allows us to model the two different sectors and to insure there are no corner solutions since there will always be some firms which belong to each sector. The fixed factor also gives rise to economic rents.

[5] For some equations which are time invariant I will supress the time index.

can be expressed as:

$$GK_{t+1}^f = I_t^f + (1-\delta)K_t^f. \tag{4.2}$$

The growth factor $G = (1+g)$, enters the model in its detrended form as we allow for an exogenous trend growth in labor productivity at rate g (see Appendix C1). Thus, in a balanced growth equilibrium the capital stock as well as all other variables grow at the rate g. Additionally, the firm incurs adjustment costs which provide an incentive to smooth investment over time. The adjustment cost function is assumed to be linearly homogeneous in investment and capital, and convex in investment. The steady state adjustment costs are zero such that they do not influence the steady state solution (see Appendix C3 for the calibration of the adjustment cost function).

Financial Identities and Arbitrage

Regarding the firms' financial decision, it is important to note that the three available sources of finance are debt, new share issues and retained earnings.

Concerning debt policy, I assume that interest payments on debt include an additional premium $m^f(b^f)$, which denotes the agency cost of debt depending on the debt asset ratio $b_t^f = B_t^f/K_t^f$ of a firm. The agency costs are increasing in b_t^f,[6] reflecting that a firm's risk of bankruptcy increases with rising indebtedness as the real costs of default increase.[7] Firms thus trade off the tax advantage of debt with the non-tax costs of debt. These agency costs ensure that there will always be an internal solution of the optimal debt asset ratio. The firm's effective interest cost will thus be $i_t^{BH} + m^f$. Debt accumulates according to:

$$GB_{t+1}^f = B_t^f + BN_t^f. \tag{4.3}$$

Therefore, the next period's stock of debt, B_{t+1}^f, is the sum of the existing stock of debt, B_t^f, and new debt, BN_t^f.

Net of tax profits π^f consist of output less adjustment costs, J_t^f, wage payments, $w_t^f L_t^f$, depreciation, δK_t^f and the tax liability, T_t^{Pf}, according to:

$$\begin{aligned} \pi^f &= Y^f - J^f - w^f L^f - \delta K^f - \left(i^{BH} + m^f\right) B^f - T^{P,f}, \\ T^{P,f} &= \tau^{P,f}[Y^f - J^f - w^f L^f - z_2 r(K^f - B^f) - \delta K^f \\ &\quad - (z_1 i^{BH} + m^f)B^f - z_3 IN^f]. \end{aligned} \tag{4.4}$$

Hence $\tau^{P,f}$ has to be interpreted as a source tax on corporate profits. Here z_3 represents the tax allowances for net investments IN^f[8] and r denotes an

[6] The agency cost of debt, are increasing in the debt equity ratio such that the first, $m^{f\,\prime}(b)$, and the second , $m^{f\,\prime\prime}(b)$, derivative are positive.

[7] For the calibration of the agency cost function see Appendix C4.

[8] If $z_3 = 0$ we have the case of economic depreciation. If $z_3 = 1$ we allow for a full immediate write-off and and t^{Pf} can be interpreted as a cash-flow tax.

imputed rate of return which can be deducted from the tax base. In the basic scenario $z_1 = 1$ and $z_2 = 0$ holds, implying that only interest payments on debt are tax deductible. This indicates that there is a preference for debt financed investments which accordingly leads to a higher debt asset ratio and an increasing business cycle sensitivity of the firm sector. If $z_2 = 1$, we model the case of an allowance for corporate and non-corporate equity.[9]

In the following I will distinguish between the following tax rates and tax factors. A tax on profits, $\tau^{P,f}$, one on dividends, $\tau^{D,f}$ and on capital gains, $\tau^{G,f}$ apply. $\tau^{P,C}$ is the tax rate levied on profits of corporate firms. Regarding non-corporate firms, here the owner and the investor are the same person. Thus, since all profits are considered personal income whether distributed or not, the profit tax rate is $\tau^{P,N}$, namely the personal income tax rate of the owner. No further dividend tax is imposed so $\tau^{DN} = 0$ and as such it is optimal to distribute the entire profits $D^N = \pi^N$, for retentions would just increase the tax burden due to capital gains taxation which would arise if the firm is sold or transferred.

Table 4.2. Taxes and Tax Factors

		Corporate Firm	Non-Corporate Firm	Tax Factors
Profits	$\tau^{P,f}$	$\tau^{P,C}$	$\tau^{P,N}$	$\theta^{P,f} = (1 - \tau^{P,f})$
Dividends	$\tau^{D,f}$	$\tau^{D,C} = \tau^{D}$	$\tau^{D,N} = 0$	$\theta^{D,f} = (1 - \tau^{D,f})$
Capital Gains	$\tau^{G,f}$	$\tau^{G,C}$	$\tau^{G,N}$	$\theta^{G,f} = (1 - \tau^{G,f})$

Due to the absence of a dividend tax for non-corporate firms, the dividend tax revenue, T^D, stems solely from the dividends of corporate firms Div^C:

$$T^D = \tau^{D,C} \cdot Div^C. \tag{4.5}$$

Capital gains taxes are collected both from corporate and non-corporate firms:

$$T_t^G = \sum\nolimits_{f=C,N}^{2} \tau^{G,f} \left[GV_{t+1}^f - V_t^f - VN^f \right]. \tag{4.6}$$

According to the cash flow identity:

$$IN_t^f = \left(\pi_t^f - Div_t^f \right) + VN_t^f + BN_t^f \tag{4.7}$$

net investments,[10] $IN_t^f = I_t^f - \delta K_t^f$, can be financed via a reduction in payouts (dividends) and thus out of retained earnings $\left(\pi_t^f - Div_t^f \right)$, issuing new equity, VN_t^f, or externally via new debt, BN_t^f. However, this is a general

[9] An allowance for corporate equity means that an imputed return on equity can be deducted from the interest rate, thus achieving an increased neutrality of the tax system in case a positive corporate tax applies.

[10] We assume that replacement investments are always financed internally.

expression. My approach is actually to model a corporate firm which finances only a small fixed fraction of marginal investments by new share issues such that retained earnings or new debt are the marginal source of finance. In case of a non-corporate firm, marginal investments are financed either by new share issues or new debt (see the Sections on corporate and non-corporate firms below).

Corporate Firms

Since we refer to a mature economy, characterized by mature firms[11], we follow the 'New View' of dividend taxation.[12] This is one approach used in the corporate finance literature to characterize the relationship between taxes and the cost of capital[13]. Accordingly, dividends Div^C are determined residually (Sinn, 1987). The marginal source of finance will be retained earnings $\pi^C - Div^C$ and the marginal use of funds, dividend payout. Therefore, since dividend taxes avoided today by financing investments via retained earnings can be set against the future dividend tax payments, dividend taxes will not affect the cost of capital at all. The required dividend per invested monetary unit D will be equal to $D = \frac{i^H(1-\tau^i)}{(1-\tau^{GC})(1-\tau^{PC}).}$. Thus, dividend taxes are neutral with respect to the firm's financing decision. If the dividend tax is lowered, this will just create a windfall gain to share owners but would not affect the firm's cost of capital. In contrast, the 'Old View' of dividend taxation assumes that shareholders prefer dividend distributions due to their so-called signalling function, because of a certain cash preference or since they desire to reduce managerial discretion over the use of profits.[14] Consequently, retained earnings will not suffice for financing investments such that the marginal source of finance are new share issues. As a result, dividend taxes will negatively affect the investment behavior (Sinn, 1990). If we again assume D to be the required dividends per invested monetary unit, then, according to the traditional view of dividend taxation, $D = \frac{i^H(1-\tau^i)}{(1-\tau^D)(1-\tau^{PC}).}$. If the personal tax rate on interest income τ^i and the dividend tax rate τ^D are equal, then just the corporate

[11] 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 are any new shares issued, but all profits are retained to finance profitable investments. After the nucleus has reached its stage of maturity, 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' of dividend taxation (Sinn 1991).

[12] This hypothesis on the effect of dividend taxation was developed among others by Auerbach (1979), Bradford (1981) and Sinn (1987).

[13] The cost of capital is defined as the minimum pre-tax rate of return generated by an investment if it is to be undertaken.

[14] For a detailed discussion on the 'Old' and 'New View' of dividend taxation see also Sinn (1990), Sørensen (1995) and Zodrow (1991).

tax rate τ^{PC} will determine the difference between the cost of capital and the interest rate.

Keeping in mind the empirical evidence provided by AUERBACH AND HASSET (2003)[15], who state that both views on the effects of dividend taxation are valid, we determine new share issues by $VN_t^C = \beta(1 - z_3\tau^{Pf})IN_t^C$. This approach is similar to FEHR (1999). New investments are largely financed by retained earnings or by new debt BN^C and only a fixed fraction, β, of five per cent is financed via new share issues. However, this approach does not apply to non-corporate firms, because these have to rely on external equity to finance investments (see the next Section).

Plugging eq.(4.4) into the flow of funds equation, we derive an explicit expression for dividends Div^C as output Y^C less labor costs $w^C L^C$, interest payments $i^{BH}B^C$, new shares VN_t^C, depreciation δK^C and corporate tax payments:

$$\begin{aligned} Div^C = \theta^{P,C}\left[Y^C - J^C - m^C B^C - w^C L^C - \delta K^C\right] - (1 - z_1\tau^{P,C})i^{BH}B^C \\ + BN^C + z_2\tau^{P,C}r(K^C - B^C) - \left[(1-\beta)(1 - z_3\tau^{P,C})\right] IN^C. \end{aligned} \tag{4.8}$$

In equilibrium, the return on equity has to equal the net of tax dividend payment and the net of tax capital gains which can be derived from holding firm shares. Hence

$$\begin{aligned} r_t^V V_t^C &= \theta^{D,C} Div_t^C + \theta^{G,C}\left[GV_{t+1}^C - V_t^C - VN_t^C\right] \\ [1 + \underbrace{\frac{r_t^V}{\theta^{G,C}}}_{re_t^{VC}}]V_t^C &= \underbrace{\frac{\theta^{D,C}}{\theta^{G,C}} Div_t^C - VN^C}_{\chi_t^C} + GV_{t+1}^C \ . \end{aligned} \tag{4.9}$$

Here r_t^V is the investor's required return that is necessary if the investor should be willing to hold the asset. This return is higher than the net return on firm or government bonds since it includes a risk premium.

Introducing the two tax factors $\gamma^{D,C} = \frac{\theta^{D,C}\theta^{P,C}}{\theta^{G,C}}$ and $\gamma^{I,C} = \left[\frac{\theta^{D,C}}{\theta^{G,C}}(1-\beta) + \beta\right](1 - z_3\tau^{P,C})$ as well as $\Omega^C = \frac{\theta^{D,C}}{\theta^{G,C}}$, the formula for χ_t^C is given by:

$$\begin{aligned} \chi_t^C = \gamma^{D,C}\left[Y^C - J^C - m^C B^C - w^C L^C - \delta K^C - \tfrac{(1-z_1\tau^{P,C})}{\theta^{P,C}} i^{BH}B^C\right] \\ + \Omega^C BN^C + \tfrac{\gamma^{D,C}}{\theta^{P,C}} z_2\tau^{P,C}r(K^C - B^C) - \gamma^{I,C}(I^C - \delta K^C). \end{aligned} \tag{4.10}$$

[15] Further empirical evaluations of these two specifications were performed in an econometric study by POTERBA and SUMMERS (1983) and by applying a dynamic CGE model by HUTTON and KENC (1998).

Non-corporate Firms

As opposed to corporate firms, non-corporate firms have no possibility to finance investments out of retained earnings, since all profits are distributed to the owner, implying $Div^N = \pi^N$. This is true for they are considered as part of the entrepreneur's income and are treated as if these profits were distributed.

Therefore, a non-corporate firm can only choose between new debt, BN^N, and new equity injections, VN^N, as possible sources of finance for its investments but is not able to draw like a corporate firm on retentions.

The flow of funds equation for the non-corporate firm can be simplified to:

$$VN^N = IN^N - BN^N \tag{4.11}$$

The return on equity again equals dividends and net of tax capital gains:

$$\begin{aligned} r_t^V V_t^N &= Div_t^N + \theta^{G,N}\left[GV_{t+1}^N - V_t^N - VN_t^N\right]. \\ [1 + \underbrace{\frac{r_t^V}{\theta^{G,N}}}_{re_t^{VN}}]V_t^N &= \underbrace{\frac{1}{\theta^{G,N}} Div_t^N - VN_t^N}_{\chi_t^N} + GV_{t+1}^N, \end{aligned} \tag{4.12}$$

Introducing once again the two tax factors $\gamma^{D,N} = \frac{\theta^{P,N}}{\theta^{G,N}}$ and $\gamma^{I,N} = 1 - \frac{\tau^{P,N} z_3}{\theta^{G,N}}$ as well as $\Omega^N = 1$, the expression for χ_t^N is:

$$\begin{aligned} \chi^N = \gamma^{D,N} &\left[Y^N - J^N - m^N B^N - w^N L^N - \delta K^N - \tfrac{1 - z_1 \tau^{P,N}}{\theta^{P,N}} i^{BH} B^N\right] \\ &+ \Omega^N B N^N + \tfrac{\gamma^{D,N}}{\theta^{P,N}} z_2 \tau^{P,N} r(K^N - B^N) - \gamma^{I,N}(I^N - \delta K^N). \end{aligned} \tag{4.13}$$

Intertemporal Optimization

Households, as firm owners, see through the 'corporate veil' and accordingly know that an increase in firm values will increase their wealth. Firms' goal is to maximize their value by choosing an optimal investment and financial program from period t onwards. It is quite evident that the value V_t^f of the firm will increase with the size of the capital stock K_t^f and fall with the debt level B_t^f that it inherits from the past. At the beginning of the planning period, the capital stock and the debt level are exogenous, as they are given as initial conditions resulting from historical decisions. It is the future capital stock and debt which are chosen endogenously as a result of an optimal financial and investment policy. To derive an expression determining the firm value, we rearrange the valuation conditions for the corporate (4.9) and non-corporate firm (4.12) respectively:

$$V_t^{e,f} = \chi_t^f + \frac{GV_{t+1}^{e,f}}{1 + re_{t+1}^f}, \tag{4.14}$$

where V_t^e denotes the end of period firm value according to $V_t^{e,f} \equiv \left[1+r_t^{e,f}\right] V_t^f$. Hence, the end of period market value of a firm is determined by the present value of all future net of tax dividend payments less new equity injections. The net dividend flow is discounted at the cost of equity which is the required gross return on firm level, $re_t^f = \frac{r_t^V}{1-\tau^{G,f}}$. Using the value function, and assuming that investment is optimized from period $t+1$ onwards, resulting in the value function $V\left(K_{t+1}^f, B_{t+1}^f\right)$, we can find today's optimal investment, labor demand and financial behavior by maximizing the *Bellman equation of dynamic programming*. The Bellman equation is nothing but the objective function written as a difference equation which is equal to the no-arbitrage condition (4.14):

$$V^{e,f}(K_t^f, B_t^f) = \max_{L^f, I^f, BN^f} \left[\chi_t^f + \frac{G}{1+re_{t+1}^f} V^{e,f}(K_{t+1}^f, B_{t+1}^f) \right] \text{ s.t. (4.2) and (4.3)} \tag{4.15}$$

where χ_t^f is defined in eq.(4.10) and (4.13).

Thus, the value function $V^{e,f}(K_t^f, B_t^f)$, i.e. the maximized value of the objective function, is a function of the historically accumulated stocks capital and debt. In solving a dynamic programming problem, one must distinguish between predetermined stock variables (here K_t^f, B_t^f) that are exogenously given as an initial condition in current period t but are optimally accumulated for all future periods, and forward looking control variables (here L^f, I^f, BN^f) that can be flexibly chosen in any period t. The necessary conditions consist of (i) optimality conditions for control variables (standard first order conditions of the maximization problem) and (ii) envelope conditions for stock variables.

Defining the shadow prices of capital: $q_t^f \equiv \frac{dV_t^{e,f}}{dK_t^f}$ and debt: $\lambda_t^f \equiv \frac{dV_t^{e,f}}{dB_t^f}$, respectively,[16] the optimality conditions concerning the control variables labor, investment and new debt are:

$$\begin{aligned} &\text{(a) } L_t^f: \quad w_t^f = F_{L,t}^f, \\ &\text{(b) } I_t^f: \quad q_{t+1}^f = \left(1+re_{t+1}^f\right)\left[\gamma^{D,f} J_I^f + \gamma^{I,f}\right], \\ &\text{(c) } BN_t^f: \lambda_{t+1}^f = -(1+re_{t+1}^f)\Omega^f. \end{aligned} \tag{4.16}$$

Optimal labor demand is determined by the equality between the marginal product of labor $F_{L,t}^f$ and the labor cost w_t^f. In equilibrium, the wage rate becomes endogenous to clear the market for labor. If labor supply is fixed, eq.(4.16a) gives the market clearing wage that firms are willing to pay in order to fully employ the labor endowment. Eq.(4.16b) delivers the condition which

[16] The shadow prices determine the increase in the value of the objective function resulting from a marginal increase in the stock variables capital or debt.

describes the firm's optimal investment policy. The shadow price q_t^f gives the increase in firm value, i.e. the present value of future dividend payments, if the firm is endowed with additional capital. Optimal investment thus equates the present value of the marginal benefit that the firm will have from one more unit of capital tomorrow in period $t+1$, $\frac{q_{t+1}^f}{1+re_{t+1}^f}$ with the marginal cost incurred for carrying out this investment $\gamma^{D,f} J_I^f + \gamma^{I,f}$. The marginal cost of investing one unit of capital today is $\frac{\theta^{D,C}\theta^{P,C}}{\theta^{G,C}} J_I^C + \frac{\theta^{D,C}}{\theta^{G,C}}$ for a corporate firm.[17] This cost is lowered if we allow for instance for accelerated depreciation, so if $z_3 > 0$ (which is included in $\gamma^{I,f}$).

Moreover, condition (4.16b) implicitly yields optimal investment as a function of the current capital stock $I_t^f = I^f\left(K_t^f\right)$. This is the so-called 'policy function'. If one knew the exact form of the policy function, one could insert it into eq.(4.2) and find the optimal capital accumulation path. However, in general, there is no closed form solution for the value function. Therefore, we must numerically solve for optimal investment applying a solution procedure which is based on Hayashi's result. According to this theory, the marginal value of the shadow price of capital q_t^f can be derived from its average value. Thus $q_t^f = \frac{V_t^{f,e}}{K_t^f} - \frac{\lambda_t^f B_t^f}{K_t^f} - \frac{V_t^{f,E}}{K_t^f}$ so it is equal to the average value of q_t^f, $\frac{V_t^{f,e}}{K_t^f}$ less the present value of current and future changes in the stock of debt per unit of capital less the value of the fixed factor per unit of capital. The formal proof for Hayashi's result is derived in Appendix B1.

The envelope conditions concerning the stock variables are:

$$\begin{aligned}
&\text{(a) } K^f: q_t^f = \gamma^{D,f}\left[F_K^f - J_K^f + m'_f b_f^2 + \tfrac{z_2 \tau^{P,f}}{\theta^{P,f}} r_t\right] \\
&\qquad\qquad - \left(\gamma^{D,f} - \gamma^{I,f}\right)\delta + \tfrac{q_{t+1}^f}{1+re_{t+1}^f}(1-\delta) \\
&\text{(b) } B^f: \lambda_t^f = \gamma^{D,f}[-m'_f b_f - m_f - \tfrac{1-z_1\tau^{P,f}}{\theta^{P,f}} i^{BH} - \tfrac{z_2\tau^{P,f}}{\theta^{P,f}} r_t] + \tfrac{\lambda_{t+1}^f}{1+re_{t+1}^f}
\end{aligned} \tag{4.17}$$

These equations enable us to determine the cost of capital which influences the investment decision of the firm as well as the cost of equity and debt finance which determine a firm's financing behavior. These behavioral margins are discussed in detail in the Sections on the financial and investment behavior below.

The investment dynamics under perfect foresight are illustrated in Fig. 4.1 for a corporate firm which can only use retained earnings as a source of finance. Since we have a 'two point boundary value problem', the system starts at a predetermined capital stock $K_t^C = K_0^C$. The future equilibrium of the system is reflected by the shadow price of capital q_{t+1}^C. The transition between the initial and the final steady state must satisfy the following difference equation

[17] Assuming there is no accelarated depreciation so $z_3 = 0$ and there are no new share issues available to finance marginal investments, so $\beta = 0$.

system for the predetermined and forward looking variables where optimal investment is solved from eq.(4.16b).

$$(a) \qquad GK^C_{t+1} = I^C_t + (1-\delta)\, K^C_t, \qquad I^C_t = I^C\left(q^C_{t+1}, K^C_t\right),$$

$$(b)\ (1+re^C_{t+1})q^C_t = \left[\frac{\theta^{D,C}\theta^{P,C}}{\theta^{G,C}}(F^C_K - J^C_K - \delta) + \frac{\theta^{D,C}}{\theta^{G,C}}\right](1+re^C_{t+1}) + (1-\delta)\, q^C_{t+1}. \tag{4.18}$$

Fig. 4.1. Investment Dynamics

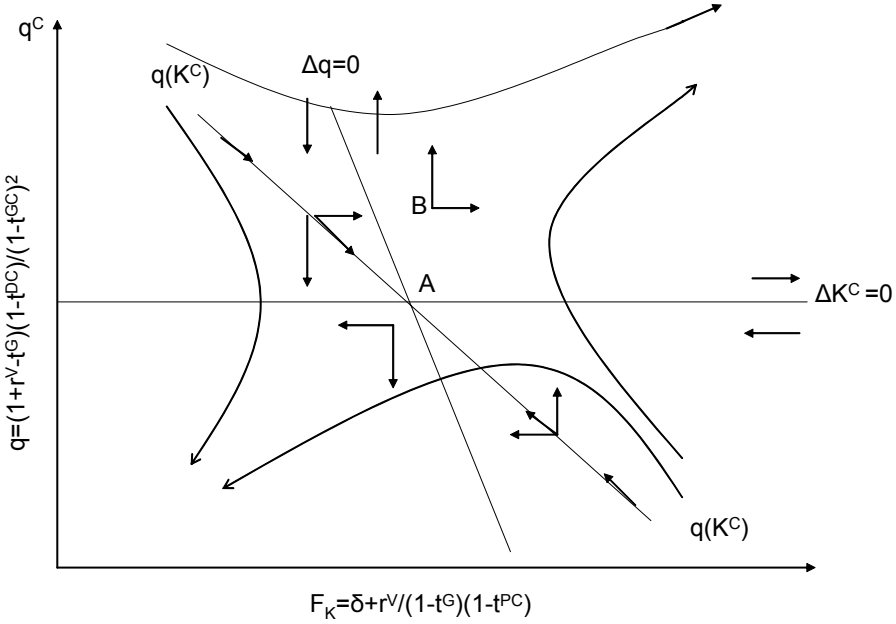
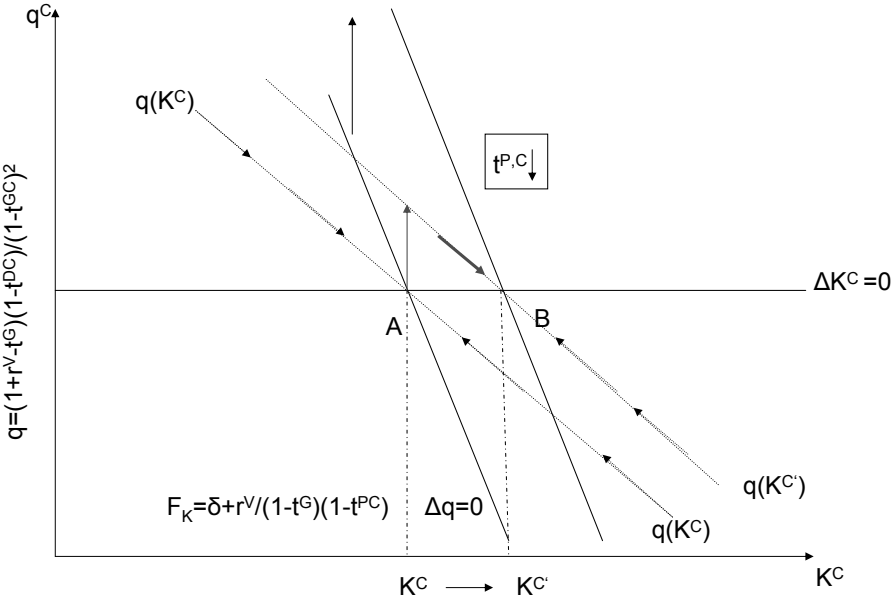


Fig. 4.1 depicts how the two variables, capital K^C and its value q^C behave to satisfy eq.(4.18) at every point in time given their initial values. Suppose, for instance, that the starting point is B. Because q^C is larger than its equilibrium value, firms increase the capital stock. Accordingly $\Delta K^C > 0$. Since profits are low because K^C is high, q^C can also be high only in case it is expected to rise such that $\Delta q^C > 0$. Consequently, we will move in the diagram up and to the right. The quantity of capital in the economy is inherited from the past and only the market value of capital adjusts. Therefore, for a specific value of K^C we can compute a unique value for q^C that determines the saddle path $q(K^C)$. Along this path K^C and q^C converge to the unique equilibrium point A. This long-run equilibrium is characterized by $q^C = \frac{(1+r^V-\tau^G)(1-\tau^{D,C})}{(1-\tau^{G,C})^2}$ (implying $\Delta K^C = 0$) and $\Delta q^C = 0$ such that given the interest rates and tax

parameters, firms have no incentive to decrease or increase the capital stock (Romer, 2001).

Fig. 4.2 shows an example for the effect of a reduction in the corporate tax rate. The economy is initially in the long-run equilibrium at point A. From eq.(4.18b) we see that the locus of the $\Delta q^C = 0$ curve is shifted upwards. q^C jumps to the point on the new saddle path for the given capital stock. K^C and q^C then move down along the path to the new equilibrium point B. Thus, a decrease in the profit tax rate leads to an increase in the capital stock from K^C to $K^{C\prime}$.

Fig. 4.2. The Effect of a Reduction in the Corporate Tax Rate



Financial Behavior

Performing a comparative static analysis allows us to derive basic insights about the economic effects arising from tax reform scenarios. In the following, I compute the effect of a marginal change in one tax rate on the marginal product of capital and the cost of equity, respectively, to examine how changes in the tax rates affect the investment and financial behavior of a representative firm. To start with, the financial behavior of the firm is considered.

In the absence of taxation and under certain additional assumptions such as (1) perfect markets (i.e. no taxes or transaction costs), (2) cash flows that

are independent of financial structure and (3) riskless debt such that firms and individuals can borrow and lend at a risk free interest rate[18], the market value of the firm is independent of its capital structure according to the MODIGLIANI MILLER Theorem (1958). In other words, the choice of the source of finance is irrelevant for the investment decision. The investment rule is the same irrespective whether investments are financed by retained earnings, debt or new share issues. In the presence of taxes and agency costs, however, the different tax constellations create a preference for a specific source of finance. The influence of different taxes on the source of finance are explained in the following.

The optimal level of indebtness of a firm is reached if the cost of equity finance equals the cost of debt finance. Substituting eq.(4.16c) into the envelope condition for the co-state variable debt shown in eq.(4.17b) the expression determining the optimal debt asset ratio is derived:

$$re^f_{t+1} - \frac{\gamma^{D,f}}{\Omega^f}\frac{z_2\tau^{P,f}}{\theta^{P,f}}r_t = \frac{\gamma^{D,f}}{\Omega^f}\left[m'_f b_f + m_f + \frac{1 - z_1\tau^{P,f}}{\theta^{P,f}}i^{BH}\right]. \qquad (4.19)$$

If debt and equity are treated equally on the personal level, then both have to yield the same pretax return, namely $re^f = i^{BH}$.

However, if a profit tax applies, debt financing incorporates the advantage of interest deductibility on corporate level, inducing a preference for debt finance in the size of $\frac{1-z_1\tau^{P,f}}{\theta^{P,f}}i^{BH}$ Since the larger indebtness increases the debt asset ratio, b^f, additional agency cost of $m'_f b_f + m_f$ arise, reducing the advantage of debt finance. The left-hand side of the above equation determines the effective cost of equity, which is lower if we introduce an allowance for corporate or non-corporate equity, so if $z_2 = 1$. Therefore, both the cost of debt and the cost of equity depend on whether they are tax deductible from the profit tax base or not. The optimal debt level is achieved, if the marginal tax preference for debt is fully offset by the marginal increase in the agency cost.

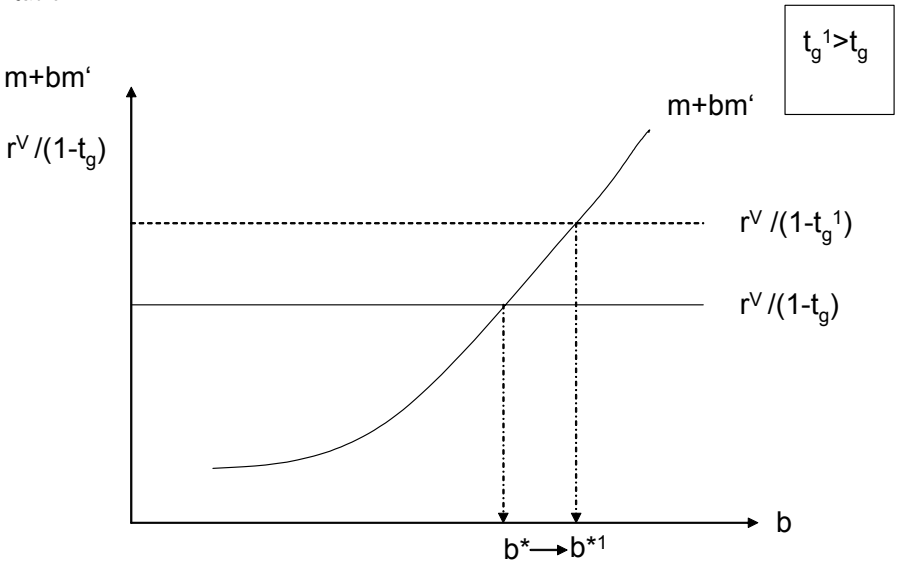
To evaluate the effects of a marginal change in the tax rates on the financial decision of a firm, we analyze the change in the cost of equity stemming from a marginal change in the tax rate under consideration. Similar to KEUSCHNIGG AND DIETZ (2004) or KEUSCHNIGG (1991), we compute the percentage change in the cost of equity (assuming no allowance for corporate and non-corporate equity applies) analogous to: $\widehat{re^f} \equiv \frac{d\,re^f}{re^f}$, where dre^f denotes the deviation from the initial value of re^f. The relative change in the particular tax rate is then defined as $\hat{\tau} \equiv \frac{d\,\tau}{1-\tau}$ to avoid division by zero. Therefore, taking r^V as given, we obtain:

$$re^f = \frac{r^V}{1 - \tau^{G,f}} \qquad \Rightarrow \qquad \widehat{re^f} = \widehat{\tau^{G,f}}. \qquad (4.20)$$

[18] Accordingly if in the here applied model agency costs of debt were absent.

According to eq.(4.20), an increase in the capital gains tax rate increases the cost of equity, $\frac{d\ re^f}{d\ \tau^{g,f}} > 0$, and stimulates debt finance. Thus, the debt asset ratio increases.

Fig. 4.3. Effect of an Increase in the Capital Gains Tax on the Optimal Debt Asset Ratio



In Fig. 4.3, the initial debt asset ratio is denoted by b^*. Now, if the the capital gains tax rate increases $t_g^1 > t_g$, the cost of equity for corporate firms, $\frac{d\ re^C}{d\ \tau^{G,C}} > 0$ will increase and enhance the attractiveness of debt finance. The debt asset ratio will rise $\frac{d\ b^C}{d\ \tau^{G,C}} = \frac{r^V/\left[(1-\tau^{G,C})^2(1-\tau^{P,C})\right]}{[2m'(b)+m''(b)]} > 0$. This reflects the advantage of debt finance under capital gains taxation.

If the interest expenditures are tax deductible, then an increase in the corporate tax rate will boost the tax advantage of debt finance. Here, $\frac{d\ b^C}{d\tau^{P,C}} = \frac{r^V/\left[(1-\tau^{G,C})(1-\tau^{P,C})^2\right]}{[2m'(b)+m''(b)]} > 0$ applies (see eq.(4.19)). For non-corporate firms, an increase in the personal tax rate will also increase the attractiveness of debt finance relative to external equity finance $\frac{d\ b^N}{d\ \tau^{P,N}} = \frac{r^V/(1-\tau^{P,N})^2}{[2m'(b)+m''(b)]} > 0$ (see eq.(4.19)).

However, if an allowance for corporate and non-corporate equity applies, an increase in the profit tax will decrease the cost of equity finance due to the advantage of deducting an imputed return on equity. This will therefore have a negative effect on the debt asset ratio.

An increase in the interest tax rate will have an influence on the cost of equity finance only to the extent that a high degree of substitutability between assets prevails (see the Section on the optimal portfolio choice below). Assuming that the elasticity of substitution between firm equity and firm bonds is high, a change in this tax will also affect the choice for a particular source of finance. The reasoning is as follows: an increase in the interest tax rate yields a lower return for savers. As an implication of arbitrage, equity finance becomes more attractive compared to external finance, because investors 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.

Investment Behavior

The shadow price of capital as given in eq.(4.17a) 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 costs future revenues increase; and third, the interest burden on debt is reduced, as the debt asset ratio decreases.

Combining eq.(4.17a) and (4.16b) we get the following expression for the cost of capital

$$F_K^f - \delta = re_t^f \frac{\gamma^{I,f}}{\gamma^{D,f}} - \frac{z_2 \tau^{P,f}}{\theta^{P,f}} r_t - m_f' b_f^2. \tag{4.21}$$

Integrating the last two eq.(4.21) and (4.19) the marginal product of capital can be expressed as the weighted sum of the cost of equity capital and external capital, where the debt asset ratio, b_f, serves as a weighting factor. The distinct and more concise formulae which clearly depict the difference between the cost of equity and the cost of debt for corporate and non-corporate firms respectively are found in eq.(4.23) and (4.27).

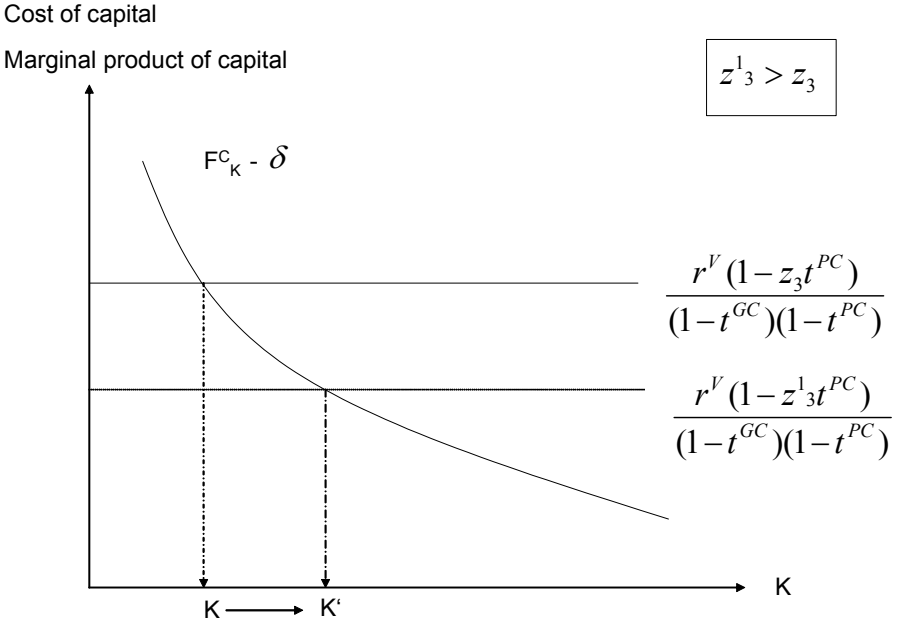
$$F_K^f - \delta = \underbrace{\left\{\frac{re_t^f}{\gamma^{D,f}}\right\}(\gamma^{I,f} - \Omega^f b_f)}_{\text{cost of equity}} + \underbrace{\left\{\frac{1 - z_1 \tau^{iP,f}}{\theta^{P,f}} i^{BH} + m_f\right\} b_f}_{\text{cost of debt}} - \underbrace{\frac{z_2 \tau^{P,f}}{\theta^{P,f}}(1 - b^f) r_t}_{\text{adv. of ACE}} \tag{4.22}$$

Without taxes, the investment must offer a rate of return at least equal to depreciation costs and interest so $F_K^f = i^{BH} + \delta$. With taxation, the cost of capital changes as shown in the above equation. The first term on the right hand side indicates the cost of equity finance. The second term, the cost of debt finance consists of interest payments plus the agency cost. The last term indicates the advantage of an allowance for corporate and non-corporate equity ($ACNE$) in the case $z_2 > 0$. The propensity to invest also depends on the tax allowance for investments, z_3 , which is included in $\gamma^{I,f}$. This term encompasses both depreciation for tax purposes and direct investment premia, and reduces the actual tax burden if $z_3 > 0$. The tax system or

different subsidies will increase or decrease the cost of capital. While the different taxes such as the corporate or the capital gains tax increase the cost of capital, the possibility to deduct interest payments and accelerated depreciation decrease it (Fehr, 1999).

Fig. 4.4 illustrates the effect of such allowances on investments and accordingly on the capital stock for an investment financed at the margin by retained earnings.

Fig. 4.4. The Effect of Tax Allowances on Investment



The optimal capital stock is given by the intersection of the downward sloping marginal product curve with the cost of capital represented by the horizontal line. We can see that an increased tax allowance $z_3^1 > z_3$ shifts the horizontal line downwards and as a result more investments are undertaken and the capital stock increases. The marginal product curve, however, remains unchanged. If $z_3 = 1$ we allow for a full immediate write-off and and τ^{PC} can be interpreted as a cash-flow tax which does not influence the investment decision. In this case, the government acts as a silent partner which participates equally in the investment's financing requirements and returns (Sinn 2003 b, Keuschnigg 2005a). If z_3 is large enough (so $z_3 > 1$), this might even lead to a so-called tax paradox since an increase in the profit tax rate τ^{PC} even encourages investment. This emerges because a higher profit tax rate increases the tax saving and rather acts as a subsidy than a tax on investments (Sinn,

1987). Thus, firms will finance less investments by retained earnings for instance and will prefer to finance investments by deferring taxes, which can be interpreted as an interest-free loan from the government (Fehr, 1999).

(a) Corporate firms

Inserting the relevant parameters for corporate firms into eq. (4.21) we can derive the following cost of capital formula for firms belonging to the corporate sector[19].

$$F_K^C - \delta = \frac{r^V}{\theta^{G,C}\theta^{P,C}}(1 - b_C) + (i^{BH} + m_C)b_C \tag{4.23}$$

For a firm which just finances investments via retained earnings, the cost of capital will be

$$F_K^C - \delta = \frac{r^V}{\theta^{G,C}\theta^{P,C}} \tag{4.24}$$

It is straightforward since we assumed the 'New View' of dividend taxation to apply, that only the capital gains and the profit tax rate affect the cost of capital. If the firm financed marginal investments entirely by new share issues, the cost of capital were $F_K^C - \delta = \frac{r^V}{\theta^{D,C}\theta^{P,C}}$. In this case, the dividend tax and not the capital gains will play a significant role. Consequently, a rise in the dividend tax negatively affects the cost of capital, as predicted also by the 'Old View' of dividend taxation. Finally, for a firm that just employs debt as a source of finance, the cost of capital equals the gross interest rate i^{BH} plus the agency cost of debt m_C. The magnitude of i^{BH} reflects the interest tax at the personal level. The higher the interest tax will be, the higher the gross interest rate will have to be to offer the investor the required net rate of return.

$$F_K^C - \delta = i^{BH} + m_C \tag{4.25}$$

Differentiating (4.23) with respect to the tax rate under consideration, we find that reducing the corporate income tax as well as the capital gains rate has a positive impact on investment, because in each case the cost of capital declines[20]:

$$\begin{aligned} \frac{d\,(F_K^C - \delta)}{d\,\tau^{P,C}} &= \frac{r^V}{(1-\tau^{G,C})(1-\tau^{P,C})^2}(1 - b_C) > 0, \\ \frac{d(F_K^C - \delta)}{d\tau^{G,C}} &= \frac{r^V}{(1-\tau^{G,C})^2(1-\tau^{P,C})}(1 - b_C) > 0. \end{aligned} \tag{4.26}$$

[19] Remember that $\gamma^{D,C} = \frac{\theta^{D,C}\theta^{P,C}}{\theta^{G,C}}$ and $\gamma^{I,C} = \frac{\theta^{D,C}}{\theta^{G,C}}$ as well as $\Omega^C = \frac{\theta^{D,C}}{\theta^{G,C}}$. Moreover I assume $\beta = 0$ indicating that there are no new share issues and that depreciation follows economic depreciation, $z_3 = 0$. Furthermore, I allow for the debt interest deductibility so $z_1 = 1$ and I disregard any allowance for corporate equity so $z_2 = 0$:

[20] Since we also assume that the debt asset ratio is optimally chosen, a marginal change in a tax rate has no influence on the optimal debt asset ratio which enters the cost of capital formula.

The economic implication of an increase in the corporate tax rate is obvious. If the corporate tax rate increases, returns stemming from real investments are more heavily taxed compared to those from a financial investment which is not subject to the corporate tax rate. Hence, the cost of capital increases resulting in less real investments. The size of this effect will be larger for firms endowed with much equity and smaller for highly indebted firms. Therefore, it is particularly important to model the debt equity ratio carefully. Concerning an increase in the capital gains tax we know that profit retentions are less favored compared to debt financed investments. Thus, the cost of capital increases to the extent that profit retentions are used as a marginal source of finance. As a consequence, the investment activity will slow down.

The effect of a change in the tax rate on interest income will depend on the degree of substitution between assets. Since we model assets to be imperfect substitutes, a rise in the interest tax rate will induce an increase in the demand for corporate equity only insofar as the substitution elasticity between assets is high. As a result, the investment in firm debt or government bonds will become more expensive due to the decrease in the net of tax interest rate such that the investor will prefer corporate equity as an investment alternative.

(b) Non-corporate Firms

Similarly, inserting the relevant tax factors and parameters for non-corporate firms, we can compute the following cost of capital formula for firms belonging to the non-corporate sector[21]:

$$F_K^N - \delta = \frac{r^V}{\theta^{P,N}}(1 - b_N) + (i^{BH} + m_N)b_N \tag{4.27}$$

The striking difference to the cost of capital for corporate firms is the fact that the capital gains tax rate does not appear in this formula. This is so because non-corporate firms can not draw on retained earnings as a marginal source of finance, and accordingly the capital gains tax rate does not influence the investment decision.

The differentiation of eq. (4.27) with respect to the tax rate under consideration, shows that increasing the personal income tax has a negative impact on investment, because the cost of capital increases.

$$\frac{d\,(F_K^N - \delta)}{d\,\tau^{P,N}} = \frac{r^V}{(1 - \tau^{P,N})^2}(1 - b_N) > 0 \tag{4.28}$$

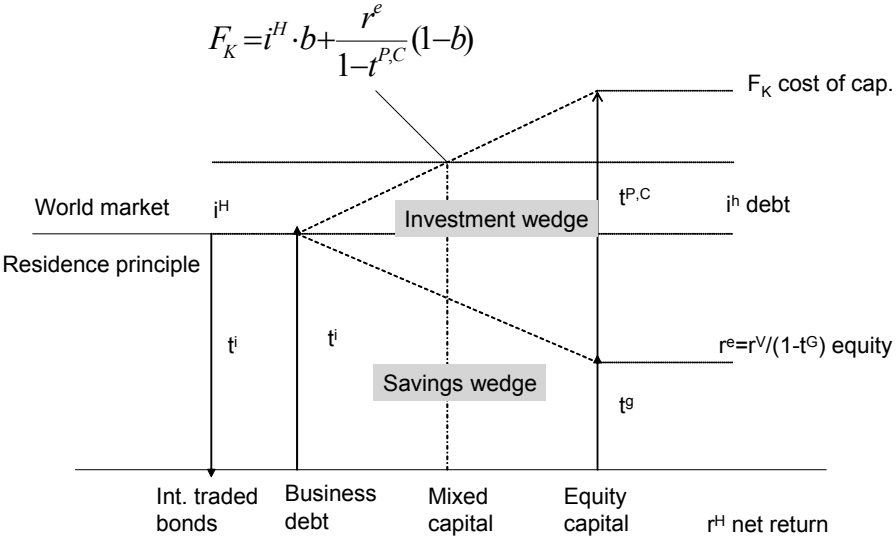
If the interest rate is increased, thus making investments in firm debt or government bonds less attractive, the investor might choose to switch to non-corporate equity. This outcome, however, will again depend on the degree of substitution between assets since these are modeled to be imperfect substitutes.

[21] Remeber here that $\gamma^{D,N} = \frac{\theta^{P,N}}{\theta^{G,N}}$ and $\gamma^{I,N} = 1 - \frac{\tau^{P,N} z_3}{\theta^{G,N}}$ as well as $\Omega^N = 1$. Moreover $z_1 = 1$, $z_2 = 0$, $z_3 = 0$.

4.2.2 Stylized Analysis of Tax Policy and Effective Marginal Tax Rates

To be able to interpret the overall effects of a tax reform, it is necessary to understand the key driving forces and the transmission channels that affect the main aggregates such as investment and saving in an open economy. Fig. 4.5 depicts these connections between taxes and required rates of return. This figure illustrates the case of a corporate firm which finances marginal investments by retained earnings or by debt, and for which the 'New View' of dividend taxation applies such that the dividend tax does not affect the cost of capital. The residence principle is adopted and accordingly the returns on domestic or foreign government bonds as well as the returns on domestic firm bonds are all taxed at the same rate τ^i. This tax rate creates a so-called savings wedge because it drives a wedge between the interest rate and the net return to the saver. Additionally, the capital gains tax τ^G lowers the return on firm equity r^V and thus negatively affects the net return to the shareholder. The corporate tax $\tau^{P,C}$ creates an investment wedge between the cost of capital F_K and the market interest rate.

Fig. 4.5. Tax Wedges and Asset Returns



Source: Keuschnigg (2005b).

In order to carry out the analysis concerning the long-run investment incentives induced by the proposed reform scenarios, I also derive the King and Fullerton (1984) type formulae: The marginal effective tax rate is defined as the difference between the pre-tax return of the corporation, denoted by u (= cost of capital) as given in eq.(4.21) and eq.(4.22), and the after-tax

return to the investor, denoted by s. As mentioned before, it can be divided into an *investment wedge*, and a *savings wedge*. The effective marginal tax rate encompasses all relevant tax parameters and thus determines the real excess burden of taxation. (For a detailed description of the marginal excess burden of taxes see Section 4.2.5)

For a corporate firm, for instance, the cost of capital is defined as in eq.(4.23). If we disregard corporate taxes, we can define the cost of holding a mix of shares and debt as $\bar{\imath} = \frac{r^V}{\theta^{G,C}}(1 - b_C) + (i^{BH} + m_C)b_C$ which gives the gross investor return. Therefore, the EMTR on investment, as a measure for the investment wedge can be defined as

$$EMTR^I = \frac{u - \bar{\imath}}{u} \Rightarrow \bar{\imath} = (1 - EMTR^I)u \tag{4.29}$$

Moreover, if we also disregard capital gains taxes we get the investor's net return on equity net of personal taxes. Eq.(4.23) becomes $s = r^V(1 - b_C) + r^{BH}b_C$ in this case. Hence the savings wedge $EMTR^S$ can be expressed as

$$EMTR^S = \frac{\bar{\imath} - s}{\bar{\imath}} \Rightarrow s = (1 - EMTR^S)\bar{\imath} \tag{4.30}$$

Combining the two wedges we obtain an expression for the overall effective marginal tax rate defined as the difference between the cost of capital and the net of tax return to the private investor divided by the cost of capital.

$$EMTR = \frac{u - s}{u} = 1 - (1 - EMTR^I)(1 - EMTR^S) \tag{4.31}$$

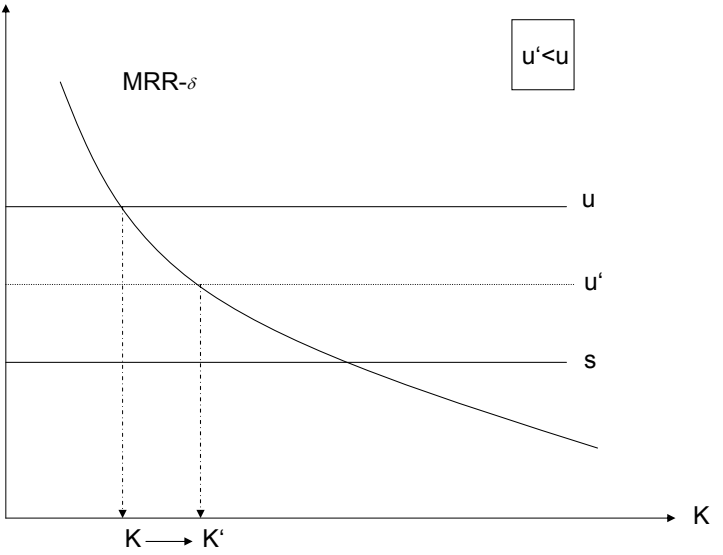
Therefore, the marginal effective tax rate measures the overall distortion of taxation with respect to investment incentives. It is straightforward that taxes at the corporate and personal level drive a wedge between the required pre-tax return u and the net of tax return s to households. In a closed economy, the overall $EMTR$ is the relevant measure, while in an open economy it is the investment wedge $EMTR^I$ which is of overriding importance for making investment decisions.

The effective marginal tax rate can be separately computed for equity, setting the debt asset ratio $b = 0$, and for debt setting $b = 1$. In the case of equity, an effective marginal tax rate can be computed for investments financed by retained earnings at the margin, if $\beta = 0$ or for investments financed via new share issues.

$$\begin{aligned}
EMTR^{debt} &= \frac{i^{BH} + m_C - r^{BH}}{i^{BH} + m_C} = 1 - \frac{r^{BH}}{\frac{r^{BH}}{1-\tau^I} + m_C} \\
EMTR^{retearn} &= \frac{\frac{r^V}{\theta^{G,C}\theta^{P,C}} - r^V}{\frac{r^V}{\theta^{G,C}\theta^{P,C}}} = 1 - \theta^{G,C}\theta^{P,C} = 1 - (1 - \tau^{G,C})(1 - \tau^{P,C}) \\
EMTR^{newshiss} &= \frac{\frac{r^V}{\theta^{D}\theta^{P,C}} - r^V}{\frac{r^V}{\theta^{D}\theta^{P,C}}} = 1 - \theta^{D}\theta^{P,C} = 1 - (1 - \tau^{D})(1 - \tau^{P,C})
\end{aligned} \tag{4.32}$$

For an investment financed by debt the overall $EMTR$ mainly depends on the interest tax rate since it is this tax which drives a wedge between the cost of capital and the investor's net return. In case an investment is financed solely by retained earnings, the capital gains tax and the corporate tax affect the investor's decisions, while the choice of using new share issues as the source of finance is distorted by the dividend and the profit tax rate.

Fig. 4.6. The Marginal Effective Tax Rate



Given decreasing returns to capital, the marginal rate of return curve will slope downward as shown in Fig. 4.6. In a world without taxation, the cost of capital, u, equals the after-tax return to private investors, s. Hence, the intersection of both curves would denote the long-run capital stock for the German 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 have a negative effect on capital accumulation. For example, as will be shown in the next Chapter, the proposed DIT reform diminishes the tax wedge by eliminating the dividend and the capital gains tax and by reducing the profit tax rate. In turn the cost of capital, u, declines to u' and consequently the distance to the after tax return to savers, s, dwindles and stimulates the capital accumulation in the economy.

4.2.3 Households and General Equilibrium

To be able to maximize household utility, we have to first determine its optimal portfolio choice which will in turn influence the composition of its budget

constraint. Such an explicit modeling of households' portfolio decision is also undertaken by Keuschnigg (2005b), Goulder and Eichengreen (1992) and Sørensen (2001a).

Optimal Portfolio Choice

IFOMod also includes a detailed modeling of private portfolio composition. The investor can choose between different asset $A^{i,j}$ where the first superscript, i, denotes the asset type, (so corporate or non-corporate equity, business debt or government bonds) and the second superscript, j the investor type (domestic or foreign). Consequently, domestic investors can hold corporate or non-corporate equity, domestic business debt and domestic or foreign government bonds. Foreign investors, however, just have access to domestic or foreign business debt or government bonds.

As mentioned above, assets are imperfect substitutes yielding different net of tax rates of return that are not equalized by no-arbitrage conditions. The domestic net interest rate on government bonds is $r^H = (1 - \tau^i)i^H$. The residence principle is adopted and leads to the equality of gross domestic and foreign interest rates such that $i^H = i^F$.

The domestic gross interest rate on government bonds is denoted by i^H while that on firm bonds is i^{BH}. Hence, the net domestic interest rate on government and firm bonds is $r^H = (1 - \tau^i)i^H$ and $r^{BH} = (1 - \tau^i)i^{BH}$ respectively, where τ^i denotes the tax rate on interest income which is the same regardless whether returns stem from domestic or foreign assets in accordance with the residence principle. The interest rate prevailing in the foreign country is given by i^F. Domestic firms issue equity and pay a return on equity denoted by r^V. Since corporate and non-corporate equity are perfect substitutes, they will offer both the same net rate of return which is higher than the net return on the other asset types as it includes an equity premium.

Table 4.3 provides an overview of the different asset types and their returns.

Table 4.3. Asset Types and Their Returns

Asset	Returns		Demand
corp. and non-corp. equity, $A^{VC} + A^{VN}$	r^V		$A^{VC} + A^{VN}$
	gross	net	
domestic business debt, A^B	i^{BH}	$(1 - \tau^i)i^{BH} = r^{BH}$	$A^{B,H} + A^{B,F}$
domestic government bonds, A^{DH}	i^H	$(1 - \tau^i)i^H = r^H$	$A^{DH,H} + A^{DH,F}$
foreign government bonds, A^{DF}	i^F	$(1 - \tau^i)i^F = r^F$	$A^{DF,H} + A^{DF,F}$

The domestic portfolio A^H consists of corporate and non-corporate equity (which is non tradable - an application of the so-called 'home-bias') and internationally tradeable assets such as domestic business debt and domestic and

foreign government bonds. This approach of modeling has also been applied by Keuschnigg (2005b) or Valkonen (1999).

$$A^H = A^{VC} + A^{VN} + A^{B,H} + A^{DH,H} + A^{DF,H} \tag{4.33}$$

The portfolio composition is predetermined from the previous period and yields an average portfolio return $\bar{r}^H$. Only in the long run, the net of tax average portfolio return equals the time preference for the home country ρ^H as required by the long-run stationary solution to the household maximization problem in the Ramsey model:

$$\bar{r}^H = \frac{r^V(A^{VC} + A^{VN}) + r^{BH}A^{B,H} + r^H A^{DH,H} + r^F A^{DF,H}}{A^H} = \rho^H \tag{4.34}$$

Fig. 4.7. Portfolio Allocation of Domestic Households

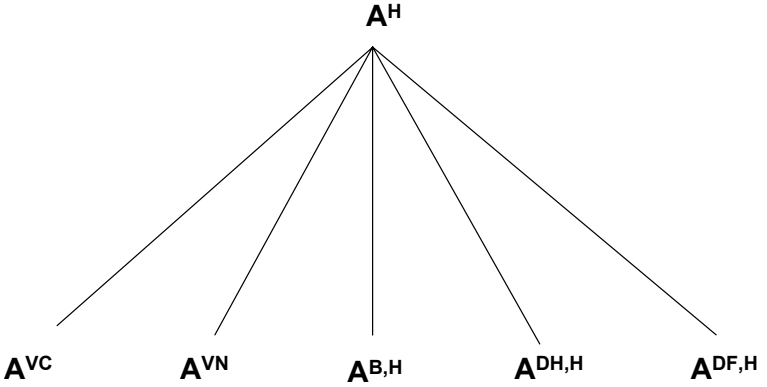
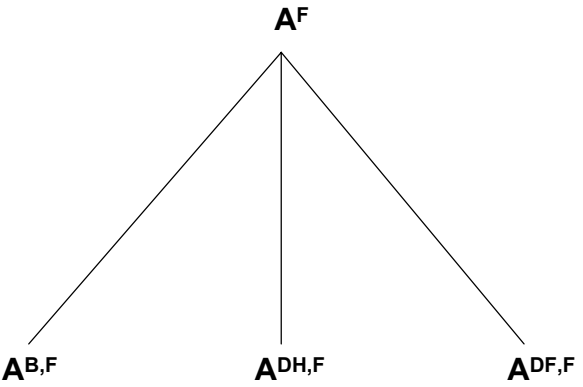


Fig. 4.8. Portfolio Allocation of Foreign Households



Domestic Equity Portfolio

The different types of assets are imperfect substitutes since they yield different net of tax rates of return. The imperfect substitution assumption is consistent with the Armington assumption (Armington 1969).[22] This assumption is usually applied in trade theory but has also been increasingly used in describing the 'home bias' which characterizes investors' portfolio choices. As the household has a preference for home goods consumption according to the Armington assumption, this presumption can be extended to explain the predilection towards a higher weight of domestic assets in the investor's portfolio. This finding has been underlined among others by French and Poterba (1991) who show that in spite of the benefits of international diversification, most investors hold a large fraction of their wealth in domestic assets. For Germany this meant that the domestic ownership share amounted to 79 per cent in 1989. A more recent study by Tesar and Werner (1998) reports that the share of German investors' equity portfolios invested in domestic equity amounted to 81.8 per cent in 1996. Moreover, Gerke et al. (2004) suggest that a home bias of 20 to 40 per cent as actually implemented by German institutional investors, is a suitable domestic equity investment range for German investors. The concrete appliance of the Armington assumption in our model indicates that foreigners are not allowed to own domestic firm equity. This ensures that just the domestic investor's (who is affected by domestic taxation) demand for firm capital will determine the required rate of return.

General Principle

Due to the portfolio diversification motive the household chooses optimal amounts of each type of asset to maximize his end of period portfolio utility generated by these different types of assets. For the overall portfolio A^C this implies:

$$A^C = \max_{A^i} \left\{ \left[\left(\alpha^i\right)^{\frac{1}{1+\mu}} \left(R^i {A^i}^{\frac{\mu}{1+\mu}} \right) \right]^{\frac{1+\mu}{\mu}} + \lambda[A - \textstyle\sum_i A^i] \right\} \tag{4.35}$$

where $(1+\mu)$ denotes the elasticity of substitution, $R^i = (1+r^i)$ stand for the respective net of tax interest factors and α^{VC}, α^{VN} are taste parameters.

From the f.o.c. for this first step of the portfolio allocation problem, one can derive the demand for the different asset types A^i .

$$A^i = (R^i/R^C)^\mu \alpha^i A;\; R^C = \left[\textstyle\sum_i \alpha^i \left(R^i\right)^\mu\right]^{1/\mu};\; A = A^C/R^C \tag{4.36}$$

Here R^C denotes the after tax return of the composite portfolio where $1/R^C$ is similar to a price index. The demand for each asset is thus determined

[22] The Armington assumption states that commodities exported and imported are imperfect substitutes of domestically used and produced commodities.

as the product of the respective unit asset demand $(R^i/R^C)^\mu \alpha^i$ and the overall portfolio A. Thus the demand for each particular asset depends not only on its own rate of return but also on all the other rates of return offered by the other assets.

Domestic Portfolio Structure

The domestic portfolio consists of domestic business debt $A^{B,H}$, domestic and foreign governmental bonds $A^{DH,H}$ and $A^{DF,H}$ and domestic firm equity A^{VC} and A^{VN}.

$$\begin{aligned} A^{C,H} = & \max_{A^V A^{B,H},\, A^{DH,H},\, A^{DF,H}} \\ & \{\left(\alpha^{B,H}\right)^{\frac{1}{1+\mu}} \left[R^{BH} A^{B,H}\right]^{\frac{\mu}{1+\mu}} + \left(\alpha^{DH,H}\right)^{\frac{1}{1+\mu}} \left[R^H A^{DH,H}\right]^{\frac{\mu}{1+\mu}} \\ & + \left(\alpha^{DF,H}\right)^{\frac{1}{1+\mu}} \left[R^F A^{DF,H}\right]^{\frac{\mu}{1+\mu}} + \left(\alpha^V\right)^{\frac{1}{1+\mu}} \left[R^V (A^{VC} + A^{VN})\right]^{\frac{\mu}{1+\mu}} \}^{\frac{1+\mu}{\mu}} \\ & + \lambda \left[A^{C,H} - A^{B,H} - A^{DH,H} - A^{DF,H} - A^{VC} - A^{VN}\right] \end{aligned} \tag{4.37}$$

The optimal portfolio demands can be derived from solving the above maximization problem according to eq. (4.36).

Again $1 + \mu$ is the elasticity of substitution and $\alpha^{B,H}$, $\alpha^{DH,H}$, $\alpha^{DF,H}$ and α^V denote taste parameters. The incentive for portfolio diversification is created by using a CES aggregate of the assets invested in different countries to model the investor's internationally traded asset stock. If the substitution elasticity between different national assets is finite, the investor's total capital stock will generate a higher return if it is allocated between the domestic and the foreign economy. Thus, by adjusting the value for the elasticity of substitution one can increase or decrease the degree of capital mobility as desired.

The return of the composite portfolio is then defined as:

$$R^{C,H} = \left[\alpha^{B,H} \left(R^{BH}\right)^\mu + \alpha^{DH,H} \left(R^H\right)^\mu + \alpha^{DF,H} \left(R^F\right)^\mu + \alpha^V \left(R^V\right)^\mu\right]^{1/\mu}. \tag{4.38}$$

where R^B, R^H, R^F and R^V denote the net of tax interest factors on domestic debt, domestic and foreign government bonds and domestic firm equity.

From the f.o.c of the maximization problem one can also compute the optimal portfolio shares a^{ij}

$$\begin{aligned} \text{(a) } a^{B,H} &= \left[\frac{R^{C,H}}{R^{BH}}\right]^\mu \alpha^{B,H} \\ \text{(b) } a^{DH,H} &= \left[\frac{R^{C,H}}{R^H}\right]^\mu \alpha^{DH,H} \\ \text{(c) } a^{DF,H} &= \left[\frac{R^{C,H}}{R^F}\right]^\mu \alpha^{DF,H} \\ \text{(d) } a^V &= \left[\frac{R^{C,H}}{R^V}\right]^\mu \alpha^V \end{aligned} \tag{4.39}$$

Using these unit demands one can compute, as shown above, the demand for domestic firm bonds as $A^{B,H} = a^{B,H} \cdot A^H$, for domestic government bonds $A^{DH,H} = a^{DH,H} \cdot A^H$, for foreign government bonds $A^{DF,H} = a^{DF,H} \cdot A^H$ and for firm equity $A^{VC} + A^{VN} = a^V \cdot A^H$.

Applying the same procedure as above, the optimal portfolio demands, the composite return and the portfolio shares can be computed for the foreign household as well. The foreigner's overall portfolio is a combination of domestic firm bonds $A^{B,F}$, domestic government bonds, $A^{DH,F}$, foreign government bonds $A^{DF,F}$ and foreign equity A^V. Note here, however, that foreigners receive interest without domestic source taxes deducted. The returns which apply to each asset type are thus the gross returns namely i^{BH}, i^H and r^f denotes the return on foreign equity which equals the return on foreign bonds i^F plus an equity premium.

$$
\begin{aligned}
A^{C,F} = & \max_{A^V A^{B,F},\, A^{DH,F},\, A^{DF,F}} \\
& \{\left(\alpha^{B,F}\right)^{\frac{1}{1+\mu}} \left[(1+i^{BH})A^{B,F}\right]^{\frac{\mu}{1+\mu}} + \left(\alpha^{DH,F}\right)^{\frac{1}{1+\mu}} \left[(1+i^H)A^{DH,F}\right]^{\frac{\mu}{1+\mu}} \\
& + \left(\alpha^{DF,F}\right)^{\frac{1}{1+\mu}} \left[(1+i^F)A^{DF,F}\right]^{\frac{\mu}{1+\mu}} + \left(\alpha^V\right)^{\frac{1}{1+\mu}} \left((1+r^f)A^V\right)^{\frac{\mu}{1+\mu}} \}^{\frac{1+\mu}{\mu}} \\
& + \lambda \left[A^{C,F} - A^{B,F} - A^{DH,F} - A^{DF,F} - A^V\right]
\end{aligned}
\tag{4.40}
$$

The return of the foreign composite portfolio is defined as

$$
R^{C,F} = \left[\alpha^{B,F}\left(1+i^{BH}\right)^{\mu} + \alpha^{DH,H}\left(1+i^H\right)^{\mu} + \alpha^{DF,H}\left(1+i^F\right)^{\mu} + \alpha^V\left(1+r^f\right)^{\mu}\right]^{1/\mu}. \tag{4.41}
$$

Capital Market Equilibrium

Both the domestic and the foreign economy have their own capital market, because assets invested in different countries are assumed to be imperfect substitutes. The capital markets are linked by capital mobility.

The following equations characterize the equilibrium conditions for the domestic and foreign asset markets.

$$
A^{B,H} + A^{B,F} = \sum\nolimits_{f=C,N} B_t^f \tag{4.42}
$$

Eq.(4.42) shows that the supply (r.h.s) and the demand for domestic bond (l.h.s) have to be equal. It should be noted here that corporate and non-corporate firm debt are perfect substitutes. Moreover, given that in a general equilibrium framework the supply of bonds is bound by the production side, an increase in the domestic demand for domestic firm bonds has to be balanced by a decrease in the foreign demand for such bonds.

In a similar way, the market for domestic and foreign government bonds must also clear. The l.h.s. of eq. (4.43) and eq.(44) represent the demand for

domestic or foreign government bonds while the r.h.s. denotes the supply of such bonds or respectively domestic or foreign government debt.

$$A^{DH,H} + A^{DH,F} = D^G \tag{4.43}$$
$$A^{DF,H} + A^{DF,F} = D^F \tag{4.44}$$

Finally, shares issued by domestic corporations are only held by domestic household investors. The same applies to non-corporate firms which are wholly owned by domestic households.

$$\sum\nolimits_{f=C,N} A^{Vf} = \sum\nolimits_{f=C,N} V^f \tag{4.45}$$

Utility Maximization

Since we mainly focus on the welfare implications rather than on the distributional issues of a tax reform, we model the household sector using the Ramsey model of an infinitely lived household. This representative agent takes the discounted utility of all future generations into account, where the subjective discount factor is denoted by $\rho^H < 1$. The subjective rate of time preference describes the household's preference for present or future consumption. Therefore, a high value of ρ^H depicts a preference for present consumption and an aversion to postponing consumption. On the contrary, a low value of ρ^H characterizes more 'patient' households who are willing to consume more in the future and less today.

Accordingly, households maximize life time utility as a function of consumption C_t less the disutility of work $\varphi(L_t^S)$ where L_t^S denotes labor supply:

$$U_t = u\left\{C_t - \varphi(L_t^S)\right\} + \rho^H \cdot U_{t+1} = \sum_{s=t}^{\infty} \rho^{H,s-t} \cdot u\left\{C_t - \varphi(L_t^S)\right\} \ , \tag{4.46}$$

This special form of preferences eliminates any income effects in the labor supply decision. Hence, since labor supply only depends on the current real wage $\varphi'\left(l_t^S\right) = \frac{\left(1-\tau^L\right)}{(1+\tau^C)} w_t$. (see for the derivation the optimality conditions in Appendix B2), we do not consider any *intertemporal* substitution effects in labor supply but only an *intratemporal* substitution effect between labor and leisure. Households face a trade-off between the utility stemming from consumption and the disutility of work, implying an endogenous labor supply in the model. This utility is maximized subject to the household's budget constraint:

$$GA_{t+1}^H = (1 + \overline{r^H}_t) A_t^H + y_t^D - (1+\tau^C)(C_t - \varphi(L_t^S)) \ , \tag{4.47}$$

where

$$y_t^D = (1-\tau^L) w_t L_t^S + \tau^L LTA_t + T_t^H - (1+\tau^C)\varphi(L_t^S) \ . \tag{4.48}$$

Financial wealth accumulates according to the interest income on financial assets plus disposable income y_t^D less consumption. Disposable income consists of net of tax labor income plus governmental lump sum transfers denoted by T_t^H. Financial assets, A^H, consist of interest bearing assets and firm equity (see eq. (4.33)) and earn an average net portfolio return $\overline{r^H}_t$ (see eq.(4.34)).

Because we also apply a tax allowance on labor income, LTA_t the tax base of the labor income tax is: $w_t L_t^S - LTA_t$. Moreover, the consumption tax τ^C increases the household's expenditures and negatively influences its budget.

Referring to eq.(4.47) total wealth in the next period is given by the interest earnings on owned assets plus after tax labor income and governmental transfers, T^H, less after tax consumption expenditures. The intertemporal budget constraint is derived by solving forward eq. (4.47). As we know that total wealth, TW, consists of financial wealth, $\bar{R}_t^h A_t^H$, and human capital, H_t, which is defined as:

$$H_t \equiv \sum_{s=t}^{\infty} \left[(1-t^L) w_s L_s^S + \tau^L LTA_s - (1+t_s^C)\varphi(L_s^S) + T_s^H\right] \cdot \prod_{u=t+1}^{s} \frac{G}{\bar{R}_u^h}$$

the equation for total wealth states:

$$TW_t = R_t^h A_t^H + H_t = \sum_{s=t}^{\infty} \left[(1+t_s^C) Q_s\right] \cdot \prod_{u=t+1}^{s} \frac{G}{\bar{R}_u^h} \tag{4.49}$$

In case we follow Sinn's DIT reform proposal (2003a) which provides for an allowance for corporate and non-corporate equity that is deductible from the profit tax and subject to a flat rate interest tax on the household side, the above formula will change to

$$TW_t = R_t^h A_t^H + H_t \tag{4.50}$$

Intertemporal Optimization of Domestic Households

The household's optimization problem includes the optimal labor supply and optimal consumption behavior. Using once again dynamic programming, the optimality and envelope conditions for the households are derived.[23] Optimal individual labor supply depends on the current real wage, which is corrected by a tax factor including the labor and consumption tax $\frac{(1-t^L)}{(1+t^C)} w_t$. Total labor supply is obtained upon aggregation of the individual labor supply. Thus, we can observe how changes in the labor income tax rate or in the VAT rate affect the individual labor supply. Applying a *CES* utility function, $u(Q_t) = \frac{Q_t^{1-1/\sigma}}{1-1/\sigma}$, where σ represents the intertemporal elasticity of substitution and $Q_t = C_t - \varphi(L_t^S)$, a closed form solution of the optimal consumption profile

[23] The extended derivative as well as all optimality and envelope conditions of the household's maximization problem can be found in the Appendix B2.

can be derived. Accordingly, the Euler equation shows how consumption, and therefore savings, evolve over time:

$$\frac{u'(Q_t)}{u'(Q_{t+1})} = \frac{1+\tau_t^C}{1+\tau_{t+1}^C}\frac{\rho^H(1+\overline{r^H}_{t+1})}{G} \ . \tag{4.51}$$

We can see that the VAT also affects consumption. A rise in τ^C leads to a decline in expected future income and thus current consumption declines and savings increase. This is, however, not a permanent but a one off effect. 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 if the return on savings becomes lower. Nevertheless, there is only a temporary change in the net interest rate since in the long run the interest rate is bound to fulfill $1+\bar{r}^H = \rho^H/G$ due to the assumptions underlying the Ramsey model and thus only the substitution effect bites.

4.2.4 General Macroeconomic Equilibrium

Public Accounts

Via taxation the domestic government introduces various distortions on the behavioral margins of the economic agents. The government total tax revenue TTR_t consists of revenue from the tax levied on corporate and personal income of corporate and non-corporate firms T^P, interest income taxation T^i, labor income taxation T^L, and the taxation of dividend income T^D as well as capital gains T^G.

$$TTR_t = T^P + T^I + T^C + T^L + T^D + T^G$$

where

$$(a)\ T^P = T^{P,C} + T^{P,N},^{24} \tag{4.52}$$

$$(b)\ \ T^i = \tau^i \left[i^{BH} A^{B,H} + i^H A^{DH,H} + i^F A^{DF,H} \right], \tag{4.53}$$

$$(c)\ T^C = \tau^C C, \tag{4.54}$$

$$(d)\ T^L = \tau^L (w_t L_t^S - LTA), \tag{4.55}$$

$$(e)\ T^D = \tau^D Div^C, \tag{4.56}$$

$$(f)\ T^G = \sum_{f=C,\ N}^{2} \tau^{G,f} \left[GV_{t+1}^f - V_t^f - VN^f \right]. \tag{4.57}$$

Business income taxes consist of corporate and personal income tax of domestic corporate and personal firms $T^{P,C} + T^{P,N}$. Dividend taxes are paid

only on dividends of corporate firms. Firms pay the interest on debt plus an agency cost $(i^{BH} + m^f)B^f$ while private households just receive the gross interest on the firm bonds they own $i^{BH}A^{B,H}$. Therefore the interest tax can just be levied on residents and the tax revenue from interest taxation includes revenues from interest taxes on domestic firm bonds as well as on domestic and foreign government bonds accruing to domestic investors. Capital gains taxes contribute to public revenues as noted in eq.(4.57) and the labor tax is levied on labor income less a labor tax allowance.

The accumulation of public debt has to cover public consumption C_t^G, the primary deficit and the interest spending on public debt $(1 + i^H)D_t^G$. The primary deficit is defined as the difference between lump-sum transfers T_t^H and total tax revenue TTR_t.

$$GD_{t+1}^G = (1 + i^H)D_t^G + C_t^G + T_t^H - TTR_t \ . \tag{4.58}$$

The government debt accumulation is intertemporally constrained. It rules out expenditure increases to finance a budget deficit. A present imbalance has to be offset by a future compensating action. To finance a tax reform that envisages lower income taxes, two alternative scenarios are considered. One envisages a reduction in transfers and the second an increase in the VAT to compensate for the revenue loss.

Current Account

The gross national product, GNP, is given by the sum of GDP and the net interest income from abroad:

$$GNP = GDP + \underbrace{i^F A^{DF,H} - i^H (A^{B,F} + A^{DH,F})}_{NCE_t = \text{ net capital export}}, \tag{4.59}$$

The above equation shows that we allow for two-way capital flows since domestic individuals can hold foreign government bonds and foreign individuals can own domestic firm and government bonds. Since we apply the residence principle of taxation, foreigners will earn the domestic gross return i^H on their domestic assets and domestic investors the foreign gross return i^F on their owned foreign government bonds.

This cross ownership of assets is also mirrored by the net foreign asset position which is defined for the home country as $NFA = A^{DF,H} - (A^{B,F} + A^{DH,F})$ and changes according to:

$$G \cdot NFA_{t+1} - NFA_t = NCE_t + TB_t \ , \tag{4.60}$$

where TB, denotes the trade balance, which is given by GDP less domestic absorption. By definition the trade deficit of one country has to equal the trade surplus of the other.

$$TB = GDP - \sum\nolimits_{f=C,\ N}^{2} I^f - C - C^G. \tag{4.61}$$

The r.h.s. of eq.(4.60) thus determines the current account surplus as the excess of GNP over domestic absorption. The current account determines the accumulation of foreign wealth.

4.2.5 Welfare Analysis and the Marginal Excess Burden of Taxes

As a measurement for welfare, we apply the equivalent variation which specifies the differences in expenditures with respect to the before and after tax reform life-time utility levels U^0 and U^1, using the pre reform price structure p^0:

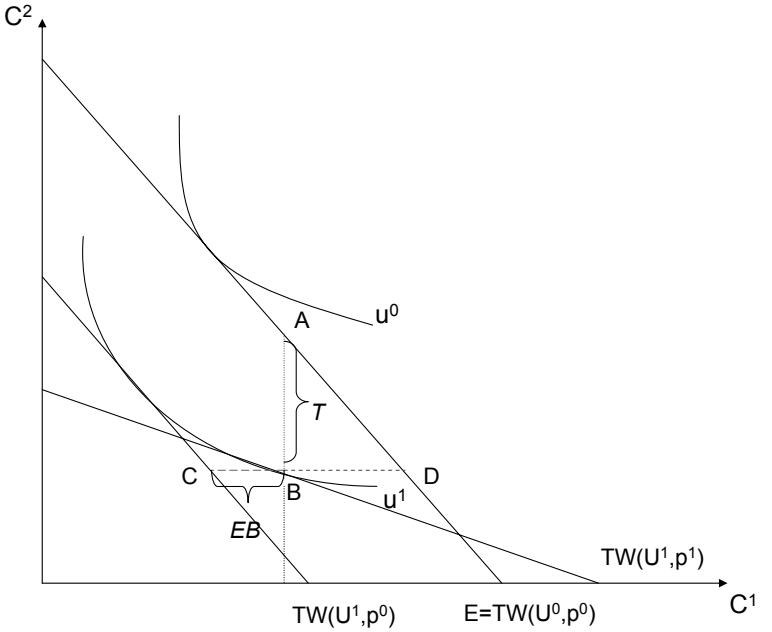
$$EV = TW(U^0, p^0) - TW(U^1, p^0) \ . \tag{4.62}$$

TW denotes total wealth including financial wealth, $(1+\overline{r^H}_t)A_t^H$, and human capital, H_t defined as the present value of wages.

$TW(U^0, p^0)$ defines the expenditure level which is assigned to the utility level U^0. Graphically, it shows the lowest budget line which is tangent to the indifference curve U^0 in Fig. 4.9. Only by applying the same reference price level (here p^0) enables us to assign correctly an expenditure value to each utility level.

The equivalent variation defines the loss or gain to the consumer following a price change. Fig. 4.9 depicts in a simplified two-period model the effects on welfare of an interest tax rate τ^i. As a consequence of taxation, the net interest rate declines, the budget line becomes flatter and due to the substitution effect the consumer will prefer present to future consumption since future consumption becomes more expensive as a result of the taxation of savings. Point E denotes the present value of total wealth. The vertical distance AB denotes the tax payment $T = \tau^i i S$ equalling the interest tax rate multiplied by the interest rate i and the savings volume S, whereas the horizontal distance BD shows the present value of these tax payments $P^0 T$. CD denotes the present value of a lump-sum tax which would lead to the same utility level as the interest tax and equals the equivalent variation $TW(U^0, p^0) - TW(U^1, p^0)$ (Keuschnigg, 2005a). In the present model, however, all good prices are normalized to unity and the equivalent variation indicates the amount of additional life-time resources necessary for the consumer to attain the utility in the new situation at initial prices. In the applied full intertemporal model the only given prices which adapt in the course of time as a result of the policy shock are the interest rate and the wage rate. Accordingly, in the multi-period model, future consumption and future utility do not refer just to the second period as in the two period model but to the whole path of future consumption and indirect utility which is a function of the marginal propensity to consume and the intertemporal elasticity of substitution in consumption (see eq.(B2.12) in the Appendix B2).

Fig. 4.9. The Equivalent Variation



Source: Keuschnigg (2005a)

If we denote by y^{EV} the equivalent variation converted into an annuity flow of the same value, so $y^{EV} = (1-\rho^H)EV$, we can compute the change in welfare in percent of GDP, or life-time income, respectively.

$$\frac{y^{EV}}{GDP} = \frac{(1-\rho^H)EV}{GDP} \ . \tag{4.63}$$

To be able to compute the EV numerically, total wealth as a function of indirect utility has to be computed. (See eq.(B2.12) and (B2.13) in Appendix B2 for the derivations) .

Another important measure for the effects of taxation on households and thus on welfare is the excess burden. The excess burden is defined as the welfare cost imposed on the individual by taxation, which expressed in money terms, exceeds the tax payment.

The deadweight loss or excess burden of the interest tax is the loss of tax revenue compared to an equivalent lump-sum tax which would enable households to reach the same utility level (see Fig. **4.7**). The excess burden (EB) is the result of the substitution effect which diminishes savings and consequently lead to a tax revenue loss (Keuschnigg, 2005a).

$$EB = EV - T = TW(U^0, p^0) - TW(U^1, p^0) - P^0 T \tag{4.64}$$

A special form of the deadweight loss of taxation is the marginal excess burden (MEB). This measure shows the extent to which the excess burden increases for each additional euro of tax revenue. The simulations using the *IFOMod* are in fact performed assuming the government budget is balanced in each period because each tax reform is revenue neutral.

In order to determine the marginal excess burden per € of additional tax revenue which results from increasing the interest tax rate we have to show how the equivalent variation reacts to a change in the price level. From solving forward eq. (4.58) we get $(1+i_t^H)D_t^G = \sum_{s=t}^{\infty}\left[TTR_t - (C_t^G + T_t^H)\right] + \prod_{u=t+1}^{s}\left(\frac{G}{1+i_u^H}\right)$. Therefore, the present value of tax revenue PVT^1 after a tax rate change (in the present example the tax on interest income) is

$$PVT^1 = \sum_{s=t}^{\infty} TTR_t \prod_{u=t+1}^{s}\left(\frac{G}{1+i_u^H}\right) = (1+i_t^H)D_t^G + \sum_{s=t}^{\infty}(C_t^G + T_t^H)\prod_{u=t+1}^{s}\left(\frac{G}{1+i_u^H}\right) \tag{4.65}$$

Accordingly, the discounted tax revenue before a tax rate change in the initial steady state is PVT^0

$$PVT^0 = \frac{TTR^0}{1-\frac{G}{1+i_t^H}} \tag{4.66}$$

Therefore, the marginal excess burden can be defined as the ratio between the equivalent variation and the difference between the present value of tax revenues before and after a tax rate change $\Delta PVT = PVT^1 - PVT^0$.

$$MEB = \frac{EV}{\Delta PVT} \tag{4.67}$$

Repeatedly this indicator measures the marginal change in the excess burden arising when we consider a marginal increase in a tax rate which induces a marginal change in the equivalent variation and a marginal change in tax revenue. The marginal excess burden will depend on the value of the tax rate and on the compensated elasticity of savings with regard to the interest rate. The higher the elasticity, the larger the marginal excess burden will be. The *MEB* also increases progressively with the tax rate (Keuschnigg, 2005a). In a partial equilibrium model which feature a representative Ramsey individual, the marginal excess burden arising from the interest tax is the largest compared to those arising from other taxes, because due to the assumption underlying the Ramsey model the interest rate is bound to equal the rate of time preference in the long run and the demand for assets is thus infinitely elastic. In a general equilibrium framework, an interest tax rise induces only a finite change in assets due to the fact that these assets are bound by the production side of the economy.

The above analysis can be performed for each tax rate separately such that the marginal excess burden can be computed for the profit tax, the labor income tax, the interest tax, the capital gains tax and for the dividend tax.

Thus, the total marginal costs of taxes, the so-called marginal costs of public funds *MCPF* are relevant when the government decides the level and structure of taxes. The *MCPF* include the additional euro tax revenue and the marginal excess burden.

$$MCPF = 1 + MEB \tag{4.68}$$

The value of the *MCPF* shows that the financed government activity must bring about a welfare gain which is at least as high as these costs. The higher the marginal excess burden of taxation is, the more difficult it will be for the government to justify an extension of its interventions and activity level (Keuschnigg, 2005a).

4.2.6 Rest of the World

The foreign economy merely serves to complete the model. The foreign production and household sectors are modeled in a rather simple manner.

Foreign Production

The production sector is described by:

$$V^e(K_t^F) = \max_{L_t^F,\, I_t^F} \left\{ \pi_t^F + \frac{G^F}{1 + r_{t+1}^F} V^e(K_{t+1}^F) \right\} \text{ s.t. } GK_{t+1}^F = I_t^F + (1-\delta)K_t^F, \tag{4.69}$$

where V^e once again denotes the end of period firm value according to: $V_t^e = (1 + r_{t+1}^F)V_t$ and profits given by:

$$\pi_t^F = F(K_t^F, L_t^F) - w_t^F L_t^F - I_t^F. \tag{4.70}$$

The firm's labor demand and investment decision are again the result of maximizing the firm value. Optimal labor demand is determined by the equality between the marginal product of labor $F_{L_t^F}$ and the wage rate w_t^F. The optimal investment level is achieved when the marginal product of capital, $F_{K_t^F}$ equals the cost of supplying capital namely the interest rate r_t^F plus depreciation δ.

Foreign Households

Also in the case of the foreign economy, the household possesses a portfolio consisting of foreign equity, domestic business debt as well as domestic and foreign government bonds:

$$A^F = A^{V,F} + A^{B,F} + A^{DH,F} + A^{DF,F} \tag{4.71}$$

Since we apply the residence principle of taxation and no taxes on interest income exist in the foreign economy, foreign households earn the gross return on domestic firm and government bonds. The foreign average portfolio return is thus defined as:

$$\bar{r}^F = \frac{i^{BH} A^{B,F} + i^H A^{DH,F} + i^F A^{DF,F} + r^F A^{V,F}}{A^F} = \rho^F \tag{4.72}$$

and again due to the assumptions underlying the Ramsey model the average interest rate $\bar{r}^F$ equals in the long-run the household's rate of time preference ρ^F.

The wealth of the representative foreign agent accumulates according to:

$$GA^F_{t+1} = (1 + \bar{r}^F)A^F_t + w^F_t L^F_t - C^F_t - T^F_t \tag{4.73}$$

where

$$T^F_t = (i^F - g)D^F$$

Lifetime utility is maximized by choosing the optimal consumption level, C^F_t, in each period of time:

$$U(A^F_t) = \max \left\{ u(C^F_t) + \rho^F U(A^F_{t+1}) \right\} \text{ s.t. eq.(4.73).} \tag{4.74}$$

Solving the maximization problem we can compute optimal consumption and accordingly the Euler equation:

$$\frac{u'(C^F_t)}{u'(C^F_{t+1})} = \frac{\rho^F (1 + \bar{r}^F_t)}{G^F} \ . \tag{4.75}$$

The equilibrium conditions satisfied by a dynamic general equilibrium model are that the behavior of each sector of the economy has to be in line with the derived paths of interest rates, wages and tax rates. The investment decision of the firm has to reflect the stock market value and the future path of interest rates. Households' consumption and labor supply have to be optimal given the evolution of wages, interest rates and taxes and the government's decisions have to fulfill its intertemporal budget constraint (Auerbach et al. 1987). Given these conditions, all markets have to clear in each period.[25](For the computations and proofs of these conditions see the Appendix B3, B4 and B5).

[25] This is the so-called Walras Law. However, this law also states that from n markets only n-1 have to be balanced since the nth market will then be automatically cleared.

5

Simulation Results

This chapter provides a detailed description of two simulation scenarios which both consider introducing a DIT in Germany. The reform alternatives were advanced by the GCEA and by Sinn in the year 2003.

In Section 5.1, I describe the calibration of the model with particular focus on the main behavioral parameters such as the intertemporal elasticity of substitution, the labor supply elasticity or the factor substitution elasticity. Sections 5.3 and 5.4 present and analyze the steady state and transitional effects of the two reform proposals. Both reform alternatives have positive macroeconomic effects and lead to an increase in the capital stock, labor supply, consumption and welfare. However Sinn's (2003a) reform scenario leads to slightly higher welfare of the representative individual as shown in Section 5.5. The sensitivity analysis with respect to the main underlying elasticities is performed in Section 5.6. Finally, the Appendix D includes a brief illustration of the computational strategy.

5.1 Model Calibration

In order to solve any CGE model numerically, and therefore to be able to evaluate a tax reform with *IFOMod* accordingly, functional forms have to be specified and a number of parameters have to be chosen. To ensure analytical tractability and to facilitate the identification of the main structural parameters, I rely on simple forms for the main applied functions (see Appendix C). In this context, calibration means that the parameters for different elasticities and major economic variables should be consistent with the empirical evidence from the econometric literature and the initial steady state values should reflect empirical data. Since unfortunately the estimated values for each variable or elasticity we need are not always unambiguous, some indirect methods have also to be applied to attain certain parameter values (Fehr, 1999). For models exhibiting a detailed production structure such as *IFOMod*, some parameters are exogenously set, while others are chosen to reflect the

empirical data for a reference year. Nevertheless, since the here applied model does not distinguish between industries it is easier to determine exogenously the relevant parameters and tax rates and to replicate the macroeconomic data of the benchmark year.

Additionally, in case of dynamic models, short-term and long-term values of the parameters might diverge which in turn, increases the difficulty of making the appropriate parameter choice. These weaknesses are usually addressed by performing a sensitivity analysis.

5.1.1 Production Technology Parameters

The most important parameters describing the production sector are the elasticity of substitution between capital and labor, the adjustment cost parameter, the economic depreciation rate, the elasticity of capital demand and the elasticity of the debt-asset ratio.

Since the simulation results of any CGE model are most sensitive with regard to the behavioral parameters applied, special diligence is needed when calibrating the model. All behavioral parameters used in this model are standard results confirmed by the empirical literature. The most important ones are summarized in Table 5.1.

The real annual growth rate of the German economy is assumed to be 1 per cent, which is the average for Germany after re-unification. Economic depreciation reaches 10 per cent of the capital stock and the adjustment speed towards the new steady state is determined by the half life of investment. In accordance with the study of Cummins et al. (1996), I take a value of 8.0, implying that during the following 8 years after the policy shock half of the long-run increase in the capital stock is accumulated. Accordingly, 99.9 per cent of the new steady state capital stock will be built up within 80 years. To achieve this, the adjustment cost parameter amounts to 2, a value that was also applied by Valkonen (1999) and represents a lower end value of available estimates (see Whited 1994).

Table 5.1. Behavioral Parameter Values

Half Life of Capital Accumulation (in years)	(Cummins et al. 1996)	8.0
Elasticity of Debt Asset Ratio [a)]	(Gordon and Lee 2001)	0.36
Intertemporal Elasticity of Substitution	(Flaig 1988)	0.4
Economic Depreciation Rate		0.1
Elasticity of Factor Substitution	(German Central Bank 1995)	0.8
Labor Supply Elasticity	(weighted average of Fenge et al. 2002)	0.37

Note: Elasticity with respect to[a)] profit tax

For the constant elasticity of substitution (CES) production function, the applied elasticity of factor substitution of 0.8 is based on German Central Bank (1995). A value ranging between 0.3 and 1.3 for West German industries was also computed by Roskamp (1977). Fehr (1999) also employs a value of 0.9 in his model which measures the welfare effects of dynamic tax reforms and Keuschnigg (1991) adopts a value of 0.95 to evaluate the effects of a switch to a cash flow income tax. There is extensive empirical literature dealing with the estimates of the elasticity of substitution between labor and capital. A survey of these studies is provided by Chirinko (2002). Accordingly, different studies employing different technique, find values between 0 and 1. A value of unity characterizes a Cobb-Douglas production function (see Jorgenson, 1963 and Hall and Jorgenson, 1967). A more recent study by Chrinko, Fazzari and Meyer (1999) using panel datasets, yields an elasticity of 0.25 whereas higher values of 0.7 for corporate and 0.5 for non-corporate capital are calculated by Jorgenson and Yun (2001) using capital stock data. Moreover, a wide range of estimates between 0.2 and 1 is confirmed by the Joint Committee on Taxation (1997).

Concerning the elasticity of the debt-asset ratio, we follow Gordon and Lee (2001) who estimate that a 10 percentage points decrease in the corporate tax rate leads to a reduction in the debt-asset ratio by three to four per cent. Thus a value of 0.36 seems to be appropriate for estimating the change in the tax advantage of debt resulting from a change in the profit tax rate.

The labor supply elasticity $\varepsilon = 0.37$, representing an average of empirical estimates for different age and sex groups (Fenge et al., 2002), is actually a compensated supply elasticity, which characterizes the relevant substitution effect between labor and leisure. However, due to the rigidities present in the German labor market, I will also carry out a sensitivity analysis using a much lower labor supply elasticity, thus showing the effect of an almost fixed labor supply on the other main macroeconomic variables. Moreover, the value assumed here lies within the range of 0.2 and 0.43 which, according to many economists' opinion, are appropriate values for compensated labor supply elasticities for men and women, respectively (Fuchs et al. 1998).

Given the fact that the macroeconomic effects of capital income taxation are very sensitive to the choice of the value of the intertemporal elasticity of substitution (King and Rebelo, 1990, Summers, 1981), the value of this parameter has to be set with great care. The intertemporal elasticity of substitution in consumption is an important value for characterizing the saving behavior. The value of 0.4 is based on Flaig's (1988) empirical research for Germany, and is just one percentage point lower than the values applied by Böhringer (2002), Keuschnigg and Dietz (2004) or by Valkonen (1999). Hall (1988) also predicted lower values, even close to zero for this elasticity, while other empirical exercises performed by Kydland and Prescott (1982) obtain a value of 0.66 or even higher (Hansen and Singleton (1983)). Altig et al. (2001) assume a value of 0.25, since a lower value of the intertemporal elasticity of substitution may account for liquidity constraints or

other factors which diminish the reaction of savings to changes in interest rates. Studies measuring the effect of changes in interest rates on intertemporal consumption decisions, such as those performed by Weber (1970, 1975) find, values ranging from 0.56 to 0.76 (if real interest rates are considered) and from 0.13 to 0.41 (in case nominal interest rates are regarded). Estimates of this parameter computed by Altonji (1986) from shifts in labor supply caused by changes in the wage rate across the life-cycle find values below 0.45. Accordingly, a value of 0.4 which was estimated using German data, reflects a consensus estimate.

5.1.2 Macroeconomic Data

The analysis relies on data from the German Statistical Office (2004c), the German Central Bank (2004 a,b and c), the German Mininstry of finance (2005a) and the Deutsches Aktieninstitut (DAI) (2004) to replicate the benchmark equilibrium and describe the macroeconomic structure of the German economy for 2004. Table 5.2 reports the values of the main macroeconomic aggregates.

Table 5.2. Macroeconomic Variables (in bill. €)

GDP	2180
Private Consumption	1270
Net Foreign Assets	134.5
Labor Income	1133
Government Debt	1394
Tax Revenue	
Labor Income Tax	123.7
Profit Tax	123.1
Dividend Tax	40.1
Interest Tax	15.6
VAT	137.1

Source: German Statistical Office (2004c), German Ministry of Finance (2005a), German Central Bank (2004c), own calculations.

While the main aggregates such as GDP, consumption or labor income exactly replicate the original statistical data, the figures for the tax revenues from different taxes may deviate from the official numbers since I do not model any tax evasion or do not allow for a progressive income tax, as the model just features one representative individual. Thus, the revenue from some taxes might be overestimated because, in pursuit of the main purpose of this study, I particularly focus on setting the tax rates and do not calibrate exactly tax revenues.

Modelling an explicit portfolio allows us to distinguish between distinct asset types which yield different returns according to their riskiness. Therefore, the gross interest rate on long-term government bonds is assumed to be three per cent and the gross return on equity equals eight per cent (DAI, 2004).

To replicate the official labor force data, I resort to data from the German Statistical Office (2004c) and multiply the population of 82.5 million people by the employment share of 0.51 to get 42.3 million employed people. Moreover, labor income of € 1133.2 Bill. is also derived from data of the German Statistical Office (2004c).

Regarding the financing structure of corporate and non-corporate firms, data provided by the DAI (2004) and by the German Central Bank (2004a) are applied. Using these data, I calibrate the following financing structure of German corporate firms: 59 per cent of new investment is financed by retained earnings, 5 per cent by new share issues and 36 per cent by new debt. For non-corporate firms, which can only employ new share issues and new debt to finance new investment, I compute, using German Central Bank (2004b) data, a 18.1 percentage points higher debt asset ratio of non-corporate firms compared to corporate firms. Accordingly, sole proprietorships and partnerships finance 54 per cent of new investment via new debt and 46 per cent via new share issues.

To identify the relative sizes of the two firm sectors, I adopt data from the Institut für Arbeitsmarkt und Berufsforschung (IAB) and compute a labor share of 65 per cent for the corporate sector. Thus, only 35 per cent of the labor force is employed in the non-corporate sector.

Regarding the shares of different assets in the domestic portfolio, I calculate, using data from the German Central Bank (2004a), a domestic ownership share of 86.5 per cent for domestic government bonds. This is consistent with the empirical literature[1] and confirms the so-called 'home bias'[2].

5.2 The Marginal Excess Burden

An additional reason why the tax system should be reformed and tax rates lowered is the excess burden inherent in the present tax system. Accordingly, Table 5.3 shows the value of the additional excess burden caused by ceteris paribus a one percentage point increase in an individual tax rate. Accordingly, the increase in the tax rate on corporate profits from 38.3 to 39.3 per cent causes a marginal deadweight loss[3] of 48.7 per cent. A similar drastic result is obtained for a one percentage point increase in the interest rate. The lowest marginal excess burden is caused by the dividend tax with 0.9 per cent,

[1] See Tesar and Werner (1998).

[2] See also Chapter 3 Section 2.3.1 for this modelling approach of a household's portfolio choice.

[3] For the definition and modelling of the marginal excess burden see Chapter 4 Section 4.2.5.

followed by the capital gains tax with 3.3 per cent and the tax rate on non-corporate profits with 4.7 per cent. A rise in the labor income tax rate of an average individual from 29.5 to 30.5 per cent leads to a deadweight loss of around 22 per cent. The lowest increases are recorded for those taxes which are either zero in the baseline calibration, as it is the case with the effective capital gains tax, or are modeled as a non-distorting tax, as it is the case with the dividend tax.

Table 5.3. The Marginal Deadweight Loss From Each Particular Tax Under the Present Tax System (in%)

Interest Income Tax	τ^I	48.8
Tax on Corporate Profits	$\tau^{P,C}$	48.7
Labor Income Tax	τ^L	21.8
Tax on Non-Corporate Profits	$\tau^{P,N}$	4.7
Capital Gains Tax	τ^G	3.3
Dividend Tax	τ^D	0.9

Source: Own calculations.

Therefore, a tax reform that envisages above all a reduction in the corporate, interest and labor income tax rate is desirable. In this context, both forms of the DIT as suggested by the GCEA and by Sinn entail a considerable decline in these tax rates and seem to be the right policy alternative.

5.3 Implementing a DIT as Suggested by the GCEA (2003)

In the German tax system prevailing in 2004, the statutory corporate tax rate amounts to 25 per cent, but adding the local trade tax and the solidarity surcharge the effective corporate tax rate comes to 38.3 per cent. On the household level, the progressive labor tax rate reaches a top marginal tax rate of 42 per cent and including the solidarity surcharge amounts to 44.3 per cent.[4] This tax rate also applies to interest income. Taking an average annual income of about € 20,814 as given, the representative individual, according to the prevailing tax bracket, is liable to a marginal income tax of 28 per cent, which, if we add the solidarity surcharge, reaches 29.5 per cent. Moreover, according to the German half income principle, income derived from dividends (distributed profits) is subject to half of the personal income tax rate, while capital gains remain untaxed.

In the following, I will consider three different policy scenarios: *Scenario 1* follows exactly the reform proposal made by the GCEA in their 2003 report

[4] The income tax rate applying to non-corporate firms is 45.4 per cent since it also includes part of the local trade tax.

(for details see Section 3.5.1 of Chapter 3). All tax rates applying to any kind of capital income are set at a flat rate of 30 per cent, while labor income is taxed progressively with a top marginal tax rate of 35 per cent.[5] Since the GCEA proposal does not specify any tax rate for the individual in the average income tax bracket, I take a value of 25 per cent which lies in between the minimum and top rates of 15 and 35 per cent respectively and which is also applied in the SINN reform scenario. 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 considered when computing the tax base, capital gains also need 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 according to 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 per cent. 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 will also be subject to taxation at a flat rate of 30 per cent. Since capital gains are only taxable upon realization and not upon accrual, I take half of the proposed statutory tax rate (that is 15 per cent) as a rule of thumb in the simulation exercise.

Table 5.4 reports the tax rates which apply to the present tax system and to the different reform proposals.

Table 5.4. Tax Rates Before and After the Reform

	Status Quo (2004)	Scenario 1	Scenario 2	Scenario 3
Profit Tax, $\tau^{P,C}/\tau^{P,NC}$	0.383/0.454	0.30	0.30	0.30
Labor Tax, τ^{L}	0.295	0.25	0.25	0.25
Tax on Interest Income, τ^{i}	0.443	0.30	0.30	0.30
Dividend Tax, τ^{D}	0.221	0.00	0.30	0.30
Capital Gains Tax, τ^{G}	0.00	0.00	0.00	0.15
VAT, τ^{C}	0.16	endogenous	endogenous	endogenous

Source: GCEA (2003), own calculations.

The column 'Status Quo' depicts the statutory effective tax rates for Germany in 2004, while the other three columns show the effective tax rates according to the simulation exercises of *Scenarios* 1 to 3. Regarding the major loss in tax revenue, which arises due to the large reduction in several tax

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

rates, there are only a few feasible ways to finance such a reform. The GCEA (2003) report proposes a comprehensive reduction of nearly all kinds of legal tax relief, but it is arguable whether this counteracting measure is sufficient. Since the tax revenue is determined endogenously in our model, we allow either for an increase in the VAT rate or for a reduction in the government's transfers to households to finance the proposed reform scenarios. The increase in the VAT rate is usually the preferred alternative by political analysts in finding ways to finance different tax reforms (Fehr and Wiegard, 2004).

5.3.1 Partial Analysis of the Effects of Each Individual Tax Rate Change

The investigated tax reform involves a number of policy actions which might either reenforce or counteract each other's effects and thus make the interpretation of the overall result more complicated. To avoid this, I will perform a simulation for each tax rate separately and ceteris paribus analyze the effects brought about by the change in this particular tax rate alone. In all cases I will assume the reform is financed by an adjustment in government transfers.

Steady State Comparisons

The first simulation applies a reduced profit tax rate τ^{Pf} of 30 per cent for corporate profits and 35 per cent for non-corporate profits. Such a reform could lead to a decrease in the cost of capital by around eight per cent for corporate firms and by nine per cent for non-corporate firms, which results in an increase in the capital stock by 6.8 per cent in the corporate sector and by 9.4 in the non-corporate sector (see Table 5.5). As a result, domestic firm values increase and accordingly also the demand for domestic firm equity and domestic firm bonds, which rise by around 10 and 12 per cent, respectively (see Table 5.7). Given the fact that labor and capital are complementary factors of production, the increase in the demand for capital induces an increase in the demand for labor, which in turn results in rising gross wages and labor supply. Due to higher real wages, disposable income and consumption also increase by one and 3.3 per cent, respectively (see Table 5.7). This tax rate change leads to an increase in welfare by 0.6 per cent in terms of life-time income. Looking at the results summarized in Tables 5.5 to 5.7 we can see that the drastic reduction in the profit tax rates τ^{Pf} has the greatest effects on capital, labor demand or demand for domestic assets compared to the effects of the other tax rate changes.

The only tax rate variation which leads to an even higher increase in welfare is the reduction in the labor tax rate τ^{L} from 29.5 to 25 per cent since this policy increases the current real wage and accordingly disposable income to an even larger extent. As shown in Table 5.7, this upswing in disposable income by 1.4 per cent leads to an increase in welfare in terms of life-time income by almost one per cent.

Table 5.5. Anticipated Effects of Individual Tax Reform Measures (in%)

	Decrease in τ^P		Decrease in τ^L		Decrease in τ^I	
	C-Firm	NC-Firm	C-Firm	NC-Firm	C-Firm	NC-Firm
Pre Reform Cost of Capital	10.6	9.9	10.6	9.9	10.6	9.9
Post Reform Cost of Capital	9.7	9	10.6	9.9	10.4	9.7
Post Reform EMTR	29.1	29.9	35.6	37.0	34.1	34.8
Long Run Change						
Capital Stock	6.8	9.4	2.0	1.7	0.7	3
Labor Demand	0.5	2.5	2.3	2.0	-0.5	1.5
Cost of Capital	-8.2	-9.1	0.0	0.0	-1.7	-2.3
EMTR	- 18.1	-19.3	0.1	0.1	-4	-6
Debt Asset Ratio	1.3	1.2	0.04	0.03	-0.2	-0.1

Source: Own calculations.

Table 5.6. Anticipated Effects of Individual Tax Reform Measures (in%)

	Increase in τ^D		Increase in τ^G	
	C-Firm	NC-Firm	C-Firm	NC-Firm
Pre Reform Cost of Capital	10.6	9.9	10.6	9.9
Post Reform Cost of Capital	10.7	10	11.9	9.9
Post Reform EMTR	36.2	37	42.7	37
Long Run Change in				
Capital Stock	-0.9	-0.2	-23.7	27
Labor Demand	-0.3	0.2	-17.6	29.8
Cost of Capital	0.7	0.6	12.8	0
EMTR	1.8	0.2	20.1	-0.1
Debt Asset Ratio	0.4	0.2	-1.9	-0.1

Source: Own calculations.

In contrast, the sole increase in the dividend tax rate τ^D from 22.2 to 30 per cent and the jump in the capital gains tax rate τ^G from zero to 15 per cent, negatively affect the cost of capital, firm values, household's assets and wages (see Tables 5.6 and 5.7). The negative outcome is larger in the case of the capital gains tax since we follow the 'New View' of dividend taxation, according to which investments are financed at the margin via retained earnings such that introducing a capital gains tax negatively influences the cost of capital and thus investments. The resulting decrease in disposable income of 3.8 per cent in this case leads to a decline in welfare measured in terms of life-time income by almost one per cent (see Table 5.7).

Table 5.7. Key Economic Figures (Long Run Change in %)

Change in	τ^P	τ^L	τ^I	τ^D	τ^G
GDP	3.8	2.0	0.8	-0.4	-3.2
Capital Stock	7.7	1.9	1.5	-0.7	-5.5
Domestic Owned Assets	9.5	2.2	2.2	-4.5	-0.6
Firm Equity	10.3	2.1	1.5	-6.5	0.5
Domestic Demand for Firm Bonds	12.2	2.5	4.8	-2.8	-1.1
Foreign Demand for Firm Bonds	3.8	0.7	-4.9	4.5	-1.9
Domestic Demand for Dom. Govt. Bonds	5.5	2.2	1.1	-1.5	-3
For. Demand for Dom. Govt. Bonds	-6.9	0.2	-1.5	7.0	-5.2
Dom. Demand for Foreign Govt. Bonds	8.6	1.9	1.9	-4.6	0
Gross Wage	3.3	-0.3	0.6	-0.3	-2.8
Current Real Wage	3.3	6.1	0.6	-0.3	-2.8
Labor Supply	1.2	2.2	0.2	-0.1	-1.1
Disposable Income	1.0	l 1.4	0.7	0.4	-3.8
Transfers	-18.0	-4.1	2.0	6.3	-15.2
Domestic Consumption	3.3	2.6	1	-0.8	-3.2
Welfare in % of Life Time Income	0.6	0.9	0.4	-0.1	-0.9
Welfare in % of GDP	0.3	0.5	0.2	-0.06	-0.5

Source: Own calculations.

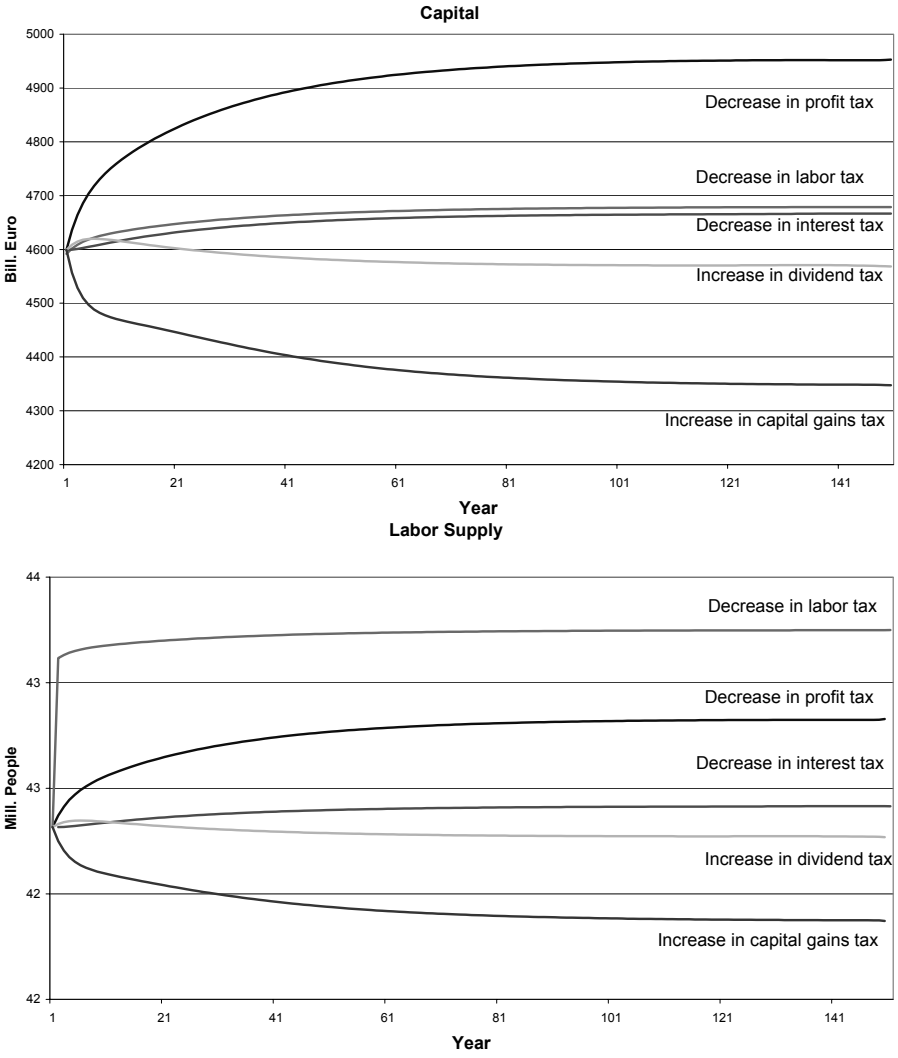
The above described effects as well as the numbers presented in Tables 5.5 to 5.7 show how difficult it is to appraise the overall effect of a tax reform that envisages several tax rate changes at the same time. The reduction in the profit, labor and interest tax rates induce positive effects on investments, capital accumulation and welfare, whereas the rise in the dividend and capital gains taxes lead to opposite effects. Accordingly, applying a CGE model helps us evaluate which effects will outweigh in the end and quantify these results. We will see that the overall results will be positive since the decrease in the profit and labor tax rates will have the most predominant and beneficial effects.

Transition Paths

Besides the steady state effects, attention has to be paid to the transition from the initial steady state to the final steady state after the reform has been implemented. Fig. 5.1 and 5.2 depict the transition paths of the main macroeconomic aggregates resulting from the individual policy change. Once again it is evident that the reduction in the profit tax rate leads to the highest increase in the capital stock, while the reduction in labor taxes results in the highest rise in labor supply and domestic consumption compared to effects caused by the other tax rate changes. It usually takes about 80 years until the new steady state level is approached.

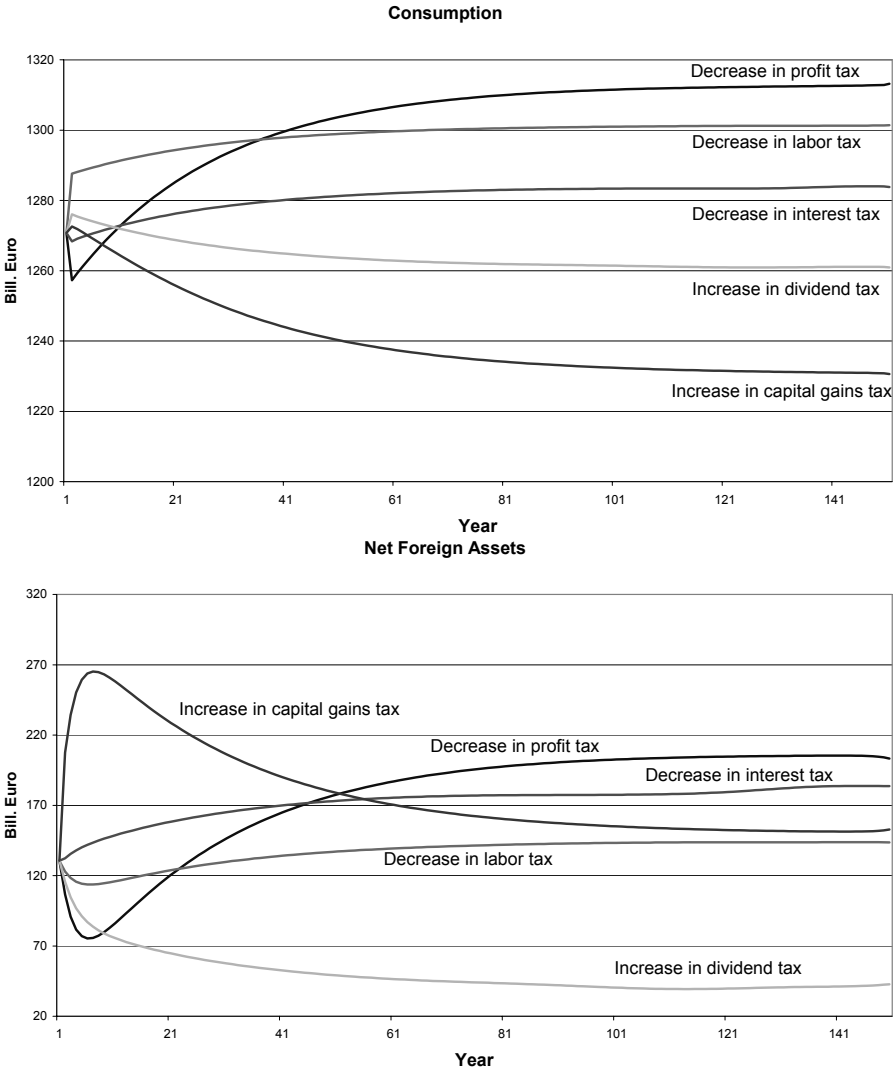
A decreasing path of capital and consumption is recorded under the policy shift that applies a higher dividend or a higher capital gains tax rate (see Fig. 5.1 and 5.2).

Fig. 5.1. The Transition Path of Capital and Labor Supply From Each Tax Rate Change



Source: Own calculations.

Fig. 5.2. The Transition Path of Consumption and Net Foreign Assets Resulting From Each Tax Rate Change



Source: Own calculations.

The only mixed picture is given by the transition path of net foreign assets as shown in Fig. 5.2. The reduced tax rate on corporate and non-corporate profits increases the domestic and foreign demand for domestic firm bonds by 12.2 and 3.8 per cent respectively. Since we assume a high degree of substitutability between assets, the increased return on firm bonds will also induce a higher return on foreign government bonds. As a result, the demand for these assets also rises by 8.6 per cent such that the net foreign asset position increases to around € 200 billion. When a capital gains tax is introduced, firm values and accordingly the return on equity will decline. Since assets are close substitutes, the return on firm and government bonds will also fall thus inducing a decline in the foreign demand for firm bonds by 1.9 per cent and in the demand for government bonds by 5.2 per cent. Therefore, this tax rise leads to an immediate jump in the net foreign asset position which then adjusts to a lower level of € 152 billion when the economy has adjusted to the policy shock.

5.3.2 Steady State Comparisons of the Overall Reform Package

Financing the Reform via a Reduction in Transfers

In this Section all simulations are performed under the assumption that government transfers are adjusted to ensure the reform is revenue neutral. Reducing lump-sum transfers is a policy that does not distort the labor supply decision of individuals, and therefore appears to be an appropriate measure to balance the government's budget.

The reform proposal is characterized by a large reduction of corporate and personal tax rates. Due to the reduction in the corporate tax rate, as well as the nonexistence of a dividend and capital gains tax, the cost of capital decreases by 11.6 per cent from 10.6 to 9.4 per cent for corporate firms and by 13.5 per cent from 9.9 to 8.6 per cent for non-corporate firms in *Scenario 1*, as shown in Table 4.8. In *Scenario 2*, the cost of capital declines only by 9 and 10.6 per cent for corporate and non-corporate firms, respectively, since in this case an increased dividend tax is levied. This considerable decline in the cost of capital goes hand in hand with a reduction of the marginal effective tax rates (EMTR) thus boosting investment and enhancing economic growth. In *Scenario 1*, the marginal effective tax rate declines by around 27 per cent for both types of firms: for corporate firms from 35.5 to 26 per cent and for non-corporate ones from 37 to 27 per cent.[6] The EMTR decreases to 28 and

[6] The numbers I compute for the EMTRs differ from the ones obtained by the GCEA (2001) due to several distinct differences in assumptions which affect the two computations. The GCEA (2001) takes into account tax depreciation and inflation and calculates EMTRs for different asset types such as machinery, buildings or financial assets. I just assume we have one type of investment good which is subject to economic depreciation. Additionally, the GCEA (2001) estimates use only one benchmark real interest rate. In *IFOmod,* the explicit modelling of a

27 per cent for corporate and non-corporate firms, respectively, in *Scenario 2*. Perhaps the most relevant measure in this context is the investment wedge, since it is the tax on company profits which distorts investment decisions (see Section 4.2.2 of Chapter 4). Accordingly, the investment wedge decreases from 31.8 to 24 per cent for corporate firms and from 31 to 23.7 per cent for non-corporate firms in *Scenario 1*. In *Scenario 2* the decline is even larger, namely to 24.8 and 21.7 for corporate and non-corporate firms, respectively.

The resulting decrease in the cost of capital and in the investment wedge increases the capital stock from its initial value by 13.6 per cent for the whole economy in *Scenario 1* (see Table 5.10). It increases by more, namely by around 18 per cent, in the non-corporate sector compared to 11.2 in the corporate sector since in the former sector the tax reform leads to a larger reduction in the cost of capital and in the investment wedge. As also shown in Table 5.8, in the second scenario the capital stock increases by 9 per cent in the corporate sector and by around 14 per cent in the non-corporate sector. Given the fact that capital and labor are complements in the production process, the demand for labor also rises in both sectors in *Scenarios* 1 and 2. The above mentioned effects lead to an increase in GDP by 7.7 and 6.4 per cent in the two scenarios, respectively (see Table 5.10). Similar results are also produced by the simulation model of Fehr and Wiegard (2004).

Concerning *Scenario 3*, the reduced corporate and top marginal income tax rate favor investment in physical capital, whereas the increased capital gains tax of 15 per cent negatively affects the cost of capital and thus investment. This occurs because I assume investment to be financed at the margin via retained earnings and the latter tax negatively influences the cost of capital and raises the cost of equity finance but only for corporate firms since non-corporate firms can not draw on retentions to finance investments. Therefore, in this Scenario the capital gains tax will just negatively affect the cost of capital of corporate firms while non-corporate firms will benefit from the reduced personal income tax. Thus, the cost of capital increases by 2.2 per cent for corporate and decreases by 11 per cent for non-corporate firms (Table 5.8). Accordingly, capital will move from the corporate to the non-corporate sector as it can be more productively employed in the latter. The overall increase in the capital stock will amount to only 5.5 per cent in this case (see Table 5.10).

portfolio consisting of different assets which yield different rates of return gives a different benchmark interest rate as a combination of the retruns on firm equity and firm bonds.

Table 5.8. Anticipated Effects of the Reform Package

	Scenario 1		*Scenario 2*		*Scenario 3*	
	C-Firm	NC-Firm	C-Firm	NC-Firm	C-Firm	NC-Firm
Pre Reform Cost of Capital	10.6	9.9	10.6	9.9	10.6	9.9
Post Reform Cost of Capital	9.4	8.6	9.6	8.9	10.8	8.8
Change in %	-11.6	-13.5	-9	-10.6	2.2	-11
Long Run Change in %						
Capital Stock	11.2	17.7	9.0	14.3	-14.5	41.4
Labor Demand	2.2	7.5	2.1	6.5	-14.3	34.2
Marginal Effective Tax Rate	-26.9	-27.3	-21.3	-27.0	0.4	-27.1
Investment Wedge	-24.0	-23.4	-22.1	-29.7	-21.1	-52.1
Retained Earnings	-0.2	-	-0.9	-	0.2	-
Debt Asset Ratio	0.3	0.5	1.5	1.3	-0.3	1.1

Notes: Retentions are only available as a source of finance for corporate firms.
Source: Own calculations.

We start each simulation scenario from a calibrated equilibrium, where on the one hand, corporate firms finance 39 per cent of net investments via retained earnings, 36 per cent via debt and 5 per cent via new share issues. On the other hand, non-corporate firms finance 54 per cent of net investments via debt and 36 per cent via new share issues. These figures are computed using data of the German Central Bank (2004b) and of the DAI (2003) as mentioned above. In all scenarios, the shares of the different sources of finance do not change much. There is only a slight increase in the debt asset ratio in almost all cases. The reduction of the profit tax rate negatively affects debt as a source of finance, whereas the reduction in the interest tax rate increases the preference for debt finance since the net interest rate increases. This outcome occurs if we assume a high degree of substitutability between assets. Nevertheless, the overall calibrated financial decision of firms does not change much.

Table 5.9 depicts the cost of capital and effective marginal tax rates if new investments were financed solely by retained earnings, by new debt or by new share issues. I introduce these separate results to interpret and assess the impact of each particular tax rate change and of the overall reform more thoroughly. As expected, the cost of capital and EMTRs for investments financed by debt are the lowest. The reform alternatives lead to a visible reduction in the cost of capital of investments financed by new share issues thus making the capital costs of the different sources of finance more similar, although their levels remain the highest regardless of scenario type. Because non-corporate firms finance around 36 per cent of new investments via external equity, they will be the largest beneficiaries of these reforms.

For an investment financed by retained earnings, the EMTR is reduced in *Scenarios* 1 and 2 to 30 per cent and it rises to 40.5 per cent in *Scenario* 3. This increase is attributed to introducing an effective capital gains tax of

Table 5.9. The Cost of Capital and Marginal Effective Tax Rates

	Scenario 1		*Scenario 2*		*Scenario 3*	
	C-Firm	NC-Firm	C-Firm	NC-Firm	C-Firm	NC-Firm
Retained Earnings						
Cap. Cost before the reform	13.0	-	13.0	-	13.0	-
Cap. Cost after the reform	11.8	-	11.3	-	13.4	-
Change in %	-9.2	-	-13.2	-	3.0	-
EMTR before the reform	38.3	-	38.3	-	38.3	-
EMTR after the reform	30.0	-	30.0	-	40.5	-
Change in %	-21.7	-	-21.7	-	5.7	-
Debt						
Cap. Cost before the reform	5.8	5.8	5.8	5.8	5.8	5.8
Cap. Cost after the reform	5.0	5.1	6.1	6.1	5.8	6.0
Change in %	-13.2	-12.8	5.4	5.4	1.6	2.7
EMTR before the reform	18.9	19.1	18.9	19.1	18.9	19.1
EMTR after the reform	9.3	9.9	13.7	13.9	11.6	13.4
Change in %	-50.8	-47.9	-27.9	-27.3	-38.6	-30.0
New Share Issues						
Cap. Cost before the reform	16.7	14.7	16.7	14.7	16.7	14.7
Cap. Cost after the reform	11.8	12.7	16.1	12.1	16.1	12.1
Change in %	-29.3	-13.4	-3.5	-17.3	-3.5	-17.3
EMTR before the reform	52.0	45.4	52.0	45.4	52.0	45.4
EMTR after the reform	30.0	35.0	51.0	35.0	51.0	35.0
Change in %	-42.3	-22.9	-1.9	-22.9	-1.9	-22.9

Note: Retained earnings are available as a source of finance just for corporate firms.
Source : Own calculations.

15 per cent. The cost of capital for an investment financed by debt decreases in *Scenario* 1 but increases slightly in *Scenarios* 2 and 3. In these last two scenarios, in spite of a decline in the interest tax, the introduction of dividend and capital gains taxes raise the investor's required gross returns on firm equity. As we assume a high degree of substitution between assets, the gross return on firm debt also rises, thus negatively influencing the cost of investments financed by debt. In case an investment is financed by new share issues, the cost of capital and the marginal effective tax rates decrease in all scenarios for both corporate and non-corporate firms.

Table 5.10 provides an overview of further important long-run changes of the key economic figures on the household side. The table displays an increase in domestic assets such as firm equity as well as government and firm bonds. This is mainly a result of applying a lower post-reform tax rate on interest income combined with the residence principle of taxation. The evident reduction in this tax rate leads to higher net-of-tax asset returns. As a consequence, households' demand for domestic assets grows. The highest

increase is recorded in *Scenario 1,* where no dividend or capital gains taxes apply.

Table 5.10. Key Economic Figures (Long Run Change in %)

	Scenario 1	*Scenario 2*	*Scenario 3*
GDP	7.7	6.4	3.3
Capital Stock	13.6	10.9	5.5
Domestic Owned Assets	28.0	9.7	10.0
Firm Equity	35.1	7.5	9.3
Domestic Demand for Firm Bonds	28.0	18.2	17.3
Foreign Demand for Dom. Firm Bonds	-11.3	2.7	0.4
Dom. Demand for Dom. Govt. Bonds	12.1	7.7	4.9
Foreign Demand for Dom. Govt. Bonds	-20.1	-1.8	-6.6
Dom. Demand for For. Govt. Bonds	25.8	7.8	8.6
Gross Wage	4.5	3.5	0.9
Current Real Wage	11.2	10.1	7.3
Labor Supply	4.0	3.6	2.7
Disposable Income	1.1	3.7	0.1
Transfers	-52.6	-15.2	-28.3
Domestic Consumption	8.8	6.5	3.6
Welfare in % of Life Time Income	2.0	1.8	1.0
Welfare in % of GDP	1.1	1.0	0.6

Source: Own calculations.

Whereas the demand for domestic assets rises, the demand for foreign assets declines, as the investor reallocates the assets in his portfolio. In *Scenario 2*, the additional introduction of a higher dividend tax causes a lower increase in the demand for firm equity.

On the household level, the reform is characterized by a major reduction in personal income tax rates. The top marginal income tax rate amounts to 45.4 per cent before and to 35 per cent after the reform. For an average individual the marginal tax rate drops from 29.4 to 25 per cent. This tax relief has a major impact on the labor-leisure decision, and households are likely to supply a larger amount of labor to the business sector. Quantifying this effect, the reduction in the labor tax leads to a rise in current real wages[7] of between 7 and 11 per cent in the respective scenarios. In turn, households increase their labor supply by 4.0, 3.6 and 2.7 per cent in *Scenarios 1* to *3*. Due to the reduction in the labor income tax rate and the increase in wages, disposable income rises, resulting in increased consumption (see Table 5.10). Given the fact that I opted for an adjustment in transfers to make the reform revenue neutral, these transfers have to be drastically reduced

[7] The current real wage is defined as $\frac{(1-\tau^L)}{(1+\tau^C)} w_t$ and is thus a function of the gross wage, the labour income and the VAT rate.

to finance the government budget. The lowest decrease by just around 15 per cent is necessary in *Scenario 2* . In this scenario, the government can draw on additional tax revenue from the increased dividend taxes that are a non-distorting revenue raising instrument. The increase in the dividend tax has however only minor negative effects on the accumulation of capital. This reflects the 'New View' of dividend taxation according to which the dividend tax does not influence the investment decision. The higher dividend tax mainly affects savings since the net return on equity from the investor's point of view is lowered. On firm level the tax is capitalized in lower firm values. Nevertheless, the most important yardstick for evaluating these tax reform scenarios is the change in welfare. Accordingly, welfare in terms of life-time income grows by 2.0, 1.8 and 1.0 per cent in *Scenarios 1* to *3*. Expressed in terms of GDP, these reform proposals also lead to an increase in welfare by 1.1, 1.0 and 0.6 per cent, respectively. The lowest increase in welfare in Scenario 3 is mainly the result of the high capital gains taxes, which lead to a weaker increase in disposable income and consumption.

Financing the Reform via an Increase in the VAT Rate

The second alternative to finance this reform is an increase in the VAT. This policy alternative has, however, distorting effects on labor supply since an increased VAT lowers current real wages. Therefore, the effects of the reform proposal will turn out to be rather smaller than in the former case with adjusted lump-sum transfers.

Accordingly, the following tables summarize the effects on the cost of capital, EMTRs and main macroeconomic aggregates of the tax reform when an endogenous increase in the VAT is allowed for.

Overall, one can first notice that the reform proposals with VAT rate adjustment have positive effects whose extent is smaller, however, than those of the previous simulations. The reduction in the cost of capital and the EMTRs remains the same since these indicators are not influenced by the way the reform is financed. The same applies to the way investments are financed since the preference for debt or equity finance is not altered by the VAT rate change. Table 5.11 illustrates the effects of the reform for corporate and non-corporate firms in *Scenarios 1* to *3*.

Table 5.11. Anticipated Effects of the Reform Package (Long Run Change in %)

	Scenario 1		*Scenario 2*		*Scenario 3*	
	C-Firm	NC-Firm	C-Firm	NC-Firm	C-Firm	NC-Firm
Capital Stock	9.3	16.0	8.4	13.8	-15.4	40.2
Labor Demand	0.1	5.6	1.5	5.9	- 15.4	32.9
Cost of Capital	-11.6	-13.5	- 9	-10.6	2.2	- 11.0
EMTR	- 26.9	-27.3	- 21.3	-27	0.4	-27.1
Investment Wedge	-24.0	-23.4	-22.1	-29.7	-21.1	-52.1
Retained Earnings	-0.2	-	-0.9	-	0.2	-
Debt Asset Ratio	0.3	0.5	1.4	1.3	- 0.3	1.1

Source: Own calculations.

Similar to the previous cases, *Scenario 1* leads to the highest increase in the capital stock, GDP and other key economic variables (see Table 5.12). Thus, GDP increases to around six per cent in *Scenario 1* and *2,* and to 2.3 per cent in *Scenario 3*, thus between one and two percentage points less than if the reform were financed via a reduction in transfers (see Table 5.10). The overall capital stock rises by around 12 per cent in *Scenario 1* and by 4.5 per cent in the last scenario. Domestically owned assets grow, almost as much as in the previous case, namely by 25.7 per cent in *Scenario 1* and by around nine per cent in *Scenarios 2* and *3*.

Table 5.12. Key Economic Figures (Long Run Change in %)

	Scenario 1	*Scenario 2*	*Scenario 3*
GDP	5.9	5.8	2.3
Capital Stock	11.7	10.4	4.5
Domestic Owned Assets	25.7	9.1	8.7
Firm Equity	32.6	6.9	8.1
Domestic Demand for Firm Bonds	25.4	17.4	15.8
Foreign Demand for Dom. Firm Bonds	-11.7	2.5	0.2
Dom. Demand for Dom. Govt. Bonds	10.0	7.1	3.7
Foreign Demand for Dom. Govt. Bonds	-20.2	-1.9	-6.6
Dom. Demand for For. Govt. Bonds	23.9	7.3	6.6
Gross Wage	4.8	3.5	1.0
Labor Supply	2.0	3.0	1.5
Disposable Income	7.9	5.7	3.8
Domestic Consumption	6.4	5.8	2.2
Increase in VAT Rate (%-points)	6.5	2.0	3.8
Welfare in % of Life Time Income	0.8	1.4	0.4
Welfare in % of GDP	0.4	0.8	0.2

Source: Own calculations.

Furthermore, an increase in welfare in terms of life-time income by 0.8 and 0.4 per cent is achieved in *Scenarios 1* and 3 respectively and by 1.4 per cent in

Scenario 2. The highest welfare improvement in *Scenario 2* can be explained by the fact that in this case the VAT rate increase by only two percentage points appears to be sufficient to safeguard the revenue neutrality because the government can also draw on the additional dividend tax revenue. This reflects once again the fact that we assume the 'New View' of dividend taxation holds such that the dividend tax has a non-distorting effect on investments. The lower increase in the VAT rate needed has a positive impact on disposable income and therefore welfare. Moreover, Table 5.12 illustrates the endogenous increase in the VAT rate required to ensure that the government budget is balanced. Simulating *Scenario 1*, the VAT increases by 6.5 percentage points from initially 16 per cent to 22.5 per cent assuring that the reform is revenue neutral. As the government can draw on additional tax revenue from dividend taxation in *Scenario 2*, the required increase in the VAT rate amounts in this case to only two percentage points to 18.0 per cent, thus nearly 5 percentage points less than in the case of *Scenario 1*. In *Scenario 3*, the VAT rate increase to a level of 19.8 per cent is necessary because the additional revenue from capital gains taxes is not sufficient to balance the government budget. The fact that the needed tax revenue to finance the reform is that high has two explanations. First, the tax base of the capital gains is very narrow and second the tax impedes investments to a large extent. Accordingly, the accumulation of capital and the growth of GDP are hindered such that the tax revenue from other main taxes also declines. Thus, the higher increase in the VAT of 3.8 per cent has negative repercussions on the labor supply decision leading to a lower tax base for the labor and consumption tax.

5.3.3 Transition Paths

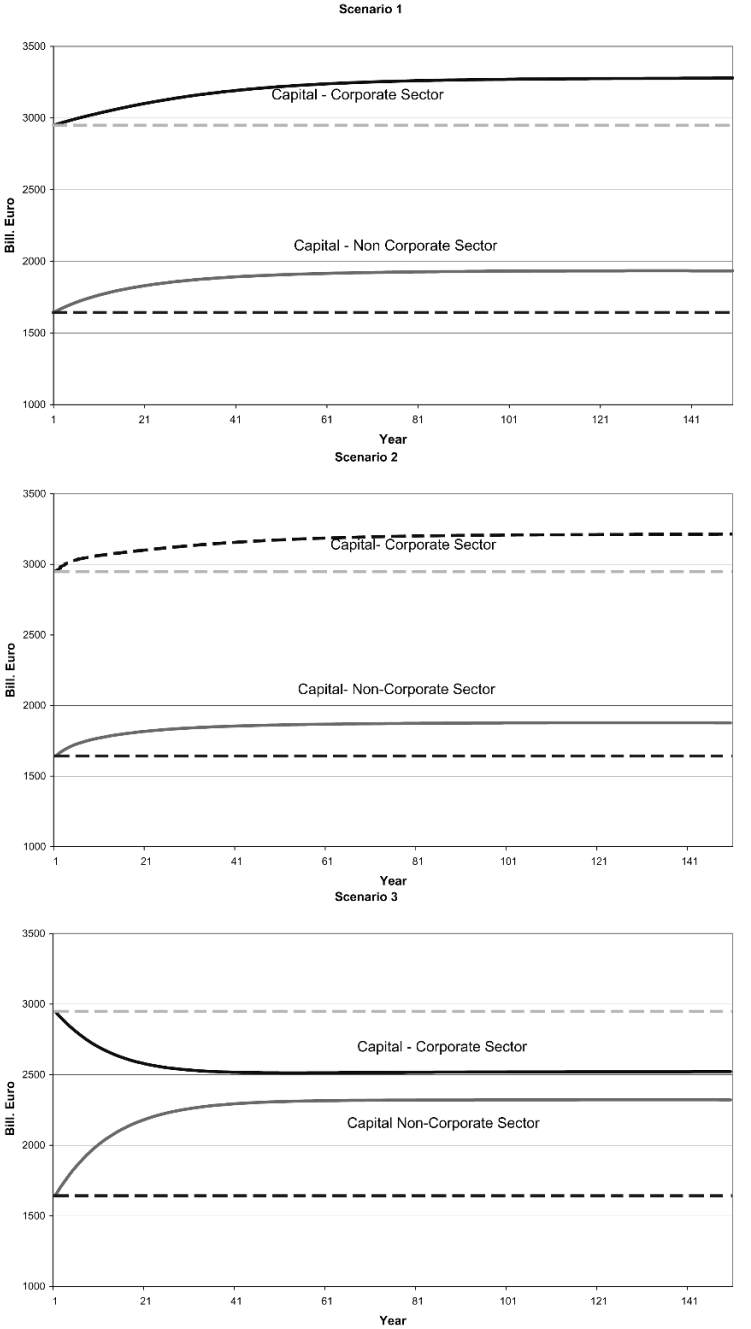
After having discussed the steady state effects of introducing the DIT in the above paragraphs, the present subsection presents the transition paths of the main macroeconomic variables in *Scenarios 1* to *3*.[8]

Fig. 5.3 and 5.4 depict the transition from the initial to the final steady state of corporate and non-corporate capital and labor demand in all three Scenarios (The dashed lines always show the evolution of the capital stock and labor demand without any shocks). Whereas *Scenarios 1* and *2* lead to an increase in the capital stock and labor demand, *Scenario 3* brings about a reduction in the capital stock and a declining demand for labor in the corporate sector. This can be attributed to the introduction of an effective 15 per cent capital gains tax that raises the corporate sector's cost of capital and thus leads to decreasing investment and further macroeconomic chain effects.

Since in *Scenario 3* the increased capital gains tax does not influence the cost of capital of non-corporate firms, which accordingly just benefit from the reduced personal income tax rate, labor demand and the capital stock will

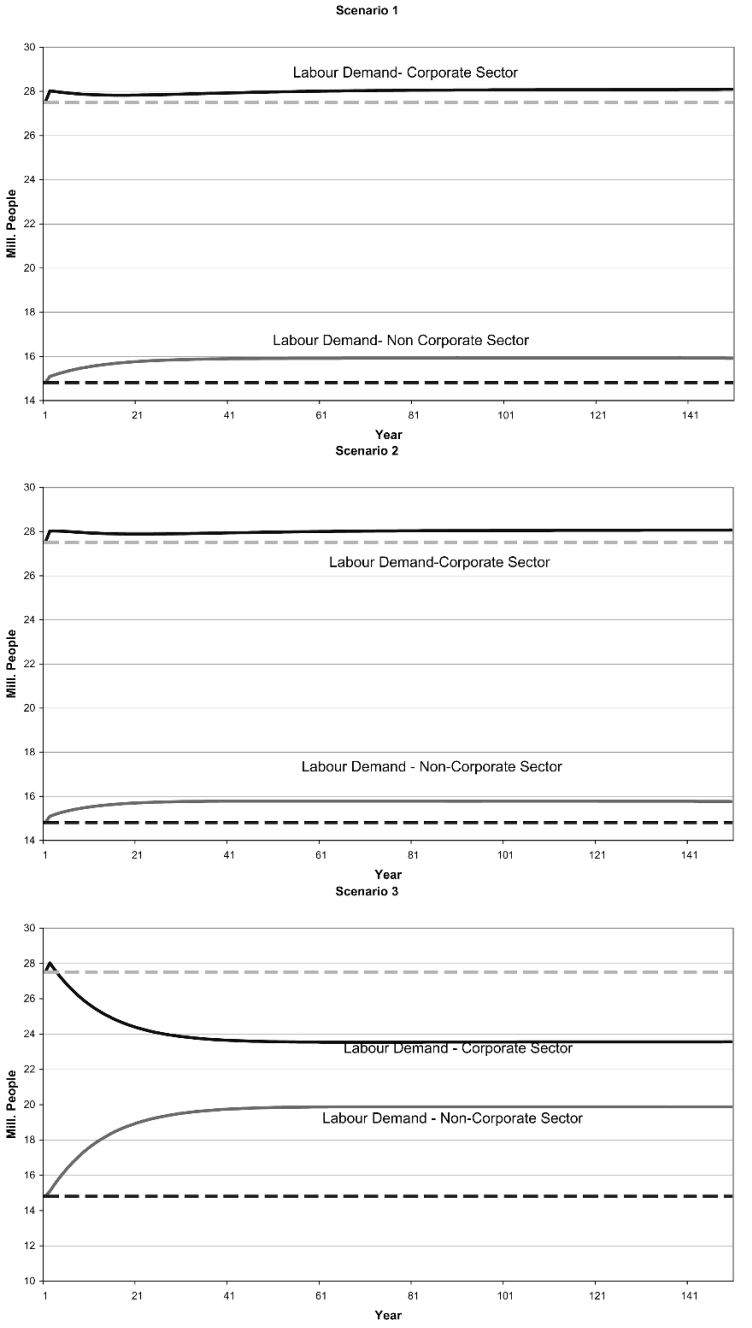
[8] The simulations are performed assuming the reform is financed by a reduction in public transfers.

Fig. 5.3. Transition Path of the Capital Stock in *Scenarios 1* to *3*



Source: Own calculations.

Fig. 5.4. Transition Path of Labor Demand in *Scenarios 1* to *3*

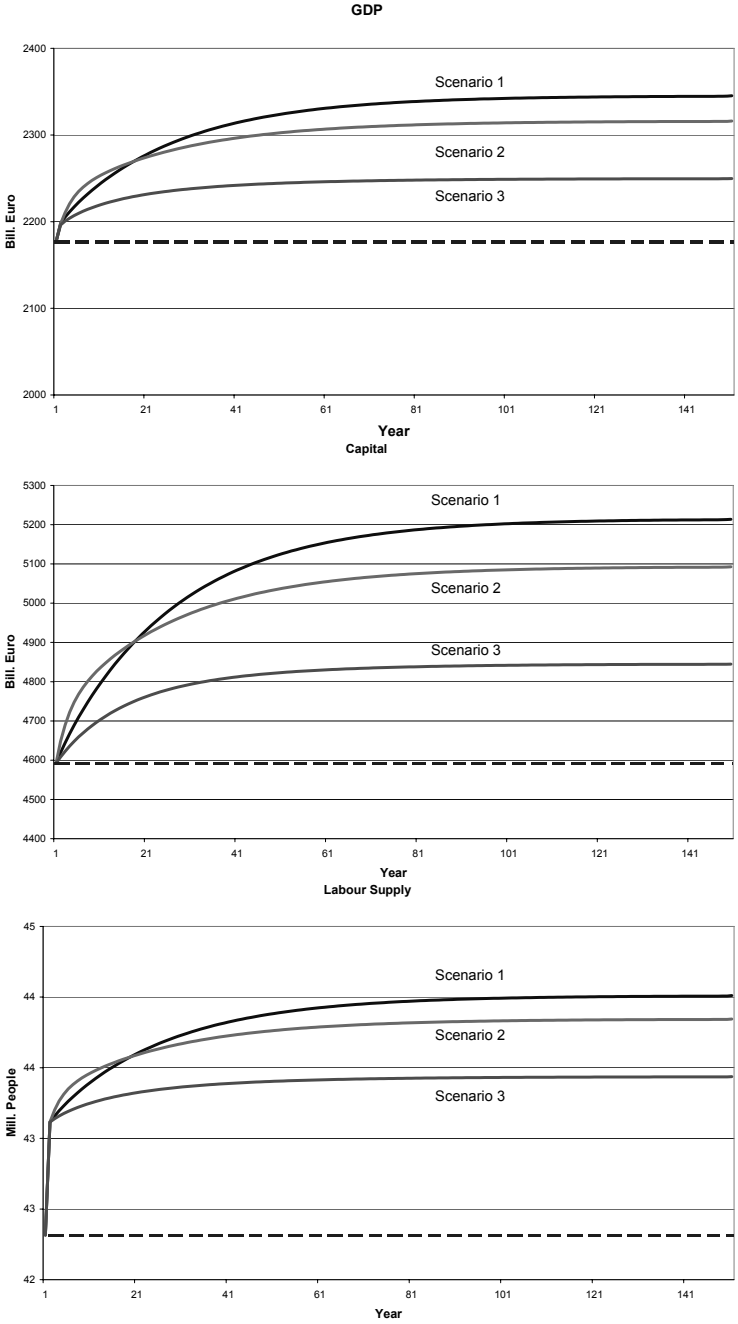


Source: Own calculations.

increase in this sector. In all cases, the new steady state level is achieved after around 40 years.

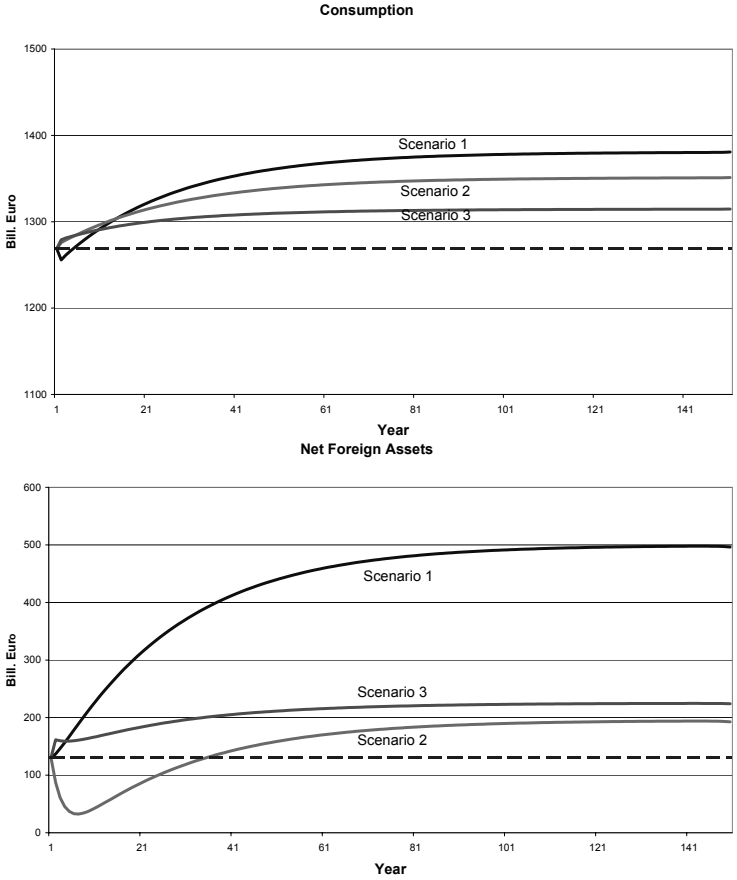
Fig. 5.5 and 5.6 show the transition paths of several macroeconomic variables under the three different scenarios (once again the dashed lines represent the initial steady state value of the variable under consideration). Again, as shown also by the steady state comparison, the reform *Scenario 1* achieves the highest path of GDP, capital accumulation, labor supply, consumption and net foreign assets. Nevertheless, all three Scenarios deliver a positive picture in the long-run as shown in Fig. 5.5 and 5.6. The positive change in the net foreign asset position in *Scenario 3* is among others due to the increased domestic demand for foreign government bonds and to the reduced demand for domestic government bonds on the part of foreign households (see Table 5.10). Under *Scenario 2*, just introducing the dividend tax does not discourage foreign investors from buying domestic firm bonds, since they increase their demand by 2.7 per cent such that the net foreign asset position is lower than in *Scenario 3*. In *Scenario 1* we have a visible increase in the domestic demand for foreign government bonds and a decrease in the foreign demand for domestic firm bonds. The first effect is a result of the reduced interest tax rate which enhances the attractiveness of foreign assets as well, since the residence principle of taxation applies. The latter effect is a result of combining the increased domestic demand for firm bonds with the fact that in a general equilibrium model the quantity of assets provided is bound by the production side of the economy. Thus, we cannot have an infinite increase in the demand for assets in this model framework, and the increase in the domestic demand for these assets has to be balanced by a decrease in the foreign demand for domestic firm bonds.

Fig. 5.5. The Transition Path of GDP, Capital and Labor Supply



Source: Own calculations.

Fig. 5.6. The Transition Path of Consumption and Net Foreign Assets

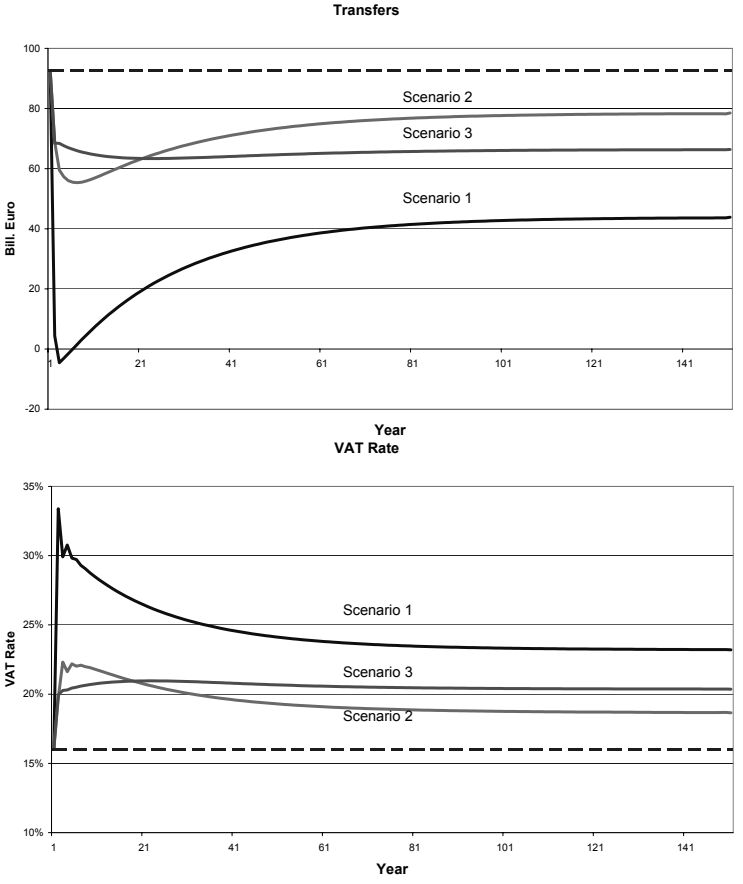


Source: Own calculations.

To finance the reform proposal, the government can resort either to reduced transfers or to an increased VAT to balance its budget. The smallest reduction in transfers necessary to finance the reform occurs under *Scenario 2* as shown in Fig. 5.7. This outcome has to be attributed to the increased tax revenue from dividend taxation. Since we adopt the 'New View' of dividend taxation, the dividend tax does not distort the investment decision and is an adequate revenue raising instrument. This line of argument also applies to the required VAT rate necessary to balance the budget. Therefore, again in *Scenario 2*, the required increase in the VAT rate is the lowest. *Scenario 1* is in both cases the most 'expensive' scenario requiring either the largest reduction in transfers or the highest rise in the VAT rate to balance the government budget. Under both alternative reforms, the government fiscal policy measures record either an initial fall - in the case of transfers - or an initial

jump - in the case of the VAT. Afterwards, the positive effects of the reform become apparent and the tax base of the other tax rates is broader, accordingly leading to increasing tax revenues. The gap in the government budget shrinks gradually, and a minor adjustment of transfers or the VAT rate is sufficient thereafter.

Fig. 5.7. The Transition Path of Transfers and VAT Rate



Source: Own calculations.

5.4 Implementing a DIT as Suggested by Sinn (2003a)

The second reform alternative was advanced by Sinn (2003a). This proposal does not implement a 'pure' DIT since it additionally features an allowance for corporate and non-corporate equity (ACNE). The ACNE provides for deducting an imputed rate of return from the profit tax base. Moreover, this imputed return is equal to the long-term interest rate on government treasury bills and subject to a flat interest rate of 20 per cent.[9]

Table 5.13. Tax Rates Before and After the Reform

	Status Quo (2004)	Sinn (2003a)
Profit Tax, $\tau^{P,C}/\tau^{P,NC}$	0.383/0.454	0.35/0.35
Labor Tax, τ^{L}	0.295	0.25
Tax on Interest Income, τ^{i}	0.443	0.20
Dividend Tax, τ^{D}	0.221	0.175
Capital Gains Tax, τ^{G}	0.00	0.00
Tax on the Imputed Return, τ^{I}	0.00	0.20
VAT, τ^{C}	0.16	endogenous

Source: German Ministry of Finance (2004c), Sinn (2003a)

In the same way as in Section 5.3.1, I will first show the effects of introducing an ACNE alone. The other tax rate variations generate similar effects as under the GCEA (2003) proposal, since the regime change is again characterized by a reduction in the profit, labor, interest and dividend taxes (see Table 5.13). The long-run steady state effects of applying an ACNE are computed assuming that the reform is financed by a decrease in governmental transfers. From Tables 5.14 and 5.15 we can see that ceteris paribus just allowing for this single change in the tax system induces large positive effects on the accumulation of capital, domestic consumption and welfare. This is mainly the consequence of narrowing the tax base for profits which leads to a reduction in the cost of capital by 9.2 per cent for corporate firms and by 8.5 per cent for non-corporate firms (see Table 5.13). Hence, the capital stock increases by eight per cent for the whole economy, the value of firms increases and accordingly the value of households' assets. Since disposable income and consumption rise, welfare increases by 0.7 per cent in terms of life-time income.

Therefore, just allowing for the deduction of an imputed return on equity brings about remarkable positive effects for the economy.

[9] An additional feature of the Sinn (2003a) proposal is the provision to deduct debt interest against the interest tax and not against the corporate tax. This approach is however not modelled here since we lack empirical estimates on how the debt asset ratio changes as a function of interest taxation. To calibrate the debt asset ratio I use an empirical estimate of the elasticity of the debt level with regard to changes in the corporate tax.

Table 5.14. Anticipated Effects of the ACNE

	C-Firm	N-Firm
Cost of Capital	9.6	9.1
EMTR	28.5	30.1
Long Run Change in %		
Capital Stock	9.4	5.5
Labor Demand	2.5	-1.0
Cost of Capital	-9.2	-8.5
EMTR	- 20.0	-18.8
Debt Asset Ratio	1.7	1.3

Source: Own calculations.

Table 5.15. Key Economic Figures (Long Run Change in %)

GDP	4.0
Capital Stock	8.0
Domestic Owned Assets	7.0
Firm Equity	6.5
Domestic Demand for Firm Bonds	10.6
Foreign Demand for Dom. Firm Bonds	6.5
Dom. Demand for Dom. Govt. Bonds	5.1
Foreign Demand for Dom. Govt. Bonds	-2.4
Dom. Demand for For. Govt. Bonds	6.0
Gross Wage	3.4
Labor Supply	1.3
Disposable Income	1.7
Transfers	-12.5
Domestic Consumption	3.3
Welfare in % of Life Time Income	0.7
Welfare in % of GDP	0.4

Source: Own calculations.

5.4.1 Steady State Comparisons

Financing the Reform via a Reduction in Transfers

Simulating this second large reform package, I will again perform two main simulations: The first allows for a change in government transfers to balance the government budget and the second computes an endogenous increase in the VAT which is necessary to finance the reform.

Tables 5.16 to 5.18 provide an overview of the long-run steady state effects of the reform. The reduction in tax rates accompanied by the introduction of an ACNE leads to a considerable decline in the cost of capital, the investment wedge and effective marginal tax rates: The cost of capital declines from 10.6 per cent for corporate firms and from 9.9 per cent for non-corporate ones to 9.2 and 8.1 per cent, respectively. The investment wedge even declines by 29.5

and 45.4 per cent for the two types of firms (see Table 5.16). This decrease along with the reduced interest taxation causes an even larger decline in the EMTR from 35.5 and 37 per cent to 24.2 and 20.2 per cent for corporate and non-corporate firms, respectively. Thus, due to the more drastic tax relief following the reduction in the tax rate on non-corporate profits the sector of non-corporate firms benefits more leading to a higher capital accumulation within this sector compared to the corporate sector.

Table 5.16. Anticipated Effects of the Reform Package

	C-Firm	N-Firm
Pre Reform Capital Cost	10.6	9.9
Post Reform Capital Cost	9.2	8.1
Change in %	-13.0	-17.8
Long Run Change in %		
Capital Stock	8.6	29.5
Labor Demand	-1.5	15.2
Marginal Effective Tax Rate	-32.0	-45.6
Investment Wedge	- 29.5	-45.4
Retained Earnings	-0.8	-
Debt Asset Ratio	1.5	1.6

Note: Retained earnings are available as a source of finance just for C-firms
Source: Own calculations.

Table 5.17 depicts the changes in the cost of capital and EMTRs assuming that an investment is financed at the margin either by retained earnings, new debt or new share issues. In each case the reform leads to a reduction in the cost of capital and EMTR's with the most drastic decline in EMTRs occurring in the case of debt finance. Nevertheless, corporations benefit from the reduction in the cost of investments financed by retained earnings, as they finance 59 per cent of new investments via internal equity. This is basically the result of the reduced profit tax rate. In addition, investments by non-corporate firms, which are financed either by new debt or new share issues, become cheaper as a consequence of the decrease in personal income taxes which lead to reduced capital costs .

Table 5.17. The Cost of Capital and Marginal Effective Tax Rates

	C-Firm	N-Firm
Retained Earnings		
Cap. Cost before the reform	13.0	-
Cap. Cost after the reform	11.5	-
Change in %	-11.6	-
EMTR before the reform	38.3	-
EMTR after the reform	30.5	-
Change in %	-20.3	-
Debt		
Cap. Cost before the reform	5.82	5.83
Cap. Cost after the reform	5.7	5.75
Change in %	-1.8	-1.3
EMTR before the reform	19.0	19.0
EMTR after the reform	7.7	8.4
Change in %	-59.2	-56.1
New Share Issues		
Cap. Cost before the reform	16.7	14.7
Cap. Cost after the reform	14.1	11.7
Change in %	-15.6	-20.2
EMTR before the reform	52.0	45.4
EMTR after the reform	43.4	31.9
Change in %	-16.6	-29.8

Note: Retained earnings are available as a source of finance just for C-firms
Source: Own calculations.

The decrease in the cost of capital leads to an increase in the economy's capital stock by around 16 per cent as shown in Table 5.18. Due to the reduction in the profit and the dividend tax rates, firm equity becomes more attractive for households' investment portfolio. Moreover, since I apply the residence principle of taxation, all assets benefit from the decrease in the tax rate on interest income, and thus the domestic demand for different assets

rises. Accordingly, domestic demand for firm bonds increases by almost 31 per cent and for domestic government bonds by 11.8 per cent (see Table 5.18). In contrast, given the fact that the overall value of assets is bound by the production side of the economy, we cannot have an infinite increase in the demand for assets. Thus, the foreign demand for domestic firm and government bonds will decrease. Since capital and labor are complementary in the production process, the demand for labor will also rise and thus wages will increase. As a result, households will supply more labor and, given the reduction in labor taxes which increase the current real wage, their disposable income and consumption rise. Consequently, as shown in Table 5.18, the reform leads to an increase in welfare by 2.3 per cent in terms of life-time income and 1.4 per cent in terms of GDP .

Table 5.18. Key Economic Figures (Long Run Change in %)

GDP	8.8
Capital Stock	16.1
Domestic Owned Assets	20.9
Firm Equity	21.0
Domestic Demand for Firm Bonds	31.6
Foreign Demand for Dom. Firm Bonds	-3.0
Dom. Demand for Dom. Govt. Bonds	11.8
Foreign Demand for Dom. Govt. Bonds	-10.0
Dom. Demand for For. Govt. Bonds	17.8
Gross Wage	5.5
Current Real Wage	12.2
Labor Supply	4.4
Disposable Income	4.8
Transfers	-22.9
Domestic Consumption	9.0
Welfare in % of Life Time Income	2.3
Welfare in % of GDP	1.4

Source: Own calculations.

Financing the Reform via an Increase in the VAT Rate

The present subsection describes the simulation results if the reform is financed by an increase in the VAT rate. The change in the cost of capital and EMTRs does not differ from the previous simulation since they are not affected by the way the reform is financed. Hence, the reform leads to an increase in the capital stock as well. The increase is more significant for the non-corporate sector because investments by non-corporate firms benefit more from the larger decline in the cost of capital (see above). Consequently, capital can be more productively employed in non-corporate firms. As shown in

Table 5.19, the firm's preference for a particular source of finance does not change much because the different tax rate changes benefit either debt or equity finance such that on average their effects will balance out.

Table 5.19. Anticipated Effects of the Reform Package (Long Run Change in %)

	C-Firm	N-Firm
Capital Stock	6.6	27.3
Labor Demand	-2.4	14.4
Cost of Capital	-13.0	-17.8
Marginal Effective Tax Rate	-32.0	-45.6
Investment Wedge	- 29.5	-45.4
Retained Earnings	-0.8	-
Debt Asset Ratio	1.2	1.5

Note: Retained earnings are available as a source of finance just for C-firms
Source: Own calculations.

Besides the decline in the cost of capital the reform also leads to an increase in wages. The increased wages generate a rise in disposable income, consumption and welfare (see Table 5.20). The demand for domestic assets rises and the reduction in different tax rates such as the profit and the dividend tax increases the value of households' assets and thus their total wealth.

Table 5.20. Key Economic Figures (Long Run Change in %)

GDP	8.0
Capital Stock	14.0
Domestic Owned Assets	16.8
Firm Equity	19.3
Domestic Demand for Firm Bonds	25.1
Foreign Demand for Dom. Firm Bonds	-3.1
Dom. Demand for Dom. Govt. Bonds	8.4
Foreign Demand for Dom. Govt. Bonds	-1.8
Dom. Demand for For. Govt. Bonds	8.4
Gross Wage	5.6
Current Real Wage	9.6
Labor Supply	3.5
Disposable Income	7.8
Domestic Consumption	8.0
Increase in VAT Rate (%-points)	4.0
Welfare in % of Life Time Income	1.2
Welfare in % of GDP	0.7

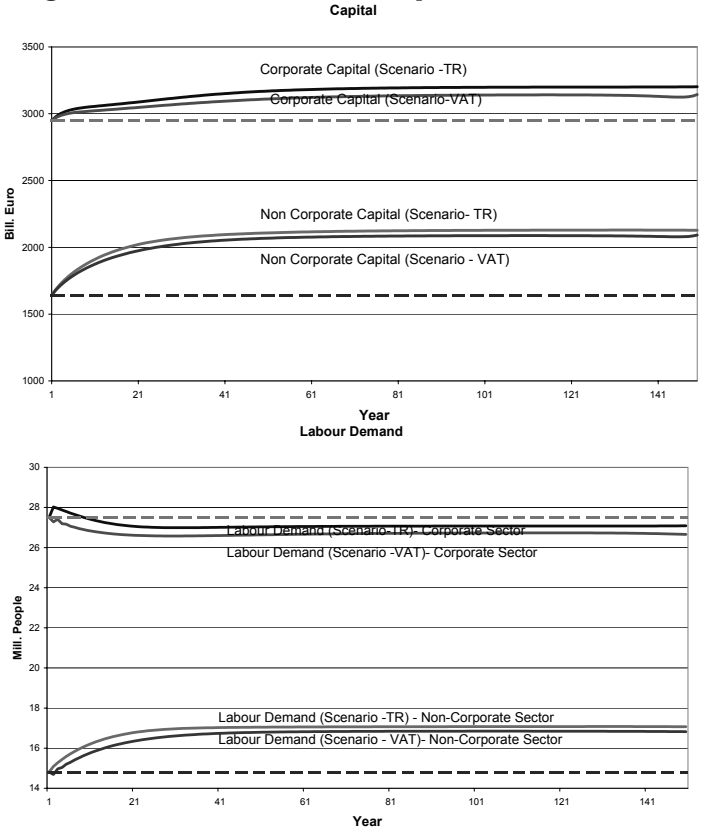
Source: Own calculations.

Under this scenario, however, the increase in welfare of 1.2 per cent in terms of life-time income turns out to be less than if the reform were financed by a decrease in transfers owing to the rise in the VAT rate from 16 to 20 per cent which negatively affects households' income.

5.4.2 Transition Paths

A consistent description of the overall impact of the reform requires an analysis of the transition paths of the main macroeconomic aggregates as well. Fig. 5.8 depicts the evolution of capital accumulation and the demand for labor in the two sectors under each of the two scenarios. If the reform is financed by an adjustment in transfers, the transition paths of capital and labor demand lie above those where it is assumed that the reform is financed by an endogenous increase in the VAT rate.

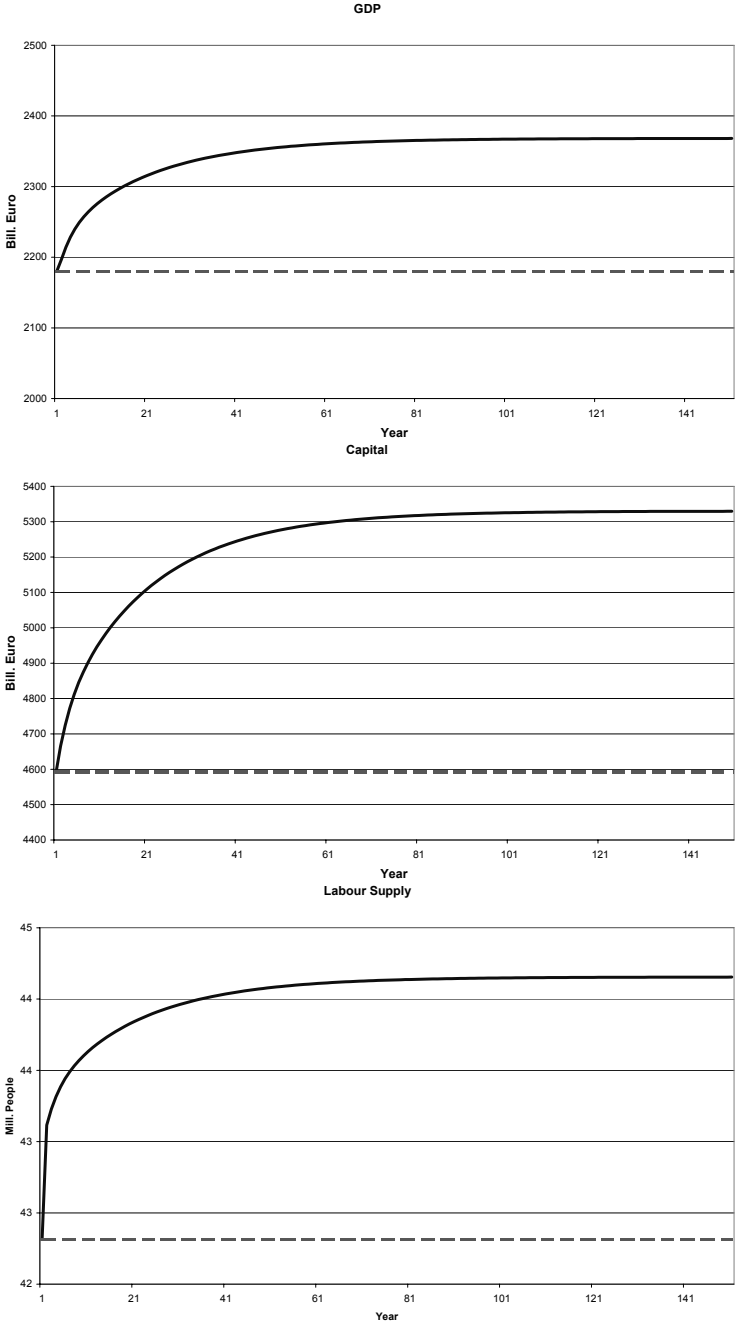
Fig. 5.8. The Transition Path of Capital and Labor Demand



Source: Own calculations.

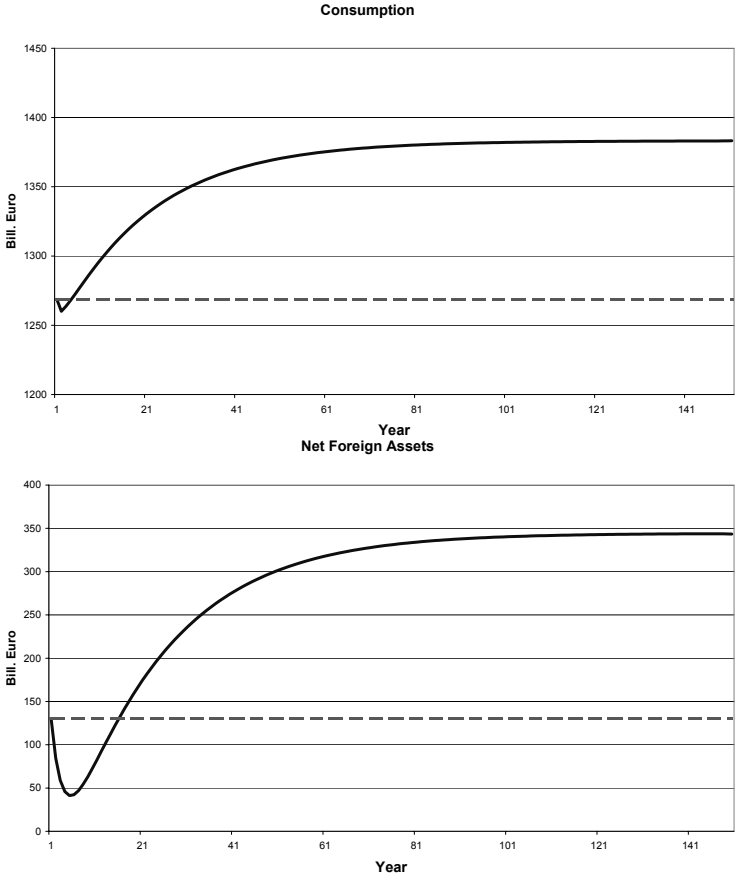
Fig. 5.9 and 5.10 depict the transition paths of GDP, capital, labor supply, consumption and net foreign assets for the first scenario. All graphs illustrate a constant growth of the mentioned aggregates until the new steady state level is achieved after approximately 80 years. Within this time period GDP increases from € 2180 bill. to € 2368 billion and labor supply from 42.3 to 44 million people. Consumption increases from € 1270 to € 1383 billion. The increase in net foreign assets is derived both from the increase in the domestic demand for foreign government bonds by 17.8 per cent (see Table 5.18) as well as from the reduced demand for domestic firm and government bonds on the part of foreign households. Thus, the net foreign asset position increases from € 130 to € 343 billion.

Fig. 5.9. The Transition Path of GDP, Capital and Labor Supply



Source: Own calculations.

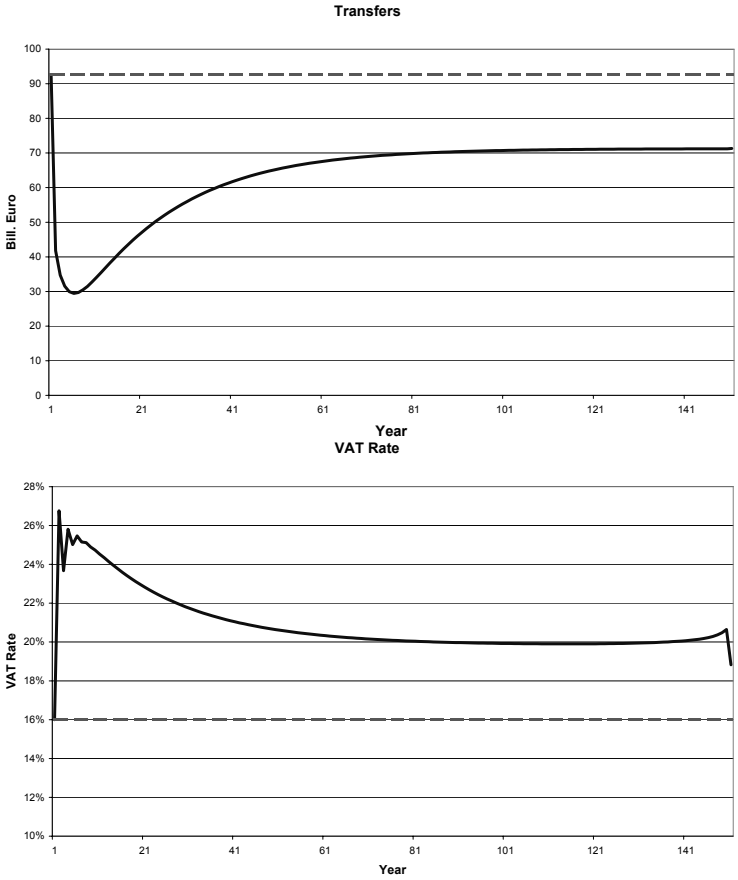
Fig. 5.10. The Transition Path of Consumption and Net Foreign Assets



Source: Own calculations.

Finally, Fig. 5.11 illustrates the adjustment in transfers and in the VAT rate necessary to finance the reform. At the beginning, both transfers and the VAT record a very large rise or drop - transfers instantaneously fall and the VAT rate jumps to around 27 per cent - until the economy has adjusted to the shock. At this time, the positive effects of the reform have led to a larger tax base of the other taxes thus diminishing the gap between government revenues and spending and requiring a smaller adjustment in transfers or in the VAT rate.

Fig. 5.11. The Transition Path of Transfers and VAT Rate



Source: Own calculations.

5.5 The Two Proposals Compared

The analyses made in the previous sections have suggested that both tax reform alternatives have positive overall macroeconomic effects, their magnitude depending on the way the different proposals are financed. Table 5.21 compares the long-run steady state effects on the cost of capital and welfare of both alternatives. The first columns of Table 5.21 illustrate the effects of *Scenario 1* of the GCEA (2003) proposal in which no dividend or capital gains taxes apply. I choose this alternative from the three GCEA scenarios because it is the original GCEA proposal and it delivers the best results for most key economic variables.

Both reform alternatives lead to a reduction in the cost of capital. However, the second proposal is more substantial in this regard. Welfare in terms of

Table 5.21. The Cost of Capital and the Change in Welfare Resulting From Implementing the Two Reform Alternatives

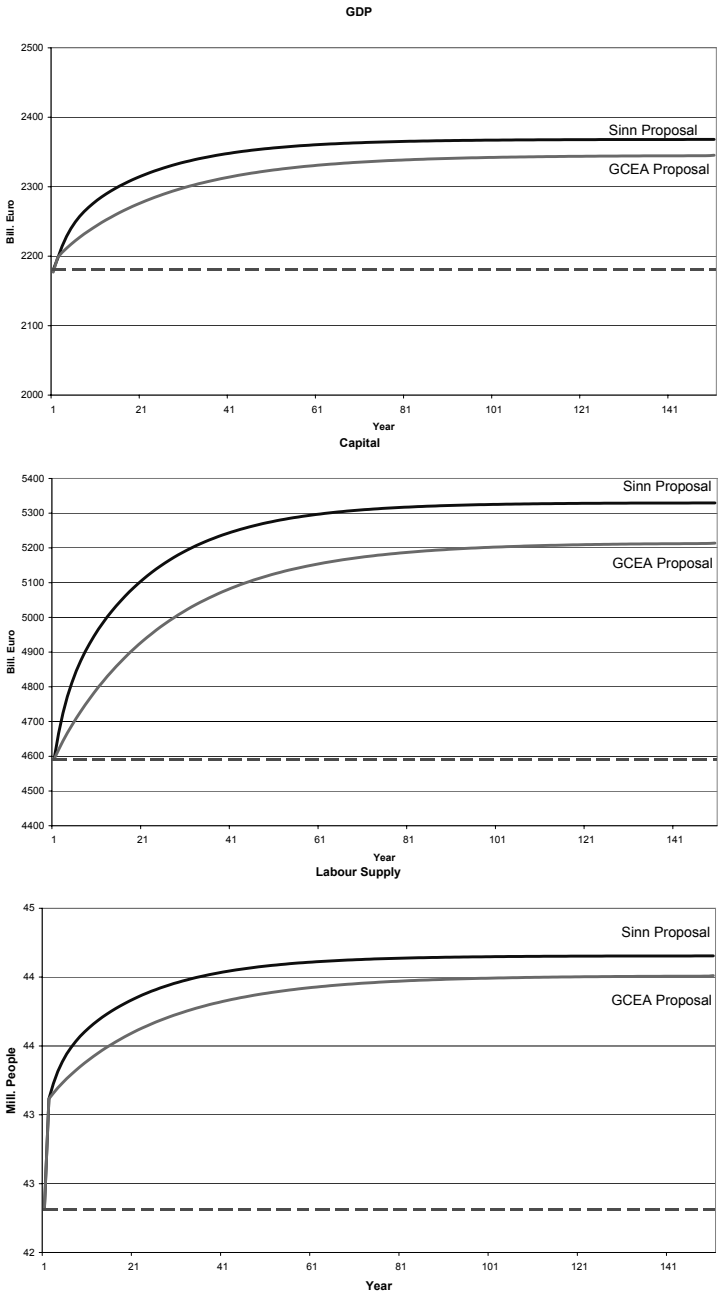
	GCEA		Sinn	
	C-firm	NC-firm	C-firm	NC-firm
Post Reform Cost of Capital	9.4	8.6	9.2	8.1
Welfare in % of life-time income (Scenario with reduction in transfers)	2.0		2.3	
Welfare in % of life-time income (Scenario with increase in VAT)	0.8		1.2	

Source: Own calculations

life-time income increases by 2.0 and 2.3 per cent, respectively, if the reform is financed by a reduction in transfers and by 0.8 and 1.2 per cent if the government budget is balanced by an increase in the VAT rate. Accordingly, the Sinn (2003a) reform proposal achieves better welfare improving results. However, if one compares the GCEA *Scenario 2,* which achieves an increase in welfare of 1.4 per cent of life-time income if the second reform financing method is adopted, with the Sinn reform proposal, the former achieves the best result. This effect owes to the fact that under the GCEA *Scenario 2* a long-run increase in the VAT rate of only two percentage points is sufficient to balance the government budget, compared to a four percentage point rise in the VAT rate in Sinn's scenario.

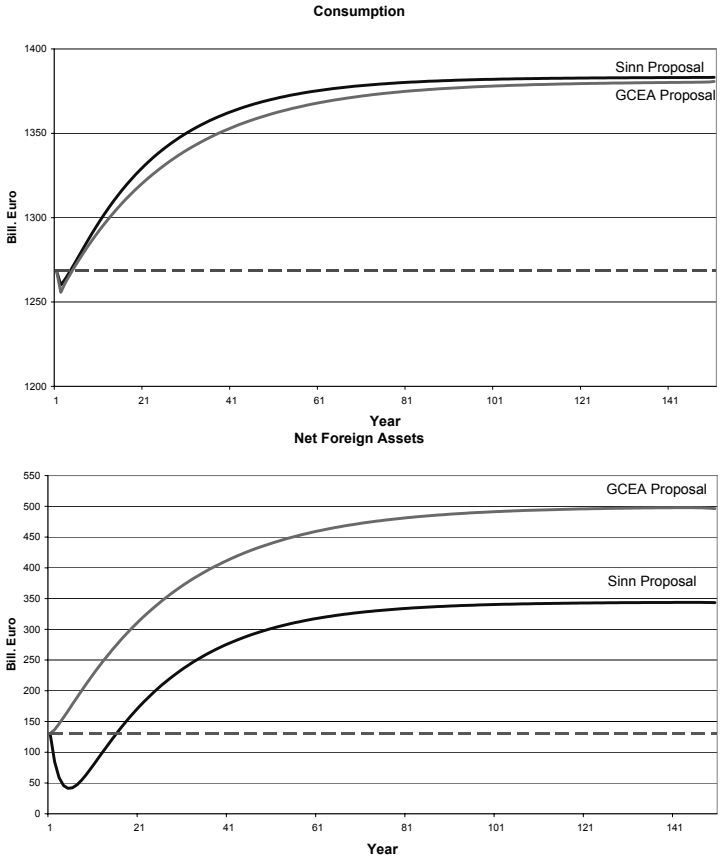
Fig. 5.12 and 5.13 complete the picture with a presentation of the transition paths for the main economic variables under the two alternative DIT proposals. For both policy options I assume that the reform is financed by an adjustment of transfers (see Tables 5.10 and 5.18). Whereas the transition paths for capital, GDP, labor supply and consumption under the Sinn proposal lie above those under the GCEA proposal, the picture changes for net foreign assets. Here the transition path is higher when the economy adjusts to the new steady state after introducing a DIT as suggested by the GCEA. The explanation for the first result regarding the development of capital and GDP mainly lies in the larger reduction in the cost of capital under the Sinn proposal. Moreover, the larger increase in current real wages under the Sinn reform proposal (see Tables 5.12 and 5.20) resulting from the lower necessary adjustment of the VAT also induces a higher labour supply under this policy reform proposal. Regarding the evolution of the net foreign asset position, in the GCEA scenario the foreign demand for domestic government and firm bonds decreases to a larger extent as a result of the reform than under the Sinn proposal such that net foreign asset curve lies higher under the former.

Fig. 5.12. The Transition Path of GDP, Capital and Labor Supply under the Two Reform Proposals



Source: Own calculations.

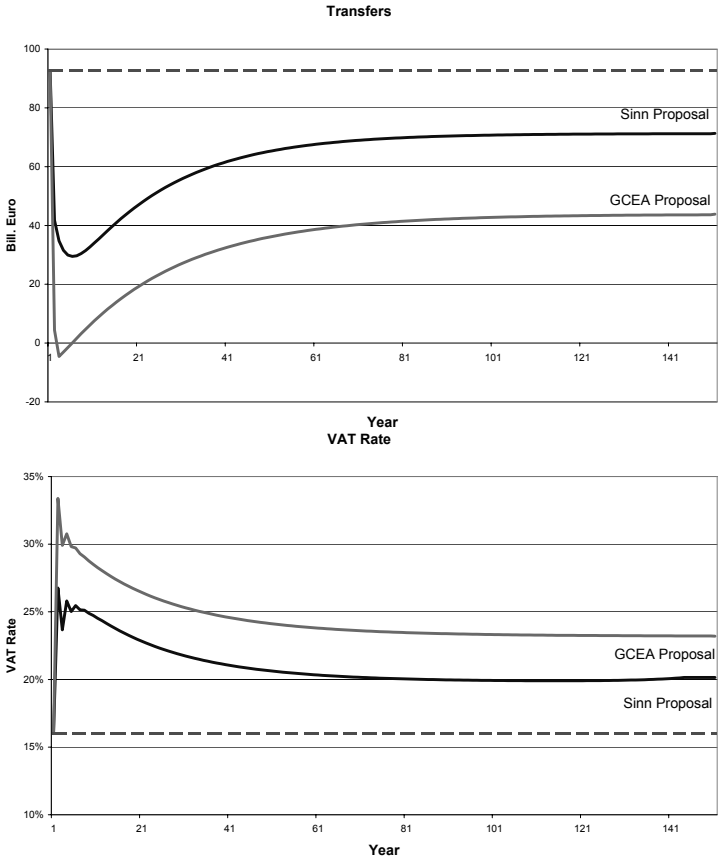
Fig. 5.13. The Transition Path of Consumption and Net Foreign Assets under the GCEA (2003) and under the Sinn(2003) Proposal



Source: Own calculations.

Last but not least, Fig. 5.14 illustrates the way in which public transfers and the VAT rate change in the course of the adjustment process after the implementation of the individual reforms. The SINN proposal seems to be less 'expensive' in the long-run, since the required adjustment in transfer payments or in the VAT rate turns out to be smaller than in the GCEA *Scenario 1*. Transfers need to be reduced by only around 22 per cent in the former, compared to around 53 per cent in the latter case and the required VAT rate increase amounts to just 20 per cent under Sinn's proposal compared to around 23 per cent under the GCEA proposal.

Fig. 5.14. The Transition Path of Transfers and of the VAT Rate under the GCEA (2003) or under the Sinn (2003a) Proposal



Source: Own calculations.

Once again the message is clear: Under both scenarios the representative individual is better off since welfare in terms of life-time income or GDP increases. However, the greatest improvement is achieved by Sinn's tax reform proposal.

5.6 Sensitivity Analysis

Any policy analysis based on a CGE model has to include a sensitivity analysis since the achieved results depend on the numerical values assigned to the behavioral parameters. The large number of empirical papers, which estimate different values for important behavioral parameters used in the model, offers

an opportunity to check the robustness of the results if different values are assumed for the key behavioral parameters. There are basically four different elasticities which are of interest in this context: The labor supply elasticity ε, the intertemporal elasticity of substitution σ^C, the elasticity of factor substitution σ^Y , and the elasticity concerning the debt asset ratio σ^B .

Table 5.22. Sensitivity Analysis (Long Run Changes in %)

GCEA (2003)	*Scenario 1* [a)]	$\varepsilon=0.01$	$\sigma^C=0.6$	$\sigma^Y=1.3$	$\sigma^B=0.16$	$\sigma^B=0.56$
Capital Stock	**11.7**	9.8	11.7	17.8	11.7	11.6
Debt Asset Ratio C-firm	**0.3**	0.3	0.3	0.5	0.1	0.5
Debt Asset Ratio NC-firm	**0.5**	0.5	0.5	0.7	0.2	0.8
Labor Supply	**2.0**	0.04	2.0	2.4	2.0	2.0
Consumption	**6.4**	4.1	6.4	8.6	6.5	6.3

Note: [a)]Applied parameters: $\varepsilon = 0.37$; $\sigma^C = 0.4$; $\sigma^Y = 0.8$; $\sigma^B = 0.36$;
Source: Own calculations.

Tables 5.22 and 5.23 show the results of simulating the reform scenario as suggested by the GCEA (2003) or by Sinn (2003a) when different values for the underlying elasticities are applied.[10] The basic scenario applies a labor supply elasticity of $\varepsilon = 0.37$ which is a weighted average of compensated wage elasticities of the labor supply for Germany estimated by Fenge et al. (2002).[11] If we set this elasticity close to zero, i.e. to $\varepsilon = 0.01$, we model an almost fixed labor supply.[12] Simulating the GCEA *Scenario 1*, the labor supply increases by only 0.04 per cent and thus capital accumulation is also impeded. In the long run, the capital stock increases by only 9.8 per cent instead of the 11.7 per cent calculated in the base *Scenario 1*. Accordingly, private consumption rises only to a smaller extent of 4.1 per cent. A similar picture arises in case the Sinn (2003a) proposal is simulated using this low elasticity. Labor supply increases by only 0.07 per cent leading to a lower capital accumulation of only 11.1 per cent compared to 14.0 per cent in the base case. As a result, consumption also rises by just 3.9 per cent instead of the previous 8 per cent.

[10] For both scenarios I perform the simulation allowing for an endogeneous increase in the VAT rate to cover the government's revenue needs.

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

[12] This is a quite realistic assumption for Germany, especially for the low skilled labor force as shown by the last tax reform : Although the German Tax Reform 2000 led to a significant decrease in personal income tax rates employment did not increase, but decreased due to labor market rigidities and various other structural problems (Sinn, 2003a).

Table 5.23. Sensitivity Analysis (Long Run Changes in %)

Sinn (2003a) [a)]		$\varepsilon = 0.01$	$\sigma^C = 0.6$	$\sigma^Y = 1.3$	$\sigma^B = 0.16$	$\sigma^B = 0.56$
Capital Stock	**14.0**	11.1	14.5	21.1	14.2	13.8
Debt Asset Ratio C-firm	**1.2**	1.2	1.3	1.4	0.5	2.0
Debt Asset Ratio NC-firm	**1.5**	1.5	1.5	1.6	0.6	2.4
Labor Supply	**3.5**	0.07	3.5	3.9	3.6	3.4
Consumption	**8.0**	3.9	8.0	10.3	8.2	7.7

Note: [a)] Applied parameters: $\varepsilon = 0.37$; $\sigma^C = 0.4$; $\sigma^Y = 0.8$; $\sigma^B = 0.36$;
Source: Own calculations.

Next, the values of the intertemporal elasticity of substitution, σ^C, reflect the change in the pattern of consumption and saving over time. I start with a value of 0.4 in the base scenario and then run the simulation with a higher value of 0.6. To a large degree, the model is robust to the change in the intertemporal elasticity of substitution. The results change only slightly as depicted in the fourth column of Tables 5.21 and 5.22. The reason why the results do change only so little owes to the fact that the long-run interest rate is bound by the relationship $R^h = G/\rho^h$ which underlies the Ramsey model. [13]

Another important parameter is the elasticity of substitution between capital and labor. In the model, this elasticity is like a capital demand elasticity. 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 Fig. **4.5** in Chapter 4 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 of this measure in the empirical literature, thus I 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 17.8 per cent in the council's scenario and by 21.1 per cent in Sinn's scenario. Moreover, due to the increased gross wages, labor supply also rises by 2.4 per cent

[13] Still, the following effects can arise as a result of a change in the taxation of interest income. 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. The substitution effect arises because a lower interest rate increases the price of future periods consumption and thus we have a substitution of present consumption for future consumption. However, a lower interest rate leads to a positive income effect as the amount of savings needed to attain a given consumption level tomorrow, is increased.

and 3.9 per cent, respectively. In turn, the consumption level of households rises by 8.6 per cent and 10.3 per cent, in each case.

Regarding the debt elasticity, this measure shows how elastic the firm's debt ratio reacts to different tax reform scenarios. In the baseline model, the elasticity concerning the debt asset ratio is set at 0.36, while column six and seven of Tables 5.20 and 5.21 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 also decline due to the shrinking debt ratio. A reduced elasticity of e.g. 0.16 leads to a less elastic reaction of firms to cheaper internal financing whereas a debt asset elasticity of 0.56 induces a higher preference for debt finance if the profit tax rate is lowered.

6

Conclusion

At present, the reform of the German tax system is a hotly debated issue. Due particularly to the country's poor economic performance and its consequences, those relevant fiscal policy measures which aim at improving Germany's standing as an investment location are of vital importance as a step towards overcoming the economic slump. The decline of the German economy was attributed, among other things, to the high German profit tax rates which inhibit investment. At present, the statutory effective tax rate on retained corporate profits amounts to 38.3 per cent (including the solidarity surcharge of 5.5 per cent and the local trade tax), and is thus about eight percentage points higher than the EU-15 average of 30.1 per cent and even around 20 percentage points higher than the average of the new EU Member States. As a result, capital flight is motivated by tax considerations, and companies shift their tax base and active production abroad, to the country's detriment since declining domestic investment has negative consequences for employment and growth.

The number of tax reform proposals recently made is overwhelming. They range from a simple reform proposal of reducing the corporate tax rate, to more complicated and comprehensive tax reforms including a fully integrated tax system for business and personal income, a consumption-based income tax and the introduction of a dual income tax.

The major purpose of the present study was to investigate the effects of introducing a dual income tax in Germany as suggested by Sinn (2003a) and the GCEA (2003), a tax system that has already been applied in Nordic countries for around a decade.

The dual income tax is aimed at enhancing economic growth, ensuring an increased efficiency and neutrality of the tax system, providing the basis to survive in international tax competition and safeguarding government revenue. More precisely, the major motivations for such a tax cut-cum-base-broadening reform are the desire to diminish the scope of tax arbitrage, to stimulate private savings, to alleviate the distortions caused by progressive capital income taxation in inflationary phases and to diminish the revenue

loss resulting from the possibility to deduct nominal interest rate payments against the high marginal personal income tax rates. Additionally, the uncoupled proportional taxation of capital income allows for sufficient flexibility to react to the persisting tax competition without changing the entire tax system.

In the light of these developments and taking account of all the mentioned considerations, introducing a dual income tax which follows the proposals of the GCEA(2003) or Sinn(2003a) is a valid alternative. The GCEA proposal features a proportional capital income tax of 30 per cent, which also equals the tax rate on corporate profits, and progressive labor income taxes up to 35 per cent. To avoid the double taxation of retained and distributed profits, no dividend or capital gains taxes apply. The Sinn (2003) reform scenario combines a DIT with an allowance for both corporate and non-corporate equity. Corporate and non-corporate profits are taxed at 35 per cent and the half income principle of dividend taxation applies such that distributed profits exceeding the imputed return are subject to 46 per cent taxation. Interest income as well as the imputed return on equity is taxed at a flat rate savings tax of 20 per cent. Labor income is subject to progressive taxation ranging from 15 to 35 per cent.

To evaluate the effects of introducing a DIT as suggested by the above mentioned proposals, a dynamic computable equilibrium model, *IFOMod* is applied:

- This model contains a detailed modelling of the business sector and features the traditional Ramsey model on the household side thus providing a framework to measure the welfare change of the representative individual as a result of a tax reform.
- Saving and investment decisions are forward looking and permit a consideration of important tax capitalization effects.
- The model contains an endogenous investment financing policy and labor supply as well as international portfolio investments.
- It describes the economy's new steady state solution under the new tax rules and offers additional results in the form of adjustment paths of the macroeconomic variables such as capital stock, GDP, foreign debt, labor supply and consumption. For the ultimate evaluation of a tax reform, the model also allows for the computation of welfare variations expressed as changes in the equivalent variation in consumption.

Both reform proposals have positive overall macroeconomic effects that vary according to the way they are financed, namely through a reduction of transfers or an endogenous increase in the VAT rate. The two reform alternatives both lead to a reduction in the cost of capital from 10.6 per cent for corporate firms and 9.9 per cent for non-corporate ones to 9.4 and 8.6 per cent, respectively, under the GCEA proposal and to 9.2 and 8.1 per cent for the different types of firms under the Sinn reform scenario. Welfare in terms of

life-time income increases by 2.0 and 2.3 per cent, respectively, in the two scenarios if the reform is financed by a reduction in transfers and by 0.8 and 1.2 per cent if the government budget is balanced by an increase in the VAT rate. Accordingly, the SINN (2003a) reform proposal achieves better welfare improving results. This effect mainly owes to the fact that under Sinn's scenario a long-run increase of only 4 percentage points compared to a 6.5 percentage point rise in the VAT rate in the GCEA proposal is sufficient to balance the government budget.

Moreover, the transition path of capital, GDP under the SINN (2003a) proposal lie above those under the GCEA(2003) reform alternative due to the larger reduction in the cost of capital under the former.

The message is nevertheless clear: Under both scenarios the representative individual is better off since welfare in terms of life-time income or GDP increases. However, a more considerable improvement is achieved by implementing Sinn's tax reform proposal.The study's empirical findings support the introduction of a dual income tax in Germany and provide an important platform for further political discussions on this urgent matter.

Regarding the future research agenda, one of the main coming issues is to develop *IFOmod* further such that it includes a more detailed representation of the economy and to refine the calibration of the model. In this context, if the two reform proposals presented here are additionally equipped with an exact splitting rule for income arising in non-corporate firms, this expansion can be incorporated in *IFOmod* to deliver a more accurate picture of such a reform.

Appendix A

This Appendix shows the equations for computing effective statutory tax rates τ^c_{ret} for retentions and τ^C_{dist} for distributed profits of German corporations as well as τ^{NC} for distributed profits of non-corporate firms prevailing in 2005.

τ^C denotes the statutory tax rate on corporate profits which amounts to 25%, *soli* stands for the solidarity surcharge of 5.5% and τ^{LT} defines the local trade tax which is deductible from corporate income tax base. Hence,

$$\tau^c_{ret} = \tau^C \cdot (1 + soli) \cdot (1 - \tau^{LT}) + \tau^{LT} \tag{A.1}$$

When an average multiplier, the so-called "Hebesatz" of $h = 387\%$ and a uniform base rate ("Gewerbesteuermesszahl") of $m = 5\%$ are inserted to calculate the local trade tax τ^{LT}

$$\tau^{LT} = \frac{h \cdot m}{1 + h \cdot m} \tag{A.2}$$

then $\tau^{LT} = 16.2\%$.
Consequently

$$\tau^C_{ret} = 0.25 \cdot (1 + 0.055) \cdot (1 - 0.162) + 0.162 = \mathbf{0.383} \tag{A.3}$$

Following a similar procedure, we can compute the effective statutory tax rate for a corporate firm that distributes its entire profits. In this case we have to take into consideration the personal income tax rate τ^L since a half of distributed dividends are subject to personal income taxation and the solidarity surcharge. Thus,

$$\tau^C_{dist} = \tau^C_{ret} + \frac{\tau^L \cdot (1 + soli)}{2} \cdot (1 - \tau^C_{ret}) \tag{A.4}$$

Applying for 2005 the top marginal tax rate for personal income of 42%,

$$\tau^C_{dist} = 0.383 + \frac{0.42(1 + 0.055)}{2}(1 - 0.383) = \mathbf{0.52} \tag{A.5}$$

In the case of non-corporate firms, profits are subject to the personal income tax augmented by the solidarity surcharge and to the local trade tax. However, the local trade tax can be credited against the income tax liability by a factor of 1.8. Therefore, the formula for the effective statutory tax rate applying to non-corporate firms is

$$\tau^{NC} = \tau^{L} \cdot (1+soli) + \tau^{LT} - \tau^{L} \cdot (1+soli) \cdot \tau^{LT} - 1.8 \cdot m \cdot (1-\tau^{LT})(1+soli) \quad \text{(A.6)}$$

Inserting the corresponding parameters into the equation (A.6), one can obtain

$$\begin{aligned} \tau^{NC} = {} & 0.42 \cdot (1 + 0.055) + 0.162 - 0.42 \cdot (1 + 0.055) \cdot 0.162 \\ & -2 \cdot 0.05 \cdot (1 - 0.162)(1 + 0.055) = \mathbf{0.454} \end{aligned} \quad \text{(A.7)}$$

Appendix B

B.1 Hayashi's Proof (1982)

Proposition. *According to Hayashi (1982), the firm value is:*

$$V_t^{f,e} = q_t^f K_t^f + \lambda_t^f B_t^f + V_t^{f,E} \tag{B1.1}$$

where $V_t^{f,E} = \gamma^{D,f} F_E^f E^f + \dfrac{G}{1+re_{t+1}^f} V_{t+1}^{f,E}$.

Proof. Multiplying the envelope condition for the stock variable capital expressed by eq.(4.17a) by K_t^f and using the equation of motion for capital, eq.(4.2), we obtain:

$$\begin{aligned} q_t^f K_t^f = {} & \gamma^{D,f} \left[F_K^f K_t^f - J_K^f K_t^f + m_f' b_f^2 K_t^f + \frac{z_2 \tau^{P,f}}{\theta^{P,f}} r K_t^f \right] \\ & - \left(\gamma^{D,f} - \gamma^{I,f} \right) \delta K_t^f + \frac{q_{t+1}^f}{1+re_{t+1}^f} \left[G K_{t+1}^f - I_t^f \right]. \end{aligned} \tag{B1.2}$$

Applying linear homogeneity of the production and adjustment cost function according to eq.(4.1) and (C3.1), as well as using the optimality conditions shown in eq.(4.16a, b) eq. (B1.2) changes to:

$$\begin{aligned} q_t^f K_t^f = {} & \gamma^{D,f} \left[Y^f - J^f - F_E^f E^f - w_t^f L^f - \delta K_t^f + \frac{z_2 \tau^{P,f}}{\theta^{P,f}} r K_t^f \right] \\ & + \gamma^{D,f} m_f' b_f^2 K_t^f - \gamma^{I,f} I N_t^f + \frac{G}{1+re_{t+1}^f} q_{t+1}^f K_{t+1}^f. \end{aligned} \tag{B1.3}$$

Multiplying the envelope condition for the stock variable debt described in eq.(4.17b) by B_t^f and inserting the equation of motion (4.3), as well as the optimality condition (4.16c), we have:

$$\lambda_t^f B_t^f = -\gamma^{D,f} m'_f b_f^2 B_t^f - \gamma^{D,f} m_f B_t^f - \gamma^{D,f} \frac{1 - z_1 \tau^{P,f}}{\theta^{P,f}} i^{H,B} B_t^f$$
$$-\gamma^{D,f} \frac{z_2 \tau^{P,f}}{\theta^{P,f}} r B_t^f + \Omega^f B N_t^f + \frac{G}{1 + re_{t+1}^f} \left[\lambda_{t+1}^f B_{t+1}^f \right]. \quad \text{(B1.4)}$$

Adding eq.(B1.3) to eq. (B1.4) and bearing in mind that $\gamma^{D,f} m'_f b_f^2 K_t^f - \gamma^{D,f} m'_f b_f B_t^f = \gamma^D m'_f b_f \left(\frac{B^f}{K^f} K^f - B^f \right) = 0$ and using the expression for χ_t^f as given in eq.(4.10) and (4.13), we derive:

$$q_t^f K_t^f + \lambda_t^f B_t^f = \chi_t^f - \gamma^{D,f} F_E^f E^f + \frac{G}{1 + re_{t+1}^f} \left[q_{t+1}^f K_{t+1}^f + \lambda_{t+1}^f B_{t+1}^f \right]. \quad \text{(B1.5)}$$

According to Hayashi's proof, we have:

$$V_t^{f,e} = \chi_t^f + \frac{G}{1 + re_{t+1}^f} \left[q_{t+1}^f K_{t+1}^f + \lambda_{t+1}^f B_{t+1}^f + V_{t+1}^{f,E_{fix}} \right],$$

which is equal to: $V_t^{f,e} = \chi_t^f + \frac{G V_{t+1}^{f,e}}{1 + re_{t+1}^f}$ as given in eq.(4.14).

B.2 Intertemporal Optimization of Domestic Households

The household Bellmann problem states:

$$U^*\left(A_t^H\right) = \max_{Q_t, L_t^S} \left\{ u\left(Q_t\right) + \rho^H U^*\left(A_{t+1}^H\right) \quad s.t. \quad eq.(4.47) \right\}. \tag{B2.1}$$

Defining $\kappa_t \equiv \partial U_t^* / \partial A_t^H$, the **optimality** conditions for the controls L_t^S and Q_t are:

$$\begin{aligned} \text{(a)} \quad L_t^S : \varphi'\left(l_t^S\right) &= \frac{\left(1-\tau^L\right)}{\left(1+\tau^C\right)} w_t. && \text{(B2.2)} \\ \text{(b)} \quad Q_t : u'\left(Q_t\right) &= \kappa_{t+1}\left(1+\tau_t^C\right)\rho^H / G, && \text{(B2.3)} \\ &=> \kappa_{t+1} = \frac{G\ u'\left(Q_t\right)}{\rho\left(1+\tau_t^C\right)} && \text{(B2.4)} \end{aligned}$$

Let l_t^S denote individual labor supply, while γ represents a scaling parameter and ε the labor supply elasticity. Given this functional form of the disutility of work, the individual labor supply is:

$$\varphi(l_t^S) = \gamma^{-1/\varepsilon} \frac{l^{1+1/\varepsilon}}{1+1/\varepsilon} \qquad => l_t = \gamma \left[\frac{\left(1-\tau^L\right)}{\left(1+\tau^C\right)} w_t \right]^{\varepsilon}. \tag{B2.5}$$

Aggregated labor supply is then given by: $L_t^S = l_t \cdot N_t$, where N_t denotes the size of the labor force in the economy.

The **envelope condition** for the stock variable A^H states:

$$A_t^H : \kappa_t = \frac{\rho^H (1 + \overline{r^H}_t)}{G} \kappa_{t+1}\ . \tag{B2.6}$$

Thus, the **Euler equation** for consumption is:

$$\frac{u'\left(Q_t\right)}{u'\left(Q_{t+1}\right)} = \frac{1+\tau_t^C}{1+\tau_{t+1}^C} \frac{\rho^H (1 + \overline{r^H}_{t+1})}{G}\ . \tag{B2.7}$$

Applying a *CES* utility function[1], and constraining the optimal consumption profile by the intertemporal budget constraint, an expression specifying the marginal propensity to consume is achieved:

$$mpc_t = \frac{(1+\tau_t^C)^{1-\sigma}}{mc_t}\ , \tag{B2.8}$$

[1] If $\sigma = 1$ we have the case of a logarithmic utility function where $(1+\tau_t^C) \cdot Q_t = (1-\rho^H) \cdot TW_t$.

with $mc_t = \dfrac{(1+\tau_t^C)^{1-\sigma}}{\sum_{s=t}^{\infty}[1+\tau_s^C]^{1-\sigma} \cdot \prod_{u=t+1}^{s}\left[\rho^{H,\sigma}\left(\dfrac{G}{1+\overline{r}_u}\right)^{1-\sigma}\right]}$.

In steady state $\tau_t^C = \tau_{t+1}^C = \tau^C$ and $\rho^H = \dfrac{G}{1+\overline{r^H}}$ holds, implying that the marginal propensity to consume is equal to:

$$mpc_t^{SS} = 1 - \rho^H \ . \tag{B2.9}$$

But this is not true for the transition path. Solving forward the expression for mc, we obtain:

$$mpc_t^{TR} = \frac{(1+\tau_t^C)^{1-\sigma}}{(1+\tau_t^C)^{1-\sigma} + \rho^{H,\sigma}\left(\dfrac{G}{1+\overline{r^H}_{t+1}}\right)^{1-\sigma} mc_{t+1}} \ . \tag{B2.10}$$

Hence, consumption is described by:

$$\left(1+\tau_t^C\right) Q_t = mpc_t \cdot TW_t \ . \tag{B2.11}$$

and indirect utility is defined as

$$U_t^* = \frac{1}{1-1/\sigma}\left[\frac{Q_t^{1-1/\sigma}}{mpc_t} - \frac{1}{1-\rho}\right] \tag{B2.12}$$

Therefore, we can express total wealth as a function of indirect utility as

$$TW_t = \frac{\left(1+\tau_t^C\right)}{mpc_t^{\frac{1}{1-\sigma}}}\left[(1-1/\sigma)\, U_t^* + \frac{1}{1-\rho}\right]^{\frac{\sigma}{\sigma-1}} \tag{B2.13}$$

B.3 Walras Law

Lemma. ***Walras' Law:*** *The sum of valued excess demands is zero:*

$$\zeta^{EDV\_H} = G(\zeta^{V}_{t+1} + \zeta^{DGH}_{t+1} + \zeta^{B}_{t+1}) - (1 + i^{H}_{t})\zeta^{DGH}_{t} \tag{B3.1}$$

$$- (1 + i^{B,H}_{t})\zeta^{B}_{t} + \zeta^{Gov}_{t} + w\zeta t^{L} + \zeta^{N}_{t} = 0. \tag{B3.2}$$

and must hold also out of equilibrium.

$$\zeta^{V}_{t} = A^{VC}_{t} + A^{VN}_{t} - V^{C}_{t} - V^{N}_{t}; \tag{B3.3}$$

$$\zeta^{B}_{t} = A^{B,H}_{t} + A^{B,F}_{t} - \sum\nolimits^{2}_{f=C,N} B^{f}_{t}; \tag{B3.4}$$

$$\zeta^{DGH}_{t} = A^{DH,H}_{t} + A^{DF,H}_{t} - D^{G}_{t}; \tag{B3.5}$$

$$\zeta^{Gov}_{t} = GD^{G}_{t+1} - (1 + i^{H}_{t})D^{G}_{t} - C^{G}_{t} - T^{H}_{t} + TTR_{t}; \tag{B3.6}$$

$$\zeta^{L}_{t} = \sum\nolimits^{2}_{f=C,N} w^{f}_{t} L^{f,S}_{t} - L^{D}; \tag{B3.7}$$

$$\zeta^{N}_{t} = GNFA_{t+1} - NFA_{t} - NCE_{t} - TB_{t} \tag{B3.8}$$

Proof. Substituting $Q_t = C_t - \varphi\left(L^{S}_{t}\right)$ into the the asset accumulation eq.(4.47), and rearranging it, we get:

$$GA^{H}_{t+1} - A^{H}_{t} = \overline{r^{H}}_{t} A^{H}_{t} + \sum\nolimits^{2}_{f=C,N} (1 - \tau^{L}) w^{f}_{t} L^{f,S}_{t}$$

$$+ \tau^{L} LTA + T^{H}_{t} - (1 + \tau^{C}) C_{t}. \tag{B3.9}$$

Applying the portfolio identity (4.33):

$$A^{H} = A^{B,H} + A^{DH,H} + A^{DF,H} + A^{VC} + A^{VN},$$

and the expression for the average portfolio return, (4.34):

$$\overline{r^{H}}_{t} = \{(1 - t^{i}) i^{B,H} A^{B,H} + (1 - t^{i}) i^{H} A^{DH,H}$$

$$+ (1 - t)^{i}) i^{F} A^{DF,H} + r^{V} A^{VC} + r^{V} A^{VN}\} / A^{H}, \tag{B3.10}$$

we get:

$$GA^{B,H}_{t+1} - A^{B,H}_{t} + GA^{DH,H}_{t+1} - A^{DH,H}_{t} + GA^{DF,H}_{t+1} - A^{DF,H}_{t} + GA^{VC}_{t+1} - A^{VC}_{t}$$

$$+ GA^{VN}_{t+1} - A^{VN}_{t} = (1 - t^{i}) i^{B,HB} A^{B,H} + (1 - t^{i}) i^{H} A^{DH,H} + (1 - t)^{i}) i^{F} A^{DF,H}$$

$$+ r^{V} A^{VC} + r^{V} A^{VN} + \sum\nolimits^{2}_{f=C,N} w^{f}_{t} L^{f,S}_{t} - T^{L}_{t} + T^{H}_{t} - C_{t} - T^{C}_{t}. \tag{B3.11}$$

The internationally tradable bonds which include domestic business debt: $\sum\nolimits^{2}_{f=C,N} B^{f}_{t} + \zeta^{B} = A^{B}_{t} = A^{B,H}_{t} + A^{B,F}_{t}$, domestic government bonds: $D^{G}_{t} +$

$\zeta^{Dgh}= A_t^{DH} = A_t^{DH,H}+A_t^{DH,F}$ and foreign government bonds: $D_t^F= A_t^{DF}$ $= A_t^{DF,H}+A_t^{DF,F}$, are demanded by domestic and foreign investors while domestic equity consisting of corporate and non-corporate equity: $V_t^C + V_t^N + \zeta^V= A_t^{VC}+A_t^{VN}= A_t^{VC,H}+A_t^{VN,H}$, is only held by domestic investors. Moreover, adopting the definition of the tax base for interest income, expressed in eq. (4.57) $T^i= \tau^i \left[i^{B,H}A^{B,H} + i^H A^{DH,H}+i^F A^{DF,H}\right]$, we obtain :

$$\begin{aligned}
&\textstyle\sum_{f=C,N}^{2} GB_{t+1}^f - B_t^f + G\zeta_{t+1}^B - \zeta_t^B - GA_{t+1}^{B,F} + A_t^{B,F} + GD_{t+1}^G - D_t^G \\
&- \zeta^{Gov} + G\zeta_{t+1}^{Dgh} - \zeta_t^{Dgh} - GA_{t+1}^{DH,F} + A_t^{DH,F} + GA_{t+1}^{DF,H} - A_t^{DF,H} \\
&= i^{B,H}(A_t^B - A_t^{B,F}) + i^H(A_t^{DH} - A_t^{DH,F}) + i^F A^{DF,H} - GV_{t+1}^C + V_t^C \\
&- G\zeta_{t+1}^V + \zeta_t^V - GV_{t+1}^N + V_t^N + \zeta^{Gov} + r^V V_t^C + r^V V_t^N \\
&+ \textstyle\sum_{f=C,N}^{2} w_t^f L_t^{f,S} + T_t^H - T_t^L - T_t^C - T^i - C_t.
\end{aligned} \tag{B3.12}$$

The net foreign asset position is defined by (4.60): $NFA_t= A_t^{DF,H} - A_t^{B,F}$ $-A_t^{DH,F}$, and the net capital export is given by (4.59): $NCE_t= i^F A_t^{DF,H}$ $-i^{B,H}A_t^{B,F} - i^H A_t^{DH,F}$. Substituting this condition in eq.(4.60) yields:

$$\begin{aligned}
&GNFA_{t+1} - NFA_t + \textstyle\sum_{f=C,N}^{2} GB_{t+1}^f - B_t^f + G\zeta_{t+1}^B - \zeta_t^B + GD_{t+1}^G - D_t^G \\
&+ \zeta^{Gov} + G\zeta_{t+1}^{Dgh} - \zeta_t^{Dgh} \\
&= NCE_t - GV_{t+1}^C + V_t^C - G\zeta_{t+1}^V + \zeta_t^V - GV_{t+1}^N + V_t^N + r^V V_t^C + r^V V_t^N \\
&+ i^{B,H}B_t^C + i^{B,H}B_t^N + i^H D_t^G + \textstyle\sum_{f=C,N}^{2} w_t^f L_t^{f,S} + T_t^H - T_t^L - T_t^C - T_t^i - C_t.
\end{aligned} \tag{B3.13}$$

Moreover, debt accumulates according to (4.3): $\sum_{f=C,N}^{2} GB_{t+1}^f - B_t^f$ $= BN_t^C + BN_t^N$, and the governmental budget constraint, (4.58): GD_{t+1}^G $-(1+i)^H D_t^G = C_t^G + T_t^H - \sum_{f=C,N}^{2} T_t^{P,f} - T_t^i - T_t^C - T_t^L - T_t^D - \sum_{f=C,N}^{2} T_t^{G,f}$, as well as the no-arbitrage condition for corporate firms eq.(4.9): $r^V V_t^C= Div_t^C - T_t^D + \left[GV_{t+1}^C - V_t^C - VN_t^C\right] - T^{G,C}$, and non-corporate firms shown in eq.(4.12): $r^V V_t^N= \pi_t^N + \left[GV_{t+1}^N - V_t^N - VN_t^C\right] - T^{G,N}$, simplifies eq. (B3.5) as follows:

$$\begin{aligned}
&GNFA_{t+1} + G\zeta_{t+1}^B + G\zeta_{t+1}^{Dgh} + G\zeta_{t+1}^V + \zeta^{Gov} \\
&= NFA_t + NCE_t + Div_t^C + i^{B,H}B_t^C - BN_t^C - VN_t^C \\
&+ \pi_t^N + i^{B,H}B_t^N - BN_t^N - VN_t^N + \textstyle\sum_{f=C,N}^{2} T_t^{P,f} + \sum_{f=C,N}^{2} w_t^f L_t^{f,S} - C_t - C_t^G.
\end{aligned} \tag{B3.14}$$

Applying the flow of funds equation for corporate firms (4.7): Div^C $= \pi^C + BN^C + VN^C - IN^C$, and non-corporate firms (4.11): $VN^N= IN^N - BN^N$, as well as the expression characterizing profits described in eq. (4.4):

$$\pi^f = \underbrace{Y^f - J^f - m^f B^f}_{GDP_t^f} - w^f L^f - \delta K^f - i^{B,H} B^f - T^{P,f},$$

and net investments $IN_t^f = I_t^f - \delta K_t^f$, we finally arrive at the current account:

$$\begin{aligned} & G(\zeta_{t+1}^B + \zeta_{t+1}^{Dgh} + \zeta_{t+1}^V + GNFA_{t+1} - NFA_t \\ & = NCE_t + \underbrace{GDP_t^C + GDP_t^N - C_t - C_t^G - I_t^C - I_t^N}_{TB_t}, \end{aligned} \tag{B3.15}$$

This is a direct result of Walras' Law which must hold also out of equilibrium since in eq.(B3.2) the excess demand functions equal zero so $\zeta_t^V = \zeta_t^{DGH} = \zeta_t^B = \zeta_t^{Gov} = 0$.

B.4 Savings Investment Identity

Lemma. *The **savings investment identity** states:*

$$S^H + \sum\nolimits_{f=C,N}^{2} S^{U,f} = \sum\nolimits_{f=C,N}^{2} I^f + \Delta D^G + \Delta NFA. \qquad \text{(B4.1)}$$

Household's savings, S^H, plus the retained earnings by firms, $S^{U,f}$, are equal to the amount of all investments within a economy, $\sum_{f=C,N}^{2} I^f$, plus the change (increase) in the governmental budget deficit, ΔD^G, as well as in the net foreign asset position, ΔNFA.

Proof. Keeping in mind that domestic equity of corporate firms: $V_t^C = A_t^{VC} = A_t^{VC,H}$, and non-corporate firms: $V_t^N = A_t^{VN} = A_t^{VN,H}$, is only demanded by domestic investors we rewrite eq.(B3.3) from the Appendix B3 (Walras' Law) according to:

$$\begin{aligned} &GA_{t+1}^{B,H} - A_t^{B,H} + GA_{t+1}^{DH,H} - A_t^{DH,H} + GA_{t+1}^{DF,H} - A_t^{DF,H} + GV_{t+1}^C - V_t^C \\ &+ GV_{t+1}^N - V_t^N = (1-t^i) i^{B,H} A^{B,H} + (1-t^i) i^H A^{DH,H} \qquad \text{(B4.2)} \\ &+ (1-t^i) i^F A^{DF,H} + r^V V_t^C + r^V V_t^N + \sum\nolimits_{f=C,N}^{2} w_t^f L_t^{f,S} - T_t^L + T_t^H - C_t - T_t^C. \end{aligned}$$

Integrating the no-arbitrage condition for corporate firms expressed by eq. (4.9): $r^V V_t^C = Div_t^C - T_t^D + \left[GV_{t+1}^C - V_t^C - VN_t^C\right] - T^{G,C}$, and non-corporate firms (4.12): $r^V V_t^N = \pi_t^N + \left[GV_{t+1}^N - V_t^N - VN_t^N\right] - T^{G,N}$, we obtain:

$$\begin{aligned} &\underbrace{GA_{t+1}^{B,H} - A_t^{B,H}}_{5} + \underbrace{GA_{t+1}^{DH,H} - A_t^{DH,H} + GA_{t+1}^{DF,H} - A_t^{DF,H}}_{6} + \underbrace{\sum\nolimits_{f=C,N}^{2} VN_t^f}_{7} \\ &= S^H = \underbrace{i^{B,H} A^{B,H} + i^H A^{DH,H} + i^F A^{DF,H} - T^i}_{1} + \underbrace{Div_t^C - T_t^D + \pi_t^N - T^G}_{2} \qquad \text{(B4.3)} \\ &+ \underbrace{\sum\nolimits_{f=C,N}^{2} w_t^f L_t^{f,S} - T_t^L + T_t^H}_{3} - \underbrace{(1+\tau_t^C) C_t}_{4}. \end{aligned}$$

The right hand side of eq.(B4.3) explains household's savings, S^H, as the difference between accrued income and spending, namely: after tax interest income (1) plus net of tax dividend income and income from non-corporate firms less capital gains tax (2) plus after tax labor income and governmental transfers (3) less consumption spending (4), while the left hand side shows how savings are invested. Household's savings are invested in new business debt (5), new domestic and foreign government bonds (6) and new firm equity (7). The usual definition of private savings does not include unrealized capital gains in asset holding but measures the difference between realized capital and labor income after taxes and consumer spending.

To arrive at the above state savings investment identity we use $\sum_{f=C,N}^{2} B_t^f = A_t^B = A_t^{B,H} + A_t^{B,F}$ and $D_t^G = A_t^{DH} = A_t^{DH,H} + A_t^{DH,F}$ and keep in mind that the net foreign asset position is $NFA_t = A_t^{DF,H} - A_t^{B,F} - A_t^{DH,F}$:

$$GA_{t+1}^B - A_t^B + \underbrace{GD_{t+1}^G - D_t^G}_{\Delta D_t^G} + \underbrace{G\ NFA_{t+1} - NFA_t}_{\Delta NFA_t} + \sum\nolimits_{f=C,N}^{2} VN_t^f = S^H. \quad \text{(B4.4)}$$

Following the equation for debt accumulation, (4.3): $\sum_{f=C,N}^{2} GB_{t+1}^f - B_t^f = BN_t^C + BN_t^N$, and applying the flow of funds equation for corporate (4.7): $Div^C = \pi^C + BN^C + VN^C - IN^C$, and non-corporate firms shown in eq.(4.11): $VN^N + BN^N = IN^N$, as well as the definition of net investments $IN_t^f = I_t^f - \delta K_t^f$, we have:

$$Div^C - \pi^C + I_t^C - \delta K_t^C + I_t^N - \delta K_t^N + \Delta D_t^G + \Delta NFA_t = S^H. \quad \text{(B4.5)}$$

Since replacement investments are always financed via retained earnings, savings of corporate firms are: $S^C = \pi^C - Div^C + \delta K_t^C$, and savings of non-corporate firms are: $S^N = \delta K_t^N$. Inserting these conditions in eq.(B4.5) we get:

$$I_t^C + I_t^N + \Delta D_t^G + \Delta NFA_t = S^H + S^C + S^N. \quad \text{(B4.6)}$$

Appendix C – Functional Forms

C.1 Trend Growth

IFOMOD includes a fixed exogenous trend growth of labor productivity X_t. According to a linearly homogeneous production technology, the production function is:

$$\tilde{Y}_t = F(\tilde{K}_t, X_t L_t, X_t E_t). \tag{C1.1}$$

where E_t is a sector specific factor (see Appendix C2).

Since L_t is assumed to remain constant in the long run, manpower becomes increasingly productive with the labor saving technological progress. Therefore, labor input $X_t L_t$ will grow with the productivity growth rate g,

$$X_{t+1} = G \cdot X_t; \qquad G = 1 + g. \tag{C1.2}$$

We analyze a long-run growth equilibrium where the capital output ratio remains constant. This requires capital and output to grow at the same rate g. Variables such as capital, consumption, etc. can be divided into a trend and a stationary component:

$$\tilde{K}_t = X_t \cdot K_t \qquad \Rightarrow \qquad K_t = \tilde{K}_t / X_t. \tag{C1.3}$$

In the stationary case, these variables have to be detrended. For example, the production function reduces to: $Y_t = F(K_t, L_t, E_t)$.

Taking the equation of capital accumulation, $\tilde{K}_{t+1} = \tilde{I}_t + (1-\delta)\tilde{K}_t$, as an example, we notice that difference equations refer to different time periods. Dividing this equation by X_t and noting eq.(C1.2), we derive:

$$\frac{\tilde{K}_{t+1}}{X_{t+1}} \frac{X_{t+1}}{X_t} = \frac{\tilde{I}_t}{X_t} + (1-\delta)\frac{\tilde{K}_t}{X_t} \qquad \Rightarrow \qquad G K_{t+1} = I_t + (1-\delta) K_t. \tag{C1.4}$$

In the long-run equilibrium of balanced growth, the stationary component is time invariant, $K_{t+1} = K_t = K$, leading to:

$$I = (g + \delta)K. \tag{C1.5}$$

For the household's utility function $u(Q) = \frac{Q_t^{1-1/\sigma}}{1-1/\sigma}$, consumption is subject to trend growth while labor supply is stationary. Therefore, we assume that the opportunity cost of leisure must increase with the rate of growth due to higher wages.

$$\tilde{Q} = \tilde{C} - X \cdot \varphi(l) \tag{C1.6}$$

Stationary variables are thus obtained by detrending the above equation.

The advantage of this detrending convention is, that all equations look the same as in a continuos time model.

C.2 Factor Demands

Production in each sector uses capital, K_f, labor, L_f, and a sector specific factor, E_f. The sectoral index is $f \in \{C,\ N\}$.

$$Y_f = F(K_f, L_f, E_f) = F_K^f \cdot K_f + F_L^f \cdot L_f + F_E^f \cdot E_f \tag{C2.1}$$

We apply a linear homogeneous CES technology with σ as the elasticity of factor substitution:

$$Y_f = A_f \left[d_f \cdot L_f^{-\frac{1-\sigma}{\sigma}} + (1-d_f) \cdot K_f^{-\frac{1-\sigma}{\sigma}} + E_f^{-\frac{1-\sigma}{\sigma}} \right]^{-\frac{\sigma}{1-\sigma}} \tag{C2.2}$$

Marginal products for each production factor are:

$$\begin{aligned}
&\text{(a) } F_K = [Y_f/K_f]^{1/\sigma} \cdot (1-d_f) \cdot A_f^{-\frac{1-\sigma}{\sigma}} \ , \\
&\qquad \rightarrow K_f = \left(\tfrac{1-d_f}{F_K}\right)^{\sigma} \cdot Y_f / A_f^{1-\sigma}. \\
&\text{(b) } F_L = [Y_f/L_f]^{1/\sigma} \cdot d_f \cdot A_f^{-\frac{1-\sigma}{\sigma}} \ , \\
&\qquad \rightarrow L_f = \left(\tfrac{d_f}{F_L}\right)^{\sigma} \cdot Y_f / A_f^{1-\sigma}. \\
&\text{(c) } F_E = [Y_f/E_f]^{1/\sigma} \cdot A_f^{-\frac{1-\sigma}{\sigma}} \ , \\
&\qquad \rightarrow E_f = \left(\tfrac{1}{F_E}\right)^{\sigma} \cdot Y_f / A_f^{1-\sigma}.
\end{aligned} \tag{C2.3}$$

The capital-labor ratio is:

$$k_f = \frac{K_f}{L_f} = \left[\frac{1-d^f}{d^f} \cdot \frac{F_L^f}{F_K^f} \right]^{\sigma} . \tag{C2.4}$$

The functional forms of the factor demands for capital in a steady state is:

$$K_f = A_f \cdot E_f \left\{ \left[(1-d_f) \,/\, \left(F_K^f \cdot A_f^{\frac{1-\sigma}{\sigma}} \right) \right]^{(1-\sigma)} - A_f^{-\frac{1-\sigma}{\sigma}} \left(1 - d_f + d_f \cdot k_f^{\frac{1-\sigma}{\sigma}} \right) \right\}^{\frac{\sigma}{1-\sigma}} \tag{C2.5}$$

and the labor demand is then: $L_f = l_f \cdot K_f$, where $l_f = 1/k_f$.

In a temporary equilibrium the stock of capital is predetermined and the labor demand is given by:

$$L_f = \left\{ \frac{[A_f \cdot d_f \ / \ w_f]^{(1-\sigma)} - d_f}{(1-d_f)\, K_f^{-\frac{1-\sigma}{\sigma}} + E_f^{-\frac{1-\sigma}{\sigma}}} \right\}^{\frac{\sigma}{1-\sigma}} \tag{C2.6}$$

C.3 Adjustment Cost Function

Every investment results in additional adjustment costs J^f which stem from disruptions caused by the firm's internal reorganization. The adjustment cost function is assumed to be linearly homogeneous in I and K and convex in investment.

$$J^f = J^f(I,K) = I^f \cdot J_I^f(I,K) + K^f \cdot J_K^f(I,K) \tag{C3.1}$$

$$\text{with} \qquad J_I^f > 0, \qquad J_{II}^f > 0, \qquad J_K^f < 0 \ .$$

In a balanced growth equilibrium adjustment costs are zero $J^f = J_I^f = J_K^f = 0$, such that they do not influence the steady state solution. The adjustment cost function has a quadratic form:

$$J^f = J^f(I,K) = \frac{\psi}{2}(j^f - \delta - g)^2 K^f \ , \qquad \text{with} \qquad j^f \equiv I^f/K^f \ . \tag{C3.2}$$

The first derivatives with respect to I and K respectively, yield:

$$\begin{array}{l} (a): J_I^f \ = \psi(j^f - \delta - g) \ , \\ (b): J_K^f = -\frac{\psi}{2}\left[j^2 - (\delta+g)^2\right] \ . \end{array} \tag{C3.3}$$

Applying the optimality condition shown in eq.(4.16b), the optimal investment rule is given by:

$$\psi(j^f - \delta - g) = J_I^f = 1/\gamma^D \left(\frac{q_{t+1}^f}{1 + re_{t+1}^f} - \gamma^{I,f} \right) \ . \tag{C3.4}$$

Using $q_{t+1}^f = \frac{\widetilde{VK}_{t+1}}{K_{t+1}^f}$ as well as $K_{t+1}^f = 1/G\left[j_t^f + (1-\delta)\right] K_t^f$, and solving for I_t^f yields:

$$I_t^f = \frac{1}{2} K_t^f \left[-a_1^f + \sqrt{\left(a_1^f\right)^2 - 4a_2^f} \right] \ , \tag{C3.5}$$

where:

$$\begin{array}{l} \text{(a)} \ a_1^f = 1 - 2\delta - g + \gamma^{I,f}/\psi\gamma^{D,f}) \ , \\ \text{(b)} \ a_2^f = (1-\delta)\left[\gamma^{I,f}/\psi\gamma^{D,f} - \delta - g\right] - \frac{G}{(1+re_{t+1}^f)} \frac{\widetilde{VK}_{t+1}}{K_t^f \psi\gamma^{D,f}} \ . \end{array} \tag{C3.6}$$

C.4 Agency Cost Function

The firm's vulnerability and the real cost of default increase with its debt level. Following the applied literature a positive relationship between the agency cost m and the firm's debt ratio b is assumed:

$$m^f = m^f(b^f), \qquad m'(b^f) > 0, \qquad m''(b^f) > 0, \qquad b^f = B^f/K^f \ . \quad \text{(C4.1)}$$

According to Strulik (2003) the functional form for the agency cost of debt $m(b)$ which can also be interpreted as deadweight loss is:

$$\begin{aligned} &\text{(a) } m^f(b^f) = \tfrac{m_1(b-m_2)^2}{b} \ , \\ &\text{(b) } m'(b) \quad = m_1 - m_1(\tfrac{m_2}{b})^2 > 0 \ , \\ &\text{(c) } m''(b) \quad = 2 \cdot m_1 \tfrac{(m_2)^2}{b^3} > 0 \ . \end{aligned} \quad \text{(C4.2)}$$

The optimal debt policy of a firm is derived by combining eq.(4.17b) and (4.16c):

$$re^f_{t+1} = \frac{\gamma^{D,f}}{\Omega f}\left[m'_f b_f + m_f + \frac{1 - z_1\tau^{P,f}}{\theta^{P,f}} i^H + \frac{z_2\tau^{P,f}}{\theta^{P,f}} r\right] \ . \quad \text{(C4.3)}$$

Totally differentiating yields:

$$\left[\frac{re^f_{t+1}}{\theta^{P,f}}\frac{\Omega^f}{\gamma^{D,f}} - \frac{(1 - z_1\tau^{P,f})i^H}{\left(\theta^{P,f}\right)^2} + \frac{z_1 i^H}{\theta^{P,f}} - \frac{z_2 r}{\left(\theta^{P,f}\right)^2}\right] d\ \tau^{P,f} = \left[m''_f \cdot b^f + 2m'_f\right] d\, b^f. \quad \text{(C4.4)}$$

Due to the corresponding empirical study for Germany, we use the empirical evidence from Gordon and Lee (1999) to calibrate the agency cost function. According to the data, a 1 %-point increase in the profit tax rate leads to a rise in the debt-asset ratio of 0.36 %-points:

$$\frac{d\ b_f}{d\ \tau^{P,f}} = \frac{\left[\frac{re^f_{t+1}}{\theta^{P,f}}\frac{\Omega^f}{\gamma^{D,f}} - \frac{(1-z_1\tau^{P,f})i}{(\theta^{P,f})^2} + \frac{z_1 i}{\theta^{P,f}} - \frac{z_2 r}{(\theta^{P,f})^2}\right]}{\left[m''_f \cdot b + 2m'_f\right]} = 0.36 \ . \quad \text{(C4.5)}$$

Replacing the denominator of eq. (B.4.5) by using the derivatives of the agency cost function we obtain:

$$m''_f \cdot b + 2m'_f = \left(2m_1\frac{(m_2)^2}{b^3}\right) b + 2\left(m_1 - m_1\left(\frac{m_2}{b}\right)^2\right) = 2m_1 \ . \quad \text{(C4.6)}$$

Thus, an explicit value for m_1 according to:

$$m_1 = \frac{1}{2 \cdot 0.36}\left[\frac{re^f_{t+1}}{\theta^{P,f}}\frac{\Omega^f}{\gamma^{D,f}} - \frac{(1 - z_1\tau^{P,f})i^H}{\left(\theta^{P,f}\right)^2} + \frac{z_1 i^H}{\theta^{P,f}} - \frac{z_2 r}{\left(\theta^{P,f}\right)^2}\right] \ . \quad \text{(C4.7)}$$

can be computed.

Substituting the first and second derivative of the agency cost function into the expression for optimal debt described by eq.(C4.3), we are able to calculate an explicit value for m_2 dependent on m_1:

$$m_2 = b + \frac{1}{2m_1}\left[re^f_{t+1}\frac{\Omega^f}{\gamma^{D,f}} - \frac{(1 - z_1\tau^{P,f})i^H}{\theta^{P,f}} - \frac{z_2\tau^{P,f}}{\theta^{P,f}}r\right] . \qquad \text{(C4.8)}$$

Appendix D – Computational Strategy

The equilibrium prices and quantities computed solve the optimization problem of households and firms and satisfy the government's intertemporal budget constraint. The initial steady state can be solved given the parameters describing the technology, preferences and the tax system. Solving for transitional equilibria is a two-point boundary problem, meaning that all predetermined values like historically accumulating capital and debt stocks start from initial conditions reflecting the actions in previous periods and converge to final steady state values of the expected variables. The transition from the initial steady state to the final steady state starts when the individuals are informed about the coming policy change. The temporary equilibria depend on a number of predetermined and on a number of forward looking variables, assuming perfect foresight. Predetermined variables such as the initial capital stock are derived from actions in previous periods while forward looking variables reflect the information inherent in future equilibria - for instance firm values equal the present value of future dividend payments or human capital represents the present value of future wages. Thus, the solution to this model must satisfy initial and terminal conditions and must be the result of solving a system of nonlinear differential equations. The terminal conditions are given by the steady state to which the model converges. To solve the applied dynamic CGE model I apply an iterative technique. Under the so-called Fair Taylor algorithm, one starts with time vectors of guessed values of expected variables. These values satisfy the terminal conditions. Then a sequence of temporary equilibria conditional on expected variables is computed. These equilibria are connected between periods by the accumulation of stocks. Afterwards revised vectors of expected variables are calculated and used to compute a new sequence of temporary equilibria. The iteration procedure is finished when the difference between guessed and actual values has almost vanished. (Fehr, 1999, Keuschnigg, 2002, Auerbach and Kotlikoff, 1987)

An additional issue relates to the uniqueness and stability of the achieved equilibrium. Since the model can actually be reduced to the core investment model which displays a unique, stable equilibrium, *IFOMod* also ensures uniqueness and stability.

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