Could the World be Flat?

Simulating Flat Tax Reforms in Western Europe

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Introduction

1.1 Motivation and key questions

"*The world is flat*",[1] but "*the world is not [flat] enough*"[2]. The flat tax idea has given rise to an ongoing debate both in academics and politics. Further on, it has recently been very successful, especially in transition countries in Eastern Europe. Although flat taxes are high on the political agenda in various Western European countries, they have not been implemented in these grown-up welfare states.[3]

The introduction of a flat tax with a basic tax allowance, a low uniform marginal tax rate, and a broad tax base as a reform of existing tax systems is supposed to have several advantages. "*[T]he flat-tax plan we have developed [...] is, we believe, the most fair, efficient, simple, and workable plan on the table*".[4] Most importantly, positive effects on employment and GDP as well as reduced tax distortions are expected. In addition, flat tax reforms are thought to reduce administration and compliance costs as well as incentives for tax avoidance or evasion. Therefore, "*the flat tax [...] is probably my favorite one of all. [...] But if we did pass it, all of a sudden, what do you have? You have the whole tax system run by a little old lady on a home computer, doing the work of all these thousands of*

[1] Friedman (2005).
[2] "The World Is Not Enough" (released in 1999) is the nineteenth film of the James Bond series and was directed by Michael Apted.
[3] Cf. **?** and Nicodeme (2007).
[4] Hall and Rabushka (2007), p. xiii-xiv.

bureaucrats and accountants. Passing that would be amazing, wouldn't it?"[5]

If it is such a good idea, why have only few countries implemented it? A reason for the recent flat tax success in transition countries could be the use of the low marginal tax rate by new governments as a signal for a regime shift towards more market-oriented policies (see **?**). Therefore, if such a reputation does not need to be acquired (e.g. in Western Europe), the flat tax idea might be less appealing. "*The simple fact though is that most of the world is not using flat taxes, and more seriously, they could not achieve many of these [flat tax] objectives even if they did*".[6] Indeed, the distributional effects seem to prevent a flat tax adoption in democracies with a well-established middle class. So maybe it is not such a good idea after all? "*[I]t is possible to have a flat tax, or to have democracy, but not both*".[7] Are all the countries with flat taxes on the wrong track? "*Adopting the flat tax would improve the overall performance of the economy. [...] Everyone's aftertax income would rise*".[8]

This disagreement on the implication of a flat tax raises questions. On the one hand, rather straightforward questions like "*What is a flat tax?*", "*Where to find it?*" or "*How to design it?*", are addressed in the next section. On the other hand, more complex problems arise:

1. *"How flat is the world?"*, i.e. to what extend do existing tax benefit systems differ from linearity?

2. *"What effects can be expected from a flat tax reform?"*, i.e. does a flat tax always yield adverse distributional effects in conjunction with positive efficiency effects? Or is it possible that a flat tax reform can overcome the fundamental equity efficiency trade-off?

3. *"Could or should the world be flat?"*, i.e. are there compelling reasons why countries should introduce flat taxes, or why they should not? Is it really possible that everybody could be better off after such a reform?

[5] Clint Eastwood, Hollywood director and film star, in Denis Mamill, "The age of Eastwood: Clint on fame, directing daughter Alison in Midnight 7, why Dirty Harry is History", New York Daily News, 19 November 1997.
[6] Murphy (2006), p. 95.
[7] Hettich and Winer (1999), p. 92.
[8] Hall and Rabushka (2007), p. xv.

The standard economic answer to these questions is: "*It depends*". Therefore, the key question underlying this analysis is: "*It depends on what?*". The motivation of this book is to answer these questions and to identify hereby the driving forces behind the economic effects of a flat tax reform. There are two dimensions to be considered that are mutually interdependent: the details of the reform and the environment of its implementation. First, the flat tax design (e.g. parameters such as marginal rate and allowance, tax base simplification or cash flow corporate taxation) plays an important role for the results. Second, the results crucially depend on the country under observation. The underlying income distribution and demographic structure as well as the institutional background (i.e. the tax benefit system, welfare state) are decisive for the outcome of such a reform.

The present book contributes to the existing literature in various ways. First, we provide a comprehensive survey of the state-of-the-art in simulation modelling for the ex-ante analysis of tax reform proposals and introduce three extensions to this methodology. Second, we analyse and compare different types of welfare states and tax benefit systems especially with respect to the distribution and redistribution of income to explain differing results across countries. Third, we conduct an extensive analysis of the key sources of the economic outcomes of flat tax reforms. For this purpose, the extended methodology of simulation analysis is applied to analyse different hypothetical flat tax scenarios and the impact of their key elements (tax base simplification, marginal tax rate and basic allowance) on equity and efficiency for Germany and the other EU-15 countries in a common microeconometric framework. The analysis differs from the existing literature mainly by analysing the distributional effects as well as the effects on welfare and employment in a uniform simulation model and by applying a systematic approach for choosing the flat tax parameters. In the remainder of this first introductory chapter, we will proceed as follows. In the next section 1.2, we will briefly describe the general flat tax idea, review the literature on flat tax reform and introduce the systematic approach of choosing its parameters. Then, in section 1.3, we will contextualize the different chapters and summarise their main results.

1.2 The Flat Tax

In this section, we describe when to call a tax "flat", discuss reasons why a country should, or should not, introduce a flat tax and summarise which countries have flat taxes. Furthermore, we review the empirical evidence on flat tax reforms and present a concept of systematically choosing flat tax parameters.

1.2.1 What makes a tax "flat"?

The probably most famous flat tax proposal is associated with Robert Hall and Alvin Rabushka.[9] Their "*Flat Tax*" is defined as a comprehensive income tax with a single marginal tax rate that is also applied to business income on a cash-flow basis. A personal allowance is available for labour income. Therefore, the Hall-Rabushka-Flat-Tax (HR) is essentially a consumption tax (VAT) with a rebate for low income households. However, this proposal has not been implemented in any country yet. Nonetheless, the HR proposal fuelled the political and academic debate about flat taxes around the world, starting in the U.S. and then continuing in Europe, as well. In this debate, the phrase "flat tax" is used more loosely and generally not associated with HR anymore.

Flat tax implies that some sort of proportionality is embedded in the income tax system, i.e. income is taxed at the same (flat) rate along the whole range of income. Its design, however, can be very different. There are two dimensions to be distinguished: tax schedule and tax base.

In general, a tax schedule can apply the same rate on all sources of income (i.e. comprehensive tax) or different rates on different types of incomes (i.e. schedular tax). Most countries with a flat tax system apply different rates to personal and corporate income, although a common rate has become more popular among the countries recently implementing these systems. Usually, the tax rate does not vary for components of personal income, i.e. capital and labour income is taxed at the same marginal rate independent of the level of income. There is also a number of countries which tax only capital income at a flat rate and levy a progressive rate schedule on labour income. However, these are usually not considered as flat tax

[9] See Hall and Rabushka (1983) and Hall and Rabushka (1985).

systems but dual or semi-dual income tax systems.[10]

For the tax base one can differentiate between concepts that allow or do not allow for tax reliefs which can be categorised into five groups (see OECD (1996)):

1. *tax exemption (E)*: part of income is tax exempt, i.e. not taxed,
2. *income-related tax deduction (D)*: amount, that is not fixed but that depends on the level of income, is subtracted from taxable income,
3. *tax allowance (A)*: fixed amount (per tax unit) is subtracted from taxable income,
4. *preferential tax rate*: some (sources of) incomes are taxed at a lower rate,
5. *tax credit*: (fixed) amount is subtracted from the tax liability.[11]

Exemptions, deductions and allowances are subtracted from gross income X to determine the tax base:

$$taxbase = X - E - D - A$$

Certainly, only the flat tax without any tax reliefs is a “pure” flat tax as in this case tax payments are indeed proportional to incomes. A flat income tax as such has only been applied in Georgia and recently in Bulgaria. In all other cases, the tax incidence on incomes is progressive, i.e. a single marginal flat tax rate (FTR) is combined with a general personal flat tax allowance (FTA):

$$T = FTR * \max(taxbase - FTA, 0)$$

Furthermore, in most countries also exist further tax reliefs (on gross income) beyond the basic flat tax allowance.

[10] See OECD (2006) for more about dual income tax systems. These countries include e.g. the Scandinavian countries.

[11] If the tax credit exceeds tax liability two possibilities arise: either the amount of the excess of the tax credit over the tax liability is paid to the taxpayer, in which case it is a “non-wastable” (i.e. refundable) tax credit, or this does not happen, and then the tax credit is “wastable” (i.e. non-refundable).

A further step towards overall flat tax incidence would be integrating income tax with other taxes and benefits. An example of this is a flat tax with a refundable tax credit, effectively combining taxes and benefits due to negative income tax at low-income levels. Depending on the generosity of the tax credit, it is either labelled as negative income tax or basic income (flat) tax.[12]

In this book, we analyse different flat tax concepts. Therefore, we cannot provide an unique working definition of what we call "flat tax". In the following chapters, we use the expression "flat tax" if at least a single marginal tax rate on labour income is considered. In chapters 3 and 5, we analyse personal income tax reforms with a single marginal tax rate, i.e. a "flat rate personal income tax". In chapter 3, we also simulate a comprehensive cash flow flat tax on personal and corporate income in the tradition of Hall and Rabushka ("cash flow flat tax"). In chapter 4, we integrate the income tax with social insurance contributions and cash benefits to simulate two different scenarios: a "negative income flat tax" and a "basic income flat tax".

1.2.2 Why (or why not) introducing a flat tax?

Introducing a flat tax is supposed to have several advantages but also some disadvantages. First of all, a single marginal tax rate can be justified by optimal tax literature. Mirrlees (1971) simulated the optimal tax schedule being close to linearity. However, this seminal contribution rests upon strong assumptions. Loosening these assumptions shows that the optimal tax schedule can be far from linearity (see e.g. Tuomala (1990) or Saez (2002)).[13] Nevertheless, proponents of a flat tax system dream of tax returns fitting on a postcard (Hall and Rabushka (2007)) or a beer coaster (Kirchhof (2003)) because of simplified tax filing. Proponents also expect more prosperity and wealth because of increasing economic growth. How shall this be achieved? There are two main benefits usually associated with flat tax systems: increasing incentives and compliance.[14]

Firstly, flat taxes can enhance incentives for working (labour supply), saving,

[12] For more on this see e.g. Atkinson (1995).

[13] However, this does not necessarily imply a progressive tax schedule at all. Diamond (1998) and Saez (2001), for example, derive a U-shaped pattern of marginal tax rates as being optimal.

[14] Cf. e.g. ?.

investing and taking risks (entrepreneurship). This does not necessarily come from the flatness of the tax schedule per se but could also be attributed to other forms of reduction in (average and marginal) tax rates especially at the top of the income distribution. Although there is a trend of lowering marginal statutory tax rates (and reducing the number of tax brackets), top rates can still be rather high in existing systems, e.g. around 40-60% in EU-15 (Eurostat (2007)). While the gains from flat and lower tax rates are explicit for the top income range, they are not so obvious for low incomes. The results here depend on the chosen flat tax parameters and the underlying income distribution. If e.g. effective marginal tax rates (EMTR) decrease for high income households but increase for low to middle income households, the overall incentive effects will be ambiguous ex ante and depend on each group's elasticity.

Secondly, as a flat tax is often part of a more fundamental tax reform, it can simplify income taxation significantly and therefore increase tax compliance and reduce tax planning, avoidance and evasion. This effect is perhaps weaker in developed countries, but it is often central for this kind of reforms in developing and transition countries. Nevertheless, the current systems in Europe on average have evolved to quite complex entities, therefore often violating the principle that taxes ought to be clear and simple. A simpler system is not only easier to grasp from the point of view of a single taxpayer, but is also more transparent at the aggregated level. Simplification can also decrease bureaucracy and therefore the costs of administration and compliance. Flatness itself only simplifies the rate schedule structure which can to some extent reduce tax arbitrage between different sources of income. However, the primary source of complexity is rather the tax base with its various exemptions. Other tax reforms of the type "tax rate cut cum base broadening" simplifying the tax system can as well increase compliance and reduce evasion.[15] Nevertheless, from a political economy point of view, introducing a completely new tax system labelled "flat tax" might be a good chance to fundamentally reform the existing tax system.

Moreover, another political economy argument for a simple tax system and a (linear) tax schedule with some restrictions regarding the tax parameters can be drawn from Brennan and Buchanan (1977). If the government is not benevolent

[15] Cf. e.g. Gale (1998).

but solely pursuits self-interest of policymakers, a flat tax can restrict the size of government by decreasing the potential to maximise revenue through higher tax rates.[16] This argument, however, can be questioned in various dimensions (see **?**). For instance, the size of government can be limited by other institutional devices. Furthermore, changing the assumptions to a less extreme view of politicians can lead to quite different solutions.

However, flat taxes can have a serious drawback in terms of their impact on the distribution of tax burdens.[17] Previous flat tax reforms and typical proposals lower marginal tax rates at the high income levels but increase the tax burden for middle-income ranges (especially if they are designed to be revenue neutral), resulting in a widening of the distribution of after-tax incomes. Therefore, the crucial question is, if a flat tax system equitably distributes the tax burden. The answer depends on the chosen parameter values (marginal rate and basic allowance) and is not trivial to answer. In terms of progressivity, a flat tax system (with a basic allowance) can be more or less progressive than an existing graduated rate structure again depending on the parameter values. Moreover, choosing these parameters plays a key role for the expected efficiency gains in terms of incentives and compliance. A low marginal rate (and allowance) will lead to higher incentives but redistribution in favour of high income households. A high marginal rate (and allowance) will benefit low income households more but reduce incentives. Nevertheless, the middle income households will likely lose in every (revenue neutral) scenario. These distributional effects could be the main reason limiting the flat tax spread in developed countries with a well established middle class.

To sum up, the expected effects of a flat tax are not thoroughly positive in every dimension (efficiency, equity, simplicity) nor unambiguous. Therefore, the next subsections summarise the existing flat taxes around the world and review the empirical evidence of flat tax reforms in the literature.

[16] See also Brennan and Buchanan (1980).
[17] Cf. e.g. Slemrod (1997)

1.2.3 Where can flat taxes be found around the world?

Until the first half of the 19^{th} century, flat taxes were common throughout the world.[18] Progressive tax schedules were first called for by Marx and Engels (1848) in their "Manifesto of the Communist Party". Since the rising success of progressive rate structures, flat rate income taxes only existed in tax havens like Hong Kong or the Channel Islands for a long period of time. But during the last decade, the flat tax idea has been remarkably successful, coincidentally especially in former Communist countries in Eastern Europe. In 2008, there were altogether 24 countries in the world having flat tax systems, half of them in Eastern Europe. Since its introduction in Estonia in 1994 several countries followed suit. The two other Baltic countries followed the Estonian example by setting the single tax rate close to the highest marginal rate in the existing system. Russia, however, was not only the first major country to introduce a flat tax, it also started a second flat tax wave with countries setting the tax rate close to the lowest existing marginal rate. Table 1.2.1 lists the countries having a flat income tax system in order of the year of adaption.[19]

There are striking differences between the tax systems labelled "flat tax". Most countries have introduced a flat tax rate at or close to the level of previous lowest marginal rate, exceptions are Latvia and Lithuania who have chosen the opposite. Some countries apply the same tax rate on personal and corporate income, the Slovak Republic even on VAT. The pattern of setting general allowances however is less clear. In most countries a fixed allowance was retained or introduced, exceptions include Russia with a gradual withdrawal and Ukraine with a sudden withdrawal above certain income levels which makes the effective marginal tax rate high at some stages. However, the amount of allowance varies significantly. For example, Georgia and Bulgaria have no allowance at all, whereas most countries having it increased during the reforms (**?**). Furthermore, in most countries, the introduction of the flat tax system was accompanied by additional reforms of

[18] Already in the holy bible the tithe, i.e. a 10% flat tax, was paid as a tax or contribution to religious or secularised organisations (see Leviticus 27:30-33).

[19] Several countries have no tax on personal income which could be considered as the flattest of all taxes with a zero marginal rate. These countries include: Andorra, the Bahamas, Bahrain, Bermuda, Burundi, Cayman Islands, Kuwait, Monaco, Nigeria, Oman, Qatar, Saudi Arabia, Somalia, United Arab Emirates, Uruguay and Vanuatu (see Nicodeme (2007)).

e.g. the tax base, social insurance contributions, benefits, indirect taxation or tax administration. Therefore, there is not one single flat tax system in practice, there are many different tax systems labelled as "flat". "*Hence, it is far from obvious that one rate would fit all*"[20].

		Personal Income Tax Rates			Corporate Income Tax Rates			Basic allowance
	Year	Before	After	2008	Before	After	2008	
Jersey	1940			20				
Hong Kong	1947			16				
Guernsey	1960			20				
Jamaica	1980		33.3	25		33.3	33.3	
Bolivia	1986		10	13		25	25	
Estonia	1994	16-35	26	22	35	26	22	Modest increase
Lithuania	1994	18-33	33	24	29	29	15	Substantial increase
Latvia	1997	25 and 10[a]	25	25	25	25	15	Slight reduction
Russia	2001	12, 20, 30	13	13	30	35	24	Modest increase
Serbia	2003	10-40	14	14	14	14	10	
Iraq	2004	up to 75	15	15		15	15	
Ukraine	2004	10-40	13	15	30	25	25	Increase
Slovak Rep.	2004	10-38	19	19	25	19	19	Substantial increase
Georgia	2005	12-20	12	12	20	20	20	Eliminated
Romania	2005	18-40	16	16	25	16	16	Increase
Kyrgyzstan	2006	10-20	10	10	20	10	10	Unchanged
Paraguay	2006	none	10	10	20	10	10	
Macedonia	2007	15-24	12	10	15	12	10	Unchanged
Kazakhstan	2007	5-20	10	10	30	30	30	Substantial increase
Mongolia	2007	10-30	10	10	15/30	10/25	10/25	Substantial increase
Iceland	2007	24.75, 26.75	22.75	22.75	18	18	18	Modest increase
Albania	2007	1-20	10	10	20	20	10	Increase
Montenegro	2007	15-23	15	15	15/20	9	9	Increase
Czech Rep.	2008	12-32	15	15	24	22	24	Substantial increase
Bulgaria	2008	10-24	10	10	10	10	10	Eliminated

Table 1.2.1: Flat taxes around the world (rates in percent)
Sources: Nicodeme (2007), Mitchell (2007) and **?**.

To sum up, despite many differences in their design, the existing flat tax systems generally have three elements in common. First, a single positive marginal

[20] Nicodeme (2007), p. 142.

tax rate below the previous top marginal rate, second, a rather broad tax base in comparison to the previous system, and third, a rather high exemption threshold.

1.2.4 What can be expected from a flat tax reform?

Actual reforms

Only two actual reforms have been addressed in the literature: the 2001 Russian reform by Ivanova, Keen and Klemm (2005) and the 2004 reform in the Slovak Republic by, among others, Brook and Leibfritz (2005). In the Russian case, the reform was followed by significant real growth in personal income tax revenue. But there was no strong evidence that this was caused by the reform itself or by improved law enforcement, nor could any positive labour supply responses be identified.[21] The Slovakian reform was expected to increase the level and efficiency of capital formation and enhance the incentives of unemployed workers to seek work. However, no evidence apart from revenue-neutrality has been reported yet. Although most real world reforms have been very recent, research on their effects is probably also limited due to the nature of those countries, i.e. no or little high-quality (micro-)data is available for the pre-reform period.

Hypothetical reforms

In the literature, there are several studies on efficiency and equity aspects of hypothetical flat tax reforms. One focus of these studies is the impact on employment and growth. Browning and Browning (1985) estimate an increase in labour supply in the US by 5%, whereas Heer and Trede (2003) simulate an increase in employment by 2% in Germany using a macro model. Cajner, Grobovsek and Kozamernik (2006) use a CGE model for Slovenia to simulate several tax reform scenarios. They find that, in general, progressive tax systems yield better results in terms of welfare than flat tax regimes but some flat tax scenarios might perform better in terms of growth and employment. Jacobs, de Mooij and Folmer (2007)

[21] See also Gaddy and Gale (2005) and Gorodnichenko, Martinez-Vazquez and Peter (2007). Furthermore, the situation in Russia is different in comparison to Western European countries insofar as the latter have a long tradition of taxation and a rather large tax administration to ensure tax compliance. Therefore, we assume effects of a flat tax reform on compliance to be less important in Western Europe than in transition countries of Eastern Europe.

use a CGE model for the Netherlands to analyse two hypothetical flat tax scenarios. They find a trade-off between equity and efficiency, i.e. either inequality and employment increases or, if inequality is kept constant, employment decreases.

A second group of studies focuses on the distributional effects of flat tax reforms. Ho and Stiroh (1998), Dunbar and Pogue (1998) and Ventura (1999) show for the US that high income households are relieved, whereas especially middle income households are burdened by a flat tax reform. Altig, Auerbach, Kotlikoff, Smetters and Walliser (2001) conclude that the lowest income households lose through a flat tax. In a study for the Netherlands, Caminada and Goudswaard (2001) also derive the result that a flat tax would yield redistribution at the expense of the lowest income deciles, but the magnitude of these effects is quite small. Several studies (e.g. Aaberge, Colombino and Strøm (2000) for Italy, Norway and Sweden, Adam and Browne (2006) for the UK, Decoster and Orsini (2007) for Belgium, Kuismanen (2000) for Finland and González-Torrabadella and Pijoan-Mas (2006) for Spain) find that the hypothetical introduction of a flat tax would redistribute in favour of high income households and increase labour supply (incentives).

1.2.5 How to choose flat tax parameters?

An important aspect which was rarely addressed in previous studies is the setting of tax system parameters for the ex ante analysis of hypothetical tax reforms. In terms of flat tax reforms this translates into the question of how to set the flat tax rate and the basic allowance. In our case we are interested in the relationship between flat tax parameters and distributional effects.[22] Davies and Hoy (2002) show theoretically that the inequality of after-tax distribution of income is monotonically declining in the flat tax rate and the associated level of basic allowance

[22] The setting of the key flat tax design features (marginal rate, basic allowance, tax base) crucially depends on the objective of the reform (like simplifying the system, improving compliance, broadening the tax base, increasing or decreasing the tax burden for selected groups, higher, lower or constant revenue) and if other reforms (like shifting tax burden between direct and indirect taxes, social insurance, social security) are planned to accompany the flat tax introduction.

generating the same tax yield.[23] Furthermore, for revenue neutral tax reforms replacing a graduated rate tax with a flat rate tax, they prove the existence of critical flat tax rates such that after-tax income inequality is - compared to the (existing) graduated rate tax:

1. the same for a given inequality index at a certain flat tax rate, $t = t_F^* \in (t_F^l, t_F^u)$,
2. always higher (according to any inequality index) for any flat tax rate equal to or below a lower bound, $t \leq t_F^l$,
3. always lower (according to any inequality index) for any flat tax rate equal to or above an upper bound, $t \geq t_F^u$.

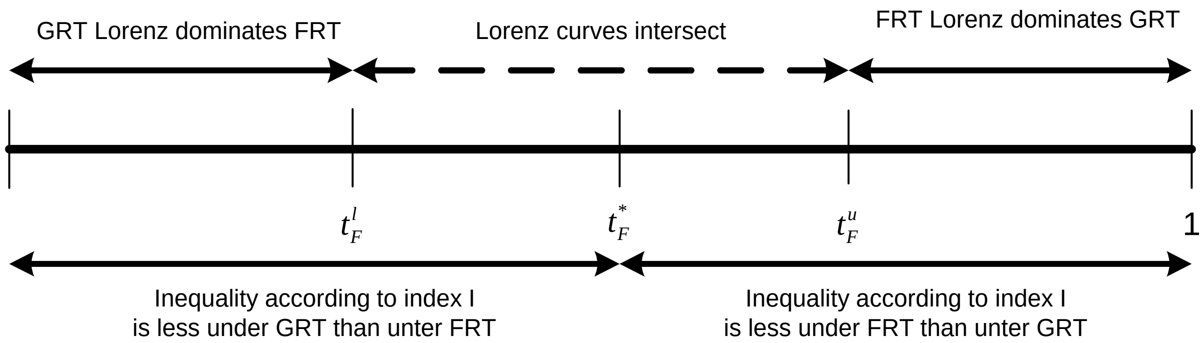

Figure 1.2.1: Comparison of critical tax rates
Source: Davies and Hoy (2002), p. 40.

Figure 1.2.1 illustrates these regularities. In other words: When moving from a graduated income tax to a flat tax system that yields the same revenue, three critical flat tax rate values with respect to after-tax income exist. The first depends on the chosen inequality index, the other two do not, i.e. they stem from the concept of Lorenz dominance. First, for a given inequality index I, a flat rate value t_F^* can be found such that inequality remains unchanged. Further on, inequality in terms of this index is always higher (lower) below (above) this critical value

[23] As a flat tax schedule has only two parameters - marginal rate and basic allowance - it is only possible to choose one freely when accounting for revenue neutrality.

after the flat tax introduction. Second, there exist a lower bound t_F^l such that for all marginal rates below this critical value inequality in terms of any inequality measure is always higher than compared to the existing system (i.e. the existing graduated rate tax Lorenz dominates the flat tax). Third, inequality is always lower above an upper bound t_F^u according to any inequality index (i.e. the flat tax Lorenz dominates the existing graduated rate tax). These results apply to any inequality measure satisfying the Pigou-Dalton principle of transfers and under the assumption that behaviour is not affected by tax system changes.

The lower bound corresponds to a flat tax rate if the personal allowance is fixed, i.e. is at the same level as for the pre-reform graduated rate tax. The upper bound is such that a person with the highest income pays the same tax under each scheme. Additionally, the flat rate at the lower bound is supposed to exceed the lowest marginal tax rate under the graduated rate and the flat rate at the upper bound remains below the highest marginal tax rate under the graduated rate. The critical value between those boundaries cannot be determined a priori as it depends on a chosen inequality index.

We rely on these theoretical insights to systematically construct hypothetical flat tax reforms. However, these theoretical regularities are only approximations for empirical estimations because existing tax systems are further complicated by the presence of other tax deductions and allowances. Some systems do not even have a (well-defined) basic allowance to start with. More so, the definition of revenue neutrality is not straightforward. If revenue neutrality is only limited to income taxes then it might not preserve the mean of the disposable income distribution, as there are often instruments whose eligibility or amount depend on net income after taxes (e.g. means-tested non-taxable benefits) and, therefore, might change their value when tax systems are modified. If the overall net balance from taxes and benefits is retained then income tax revenues rarely remain constant. Further on, the premise of ex-ante revenue neutrality (i.e. without behavioural responses) is a rather strong assumption but it is necessary to apply the Davies and Hoy (2002) approach.[24]

[24] If the scenarios were chosen to be revenue neutral ex-post, i.e. after labour supply reactions, the marginal tax rates could be lower (higher) in case of increasing (decreasing) labour supply but the underlying research question would be different. Our aim is to analyse scenarios that

1.3 The agenda

As stated above, the aim of this book is to identify the conditions which mainly influence the economic effects of a flat tax reform. The setup of this analysis is as follows. Chapter 2 introduces the methodology. Chapter 3 analyses the relevance of the flat tax design. In chapter 4, the European countries are compared regarding their institutional background and the underlying income distribution. In chapter 5, the role of these country specific aspects and their impact for possible flat tax reforms is investigated. Chapter 6 draws conclusions. In the following, we briefly summarise the content of the following four chapters and sketch the main results.

1.3.1 Chapter 2: Methodology

In this chapter, the methodology used for the analysis in this book is described together with three contributions to the literature on the ex-ante analysis of fiscal policy reforms.

First, the simulation models are introduced. The method of simulation analysis aims at analysing and quantifying the effects of different policies on individuals and key economic indicators. The first contribution to this literature is the development of a linked microsimulation and CGE model (FiFoSiM) which will be also described in this chapter.

Second, to analyse the impact of policy reforms on equity in terms of distributional effects four subconcepts are described and compared: inequality, polarisation, progression in taxation, and income poverty and richness. The second methodological contribution of this book is the introduction of a class of sophisticated richness measures.

Third, distributional effects can be computed abstracting from behavioural changes (first round effects) or allowing for behavioural responses of the individual agents in the economy (second round effects). Behavioural responses typically included in the analysis are labour supply responses. Further on, the distortion of the labour-leisure-decision can be estimated to evaluate the welfare impacts of

are equal ex-ante and to reveal the ex-post differences by analysing the economic effects of the scenarios in terms of equity and efficiency.

the reform proposal. The application of the theoretical measures of welfare to the ex-ante evaluation of fiscal reforms is the third contribution of this book.

In the following chapters, this methodology is applied to analyse different flat tax reform proposals and their consequences.

1.3.2 Chapter 3: Simplification and flat tax in Germany

The recent success of the flat income tax in Eastern Europe suggests that this concept could also be a model for countries in Western Europe. In this chapter, we conduct a simulation analysis of the economic effects of three different flat tax reforms for Germany.

In the first step, we analyse the effects of simplifying the tax base, i.e. the abolition of a set of deductions from the income tax base. We find that the effects of revenue neutral tax base broadening depend on the type of rate schedule adjustment. The combination with a flat rate tax increases income inequality, but it also leads to efficiency gains in terms of labour supply and welfare. The combination with a rate schedule adjustment which preserves the directly progressive schedule reduces inequality and efficiency.

In the second step, we analyse the effects of two revenue neutral flat tax scenarios with different marginal tax rates without changing the tax base. We find that a flat rate tax with a low tax rate and a low basic allowance yields positive static welfare effects amounting to approximately 1.8 per cent of income tax revenue but increasing income inequality. The increase in income inequality can be avoided by combining a higher tax rate with a higher basic allowance. But, in this case, the efficiency gains vanish.

In the third step, we analyse the introduction of a cash flow flat tax in the tradition of Hall and Rabushka (1985). When taking the general equilibrium effects into account, a personal income flat tax can indeed overcome the fundamental equity-efficiency trade-off. This, however, is true only in the long-run, whereas the adverse immediate distributional effects prevail. Furthermore, combining this flat tax with a flat cash flow tax on corporate income still increases inequality.

To sum up, our analysis shows that the selection of the schedule and tax base parameters are crucial for the effects of flat tax reforms in terms of equity and efficiency. We conclude that, due to their limited efficiency effects and their problematic distributional impact, flat tax reforms are rather unlikely to spill over to the grown-up democracies of Western Europe. With its socio-economic and demographic structure, Germany can be seen as a typical Western European democracy. Therefore, the qualitative results of our analysis are of interest to a wider range of countries. This is further investigated in the next chapters.

1.3.3 Chapter 4: Are European welfare states flat?

Countries worldwide differ with respect to various dimensions including the design of their tax benefit system. The outcome of a flat tax reform therefore depends not only on its design but also on the country in which the reform will be implemented. In this chapter, we compare the European countries and classify them into four types of welfare states with respect to the design of the tax benefit system in terms of distribution and redistribution of income: Anglo-Saxon, Nordic, Continental and Mediterranean welfare states.

Anglo-Saxon countries provide a minimum level of social protection. Tax rates and social insurance contributions are rather low. Continental countries use benefits that depend on the history of paid contributions (Bismarckian system) which are financed though rather high compulsory contributions. Nordic countries apply high taxes but lower contributions for a similarly high level of redistribution. However, they use universal benefits not depending on the contribution history (Beveridgean system). Mediterranean countries provide a rather low level of social security (comparable to the Anglo-Saxon countries) using contribution-based Bismarckian social insurance systems (like Continental countries).

These results suggest that the outcome of a flat tax reform should differ across heterogeneous countries but it is expected to be similar within homogeneous clusters of countries. Further on, we ask to what extent existing tax and transfer systems effectively differ from linearity. We use the deviation from linearity as a summary measure for the welfare state design. We find that a flat negative income tax is a rather good approximation of the existing tax benefit systems in some European countries, including Germany. However, the goodness-of-fit varies across the EU-15 countries implying that some countries have highly non-linear systems.

1.3.4 Chapter 5: Flat tax reforms in Western Europe

As mentioned before, the implementation of flat taxes is limited mainly to countries in Eastern Europe. One may argue that flat tax receives less political support in countries with a well-established middle class due to its distributional effects. The aim of this chapter is to provide an empirical analysis of the distributional and efficiency effects of different hypothetical flat tax reforms for Western European countries. We undertake a systematic approach for choosing flat tax parameters and rely on EUROMOD, a tax-benefit microsimulation model for the EU-15, which ensures comparable results through a common framework.

Our simulations show that, on the one hand, flat tax rates required to attain revenue neutrality with existing personal allowances improve labour supply incentives. However, they mainly benefit households with high incomes resulting in higher inequality, poverty and polarisation. On the other hand, flat rates necessary to keep the inequality levels unchanged are rather high but do not weaken labour supply incentives in all considered countries, therefore allowing for some scope for flat taxes to overcome the fundamental equity efficiency trade-off. Our analysis suggests that an implementation of a flat tax regime seems most likely in countries with a Mediterranean type of welfare state which is characterised by a high existing polarisation of the income distribution.

Chapter 2

Methodology

2.1 Introduction

In the discussion of the flat tax "a notable and troubling feature [...] is that it has been marked more by rhetoric and assertion than by analysis and evidence".[1] Given that flat taxes have not yet been implemented in Western countries, the effects of flat tax reforms in these countries can only be studied on the basis of simulation models. The method of simulation analysis aims at analysing and quantifying the economic effects of different policies based on the given institutional background to compare and evaluate different reform proposals with respect to equity and efficiency effects.

For the analysis of fiscal reforms, microsimulation and CGE models have been widely used in the literature. To utilise the complementary advantages of both types, these models can be linked. To analyse the impact of policy reforms on equity in terms of distributional effects, four subconcepts can be differentiated: inequality, polarisation, progressivity, and poverty and richness. Distributional effects can be computed without (first round effects) or with (second round effects) allowing for behavioural responses of the individual agents in the economy. Behavioural responses typically included in the analysis are labour supply responses. Based on these labour supply effects, the distortion of the labour-leisure-decision can be estimated to evaluate the welfare impacts of the reform proposal.

[1] **?**, p. 3.

Before analysing different flat tax reform scenarios in the following chapters, this chapter describes and extends the method of simulation models for the analysis of fiscal policy reforms with three contributions: First, the construction of a linked microsimulation and CGE model, second, the definition of a comprehensive measure of richness, and third, the application of theoretical measures of welfare to the ex-ante analysis of fiscal reforms. Each contribution will be explained in the next sections in the context of the methods developed in the literature. Section 2.2 introduces the method of simulation analysis. Section 2.3 reviews the analysis of distributional effects. This analysis is extended in section 2.4 to incorporate behavioural responses in terms of labour supply and welfare effects. In sections 2.5 and 2.6 the simulation models FiFoSiM and EUROMOD which are used for the analyses in this book are described in detail.

2.2 Simulation models

2.2.1 Introduction

In this section, simulation models are introduced and described as a method for the ex-ante evaluation of the various consequences of fiscal reforms.[2] Various proposals to reform the complex tax and benefit systems exist in every welfare state, and new proposals are being presented in policy debates each year. In the run-up of the implementation of a certain reform, in many cases the expected consequences remain an unsolved puzzle. Especially the behavioural responses of the (bounded) rational individuals are extremely difficult to estimate ex-ante. Knowing these responses, though, helps to evaluate and judge different reform proposals regarding their target achievement and cost efficiency. Estimating them, however, is not a trivial task. The complexity of existing welfare states requires the usage of simplified models for the evaluation of reform proposals. Theoretical models should be kept small and simple to be able to understand the general principles. They allow to point out a single argument in a simplified framework and to construct hypotheses which can be tested empirically. Empirical models allow for an econometric evaluation of a given reform and are especially useful whenever the magnitude,

[2] This section is based on Peichl (2005).

and thus not only the sign, of the effects are to be estimated. The quality of the empirical analysis crucially depends on the availability of high quality micro data. If the reform already has been implemented and data is available for the pre- and post-reform period, an ex-post analysis is possible using standard econometric procedures. On the other hand, if the reform has not been implemented, only simulation models can provide information for an ex-ante analysis of different reform proposals.

In general, simulation models are tools which are designed to answer "what if" questions about different policy reform options. The method of simulation analysis uses actual economic data to estimate how an economy might react to changes in external factors (e.g. policy parameters). Simulation models map the complex tax benefit system to analyse and quantify the effects of different policies based on the given institutional background. Other than in the natural sciences, it is seldom possible in economics to construct natural experiments for the analysis of a given treatment (policy). Policy simulations can be interpreted as quasi-experiments which allow the economist to ex-ante analyse a reform proposal controlling for behavioural responses of the micro units in the economy. Simulation models are frequently used by economists, policy-consultants and policy-makers to predict the impacts of changes in fiscal policies on individuals (gains and losses, income distribution), the government budget and key economic indicators (e.g. growth, employment, prices, consumption) to provide the political decision makers with well-founded decision guidance. This is done by setting up alternative scenarios by varying the rules of the tax benefit system and then simulating the impacts of these changes on individual and aggregated variables.

Several different types of simulation models can be used depending on the research question in mind. In the following, we focus on public economics models which can be used for the analysis of tax benefit reforms. Figure 2.2.1 classifies these model types according to the underlying level of aggregation into five classes.[3]

Microanalytic models focus on the direct effects of fiscal reforms on the micro units and do not consider the broader economic environment in which the differ-

[3]Cf. Spahn, Galler, Kaiser, Kassella and Merz (1992). Basic macro simulation models as well as group simulation models are rarely used anymore and therefore excluded from this review. See Heilemann and Wolters (1998) and Müller (2005) for further reading on these models.

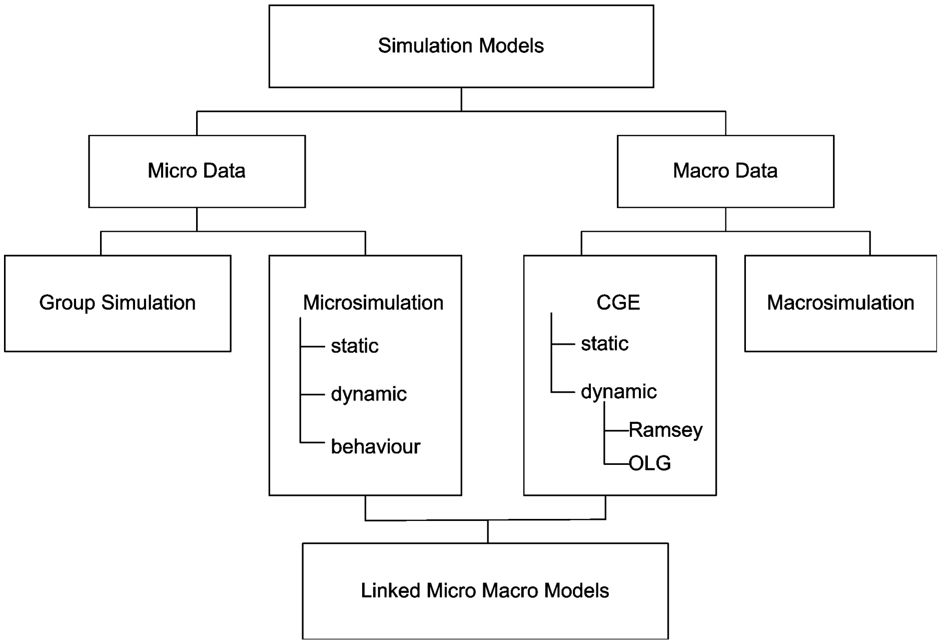

Figure 2.2.1: Classification of simulation models

ent agents are acting, whereas macroanalytic models try to additionally capture indirect macroeconomic effects. Micro models offer great flexibility specifically regarding the mapping of complex tax benefit systems, whereas macro models usually give no insight into how aggregate changes in the economy and the new equilibrium solution affect individuals and their behaviour. During the last years, a tendency of linking micro and macro models has emerged in computational economics to utilise the complementary advantages of micro and macro models.

The aim of this section is to describe the status-quo of the research in the field of simulation models by introducing and comparing the different types of models. The following subsections describe in more detail the standard procedures of computable general equilibrium models (CGE), microsimulation models (MSM) and linked micro macro models.

2.2.2 Computable General Equilibrium Models (CGE)

General equilibrium theory has provided important insights about mechanisms that determine the allocation of resources on mutually interdependent markets. Computable General Equilibrium (CGE)[4] models use this general equilibrium theory to empirically analyse and quantify this allocation of resources. CGE models are used instead of analytical general equilibrium models whenever the size and complexity make such analytical models mathematically intractable. Although CGE models are based on the microeconomic general equilibrium theory they usually use aggregated macro data for the analysis. The first CGE model was presented in Johansen (1960). With the development of fast computers and suitable software a large number of CGE models has been developed and applied to policy analysis since then.

CGE models use as realistic values as possible of exogenous variables (e.g. elasticities, tax rates) to numerically compute the values of the endogenous variables (e.g. prices, quantities) with the aim of quantifying economic equilibria to compare the impact of policy measures on these equilibria. Applications of CGE models include analyses of tax reforms, changes in trade policy regimes, economic integration, agricultural policies and energy policies. The analysis focuses particularly on the long-run allocation of factors and goods, whereas short-term distributional effects cannot be analysed in a sophisticated way using this type of models.

Standard procedure

A CGE model is usually a multi-sector model based on real world data of one or several national economies to model the interactions of individual households and firms on interdependent markets. However, in a typical CGE model there is only one or possibly a few (1 - 5) representative agents, while the number of firms (production sectors) is generally larger (3 - 75). A CGE model consists of equations describing the variables and a database consistent with these equations. For all agents (households, firms, government) an optimising behaviour, i.e. utility and

[4] Sometimes this class of numerical economic models is also called Applied General Equilibrium (AGE) models. This subsection is based on Peichl (2005), Bergs and Peichl (2006) and Bergs and Peichl (2008). Further introductions to CGE models can be found in Kehoe and Prescott (1995), Fehr and Wiegard (1996) or Bergman (2005).

profit maximization on the part of households and firms, is assumed to model their behaviour on different markets. In general, standard models assume product and factor markets to be competitive and relative prices flexible enough to simultaneously clear all markets. However, it is possible to allow for non-market clearing (e.g. unemployment or inventories), imperfect competition (e.g. monopolistic competition)[5], heterogeneous agents, and taxes or externalities (e.g. pollution). CGE models are almost always focused on the real side of the economy and thus do not include financial assets. Consequently a typical CGE model endogenously determines relative product and factor prices, but cannot determine nominal prices. In particular CGE models are aimed at quantifying the impact of specific policies on the equilibrium allocation of resources and relative prices of goods and factors.

For the numerical computation of equilibria, it is essential to specify functional forms of production and utility functions as well as the values of the exogenous parameters of the model. The specification of these functions and parameters is of key importance for the model results. There are two general approaches. On the one hand, these parameters can be estimated using econometric methods based on time series or panel data or, on the other hand, these values can be calibrated[6] using a micro consistent dataset reflecting an economic equilibrium at a given point in time. Often both methods are combined and some parameters are estimated (or estimates are taken from the literature) and other parameters are calibrated to replicate the benchmark equilibrium given in the data. The construction of a micro consistent database can be rather time consuming if information from several sources has to be combined. In general, the skeletal structure is based on an input-output-table which is enhanced to a so called "Social Accounting Matrix" (SAM).[7]

CGE models allow quantifying the impacts of policy reforms. However, they - as all models do - obviously rest upon strong simplifying assumptions about optimising behaviour, competitive markets and flexible prices. Furthermore, the calibration method which is often used to define key model parameters is often seen to be rather arbitrary. In view of this, the validity and therefore also the use-

[5] See e.g. Harris (1984).

[6] See Mansur and Whalley (1984) and Lau (1984) for an extensive discussion of the calibration method.

[7] See Pyatt and Round (1985) and Kehoe (1998) on how to construct a SAM.

fulness for policy evaluation of the results is often seriously questioned. However, the usefulness of a CGE model depends on the aims and purposes it was designed for and what the alternatives are. If a general equilibrium model cannot be solved analytically, a numerical solution can help to identify general equilibrium effects of policy changes even if key parameters of the model are quite uncertain. The role of these parameters for the results can be explained using extensive sensitivity analyses. Furthermore, even if the precise magnitude of the effects remains uncertain, it still might be possible to identify if the effects are small or large or at least to compare and rank different scenarios based on these results.

CGE categories

Different categories of CGE models can be distinguished. First of all, it should be emphasised that the models within each category can differ in many ways (e.g. heterogeneity in terms of number of agents, sectors, factors or commodities, as well as the representation of the government or foreign trade with the rest of the world). Nevertheless, some common elements can be attributed to different categories. The most appropriate classification for most modelling approaches is to distinguish between static and dynamic models. In addition it is useful to distinguish between single-country (national) and multi-country (global) models. Generally, single-country models are much more detailed in terms of sectors and household types and are especially designed to analyse country-specific policy issues. Multi-country models are used for multi-lateral policies (e.g. trade agreements, emission trading schemes) and are usually less detailed in terms of intra country heterogeneity.

Comparative-static models are by far the most common class of CGE models.[8] The economy is modelled at two given points in time only: the status quo benchmark and the future counterfactual equilibrium. The results of these models are the long-run differences (usually reported in percent changes) between the benchmark equilibrium and the future equilibrium to which the economy converges after a given exogenous shock. The transition path towards this new equilibrium is not explicitly modelled. This, however, allows for a more detailed specification of the single-period economy in terms of numbers of agents, sectors or commodities to

[8] See e.g. Shoven and Whalley (1984), Shoven and Whalley (1992) or Kehoe and Kehoe (1994) for an introduction.

be represented in the model.

Dynamic CGE models, by contrast, explicitly model this transition path. The equilibrium is computed for all future points in time (at discrete intervals) until the model horizon ends. These models are far more challenging to design, maintain and solve but allow a more realistic representation of the adjustment process of a policy change. However, the increasing complexity of dynamic models often reduces the heterogeneity of the agents and therefore, in general, smaller number of agents and sectors are represented in dynamic models. Dynamic models assume rational expectations of agents, i.e. they use all available information for the best guess of the future. This makes it necessary to simultaneously solve for all periods. Stochastic CGE models explicitly incorporate uncertainty about the future into the analysis. In contrast, recursive-dynamic CGE models assume that behaviour depends only on current and past states of the economy (assuming myopic expectations).[9] These models can be solved sequentially (one period at a time). Dynamic models can be further distinguished according to the representation of the household side of the economy. CGE models based on the Ramsey (1928) growth model assume an infinitely living representative agent. In contrast, overlapping generations models (OLG) assume periodically overlapping generations. These models can be further distinguished into models with identical lifetime for all generations (see Auerbach, Kotlikoff and Skinner (1983) and Auerbach and Kotlikoff (1987)) or models with a stochastic time of death (see Blanchard (1985)).

Applications

There are many fields for applications of CGE models in economics. The short review in this section focuses on recent models for the analysis of tax reforms especially in Germany.[10]

Hutton and Ruocco (1999) use a static model to analyse different tax reforms in Germany, France, Italy and the UK especially with respect to their labour market performance. Sørensen (2002) also uses a static model for the analysis of the German tax reform of 2000.

[9] See Ballard, Fullerton, Shoven and Whalley (1985).

[10] See e.g. Fehr and Wiegard (1996) for a review of additional models. An application for the US can for example be found in Altig et al. (2001).

Keuschnigg and Dietz (2003) use an OLG model to analyse the corporate tax reform in Switzerland. This model is adapted to Germany by Radulescu and Stimmelmayr (2004) who analyse the introduction of a dual income tax. Fehr and Wiegard (1998) use an Auerbach-Kotlikoff OLG model to analyse different income tax reform proposals.

Graafland, de Mooij and Nibbelink (2001) and Bovenberg (2003) use the recursive-dynamic model MIMIC to analyse the impact of tax reforms on the Dutch labour market. The German PACE-L model was constructed following the MIMIC approach. This model is used to analyse the labour market effects of hypothetical income tax (Boeters, Gürtzgen and Schnabel (2006)), VAT (Boeters, Böhringer, Büttner and Kraus (2006)) or welfare (Böhringer, Boeters and Feil (2005)) reforms.

2.2.3 Microsimulation Models

Microsimulation models (MSM) are quantitative models of the tax benefit system and have been introduced into social sciences and economics by Orcutt (1957) and Orcutt, Greenberg, Korbel and Rivlin (1961).[11]

Standard procedure

Microsimulation models are partial equilibrium models focusing on one side (e.g. the household side) of markets and do not consider the broader economic environment in which the micro units are acting. Tax benefit models usually only simulate first round effects where the behavioural response of the agents (to the change imposed on the system) is not captured. These tax benefit models can be combined with a labour supply model allowing the simulation of (partial) second round effects in terms of behavioural responses on the labour market.

In the centre of this microanalytic approach is the behaviour of individual agents to which the observed social and economic processes can be attributed. MSM are based on micro data which offers a great flexibility especially regarding a detailed mapping of the complex tax benefit system. These data samples allow the modelling of structural characteristics of micro units (persons, households, firms)

[11] This subsection is based on Peichl (2005). See e.g. Gupta and Kapur (2000), Harding (1996) or Bourguignon and Spadaro (2006) for further MSM surveys.

within a particular tax benefit system. This allows MSM to reflect the considerable heterogeneity within the population by taking into account the characteristics and circumstances of each individual. MSM can be used to analyse the status quo of tax benefit rules by providing detailed data on single policy variables. Furthermore, these factuals are then used as a benchmark (baseline) to evaluate the impact of a reform scenario. Such a counterfactual can be a single policy or various interacting and interdependent policies within the complex tax benefit system as well as fundamental reform proposals of the whole system. To analyse a reform scenario, the socioeconomic system is modelled and applied to the sample micro units, which in turn are weighted with population weights to extrapolate results for the whole population. Therefore, the results of MSM can be analysed either at the individual level or at different levels of aggregation. Despite these advantages there are some limitations. Every empirical analysis relies on high quality data of all key variables. If such data is not available, simplifying assumptions are necessary which lead to biased estimations. If, e.g., key information necessary for some (minor) tax rules is not available, it is not possible to include these rules into the mapping of the tax benefit system.

MSM categories

Microsimulation models can be differentiated according to the time dimension into static and dynamic models and according to the modelling of behavioural responses into behavioural and non-behavioural models.

Static vs. dynamic MSM

Static MSM use cross-sectional data at a given point in time. Often this data has to be aged to the year of analysis which might be further in the future using the static ageing technique, i.e. reweighting of individual records based on macroeconomic indicators.[12] Static models mimic the tax law by applying the (current or an alternative set of) tax benefit rules to individual units. These models are essential tax benefit calculators for all individuals and therefore allow to model the tax benefit rules for every point of the income distribution. This allows the

[12] See Gupta and Kapur (2000) for a review of the ageing techniques.

user to simulate the instantaneous first-round effects (in terms of the fiscal and distributional effects, i.e. the gains and losses in different variables at the individual or aggregated level) of policy changes. They allow for a comparative-static analysis of the pre- and post-reform state of the economy without looking at the adjustment process.

Dynamic MSM try to endogenously explain this process of adaptation through the incorporation of dynamic ageing of individual records over time based on the probabilities of the happening of different real life events (e.g. marriage, divorce, birth of a child). The relevant life processes are simulated and the individual characteristics are recalculated at each period in time which allows moving the micro units forward through time. On the one hand, dynamic MSM allows the modelling of demographic changes over time, but on the other hand, dynamic models have a higher demand regarding the modelling, the data requirements and the computational resources than static models. Therefore, often static models which are easier to build and maintain are used in combination with a behavioural model for the analysis of the short-term effects of policy reforms.

Behavioural responses

Behavioural responses can be simulated with both static and dynamic models. Sometimes behavioural models are labelled dynamic. Although dynamic models often include behavioural responses, they do not necessarily have to include them.

Non-behavioural models do not allow the individuals to change their behaviour as a consequence of a given policy reform. These models are often used to estimate the immediate fiscal and distributional effects. This is done by generating income profiles for various groups of individuals to highlight discontinuities in the tax benefit rules which in turn can be modified by policy-makers.

Behavioural models simulate some kind of behavioural response to a policy change. These responses can include the supply and demand of factors and goods. The most common applications are models of labour supply. Labour supply models allow the modelling of both the extensive (participation) and the intensive (hours worked) labour supply decision. The labour supply model can be either integrated into the microsimulation model or it can be linked to a MSM as an external module. There are several possibilities of how to model the labour supply of a tax unit (e.g. individual vs. household labour supply, discrete vs. continuous working hours, selection of utility functions). Recent surveys of the empirical labour market literature and different kinds of labour supply models are for example provided by Heckman (1993), Blundell and MaCurdy (1999) or Creedy, Duncan, Harris and Scutella (2002).

Applications

Various microsimulation models exist worldwide. The review in this subsection focuses on German models which are used for the analysis of reforms of the tax benefit system.[13]

Wagenhals (2001a) uses GMOD to simulate the fiscal and distributional effects of the income tax reform act of 2000. Wagenhals (2001b) analyses the incentive and distributional effects of the reform proposal of Kirchhof, Altehoefer, Arndt, Bareis, Eckmann, Freudenberg, Hahnemann, Kopei, Lang, Lückhardt and Schutter (2001). Haan and Steiner (2005) use STSM to estimate the fiscal, distributional and labour supply effects of the income tax reform act of 2000. Steiner and Wrohlich (2004) analyse the labour supply effects of the German system of family taxation. Merz and Zwick (2002) and Merz, Stolze and Zwick (2002) analyse the income tax reform act of 2000 with MICSIM especially with respect to the upper end of the income distribution.

Immervoll, Kleven, Kreiner and Saez (2007) use the European model EUROMOD to analyse different reform scenarios in the EU-15 countries and Verbist (2004) analyses the distributional effects of the existing tax benefit systems in these countries.

2.2.4 Linked Micro-Macro Models

On the one hand, CGE models provide an economy wide perspective of a given shock after the economy has fully equilibrated.[14] The need to specify and calibrate functional forms and parameters for all agents on all markets reduces the number

[13] See e.g. Wagenhals (2004) or O'Hare and Gupta (2000) for further surveys.
[14] This subsection is based on Peichl (2008).

of agents to be modelled dramatically. Therefore, in general, few representative agents are used which reduces flexibility and the possibilities of a detailed modelling of the tax-benefit system. In consequence, these models give no insight into how aggregate changes in the economy and the new equilibrium solution affect individuals. On the other hand, MSM are based on micro data which offers great flexibility specifically regarding the mapping of the complex tax benefit system. These models are partial equilibrium models focusing on one side (e.g. the household side) of markets and do not consider the broader economic environment in which the micro units are acting.

During the last years, a tendency of linking micro and macro models has emerged in computational economics to utilise the complementary advantages of MSM and CGE models.[15] A linked model can provide a more powerful tool for policy analysis than using results from two stand-alone MSM and CGE models.[16] Outputs from the macro model can be used to align the predictions of the micro model and to enable general equilibrium feedbacks and interactions among variables in the micro model. Outputs from the micro model can be used to calibrate the macro model and provide a microeconomic basis for aggregate behaviour. Hence, the key advantage of a linked micro macro model is the feedback which is used to resolve the model corresponding to a revised set of parameters. However, achieving these feedback effects through linking MSM and CGE models is not a trivial task.

The idea of linking micro- and macroeconomic simulation models is almost as old as the stand-alone models themselves.[17] Orcutt (1967) suggests to link models operating at different levels of aggregation through intermediate variables. Nevertheless, the number of researchers developing linked micro macro models is still very small worldwide (see Davies (2004)). Nonetheless, recent advances in computational and econometric methods are leading to a growing interest in combining these modelling techniques. The yet recent development in this area can be clearly attributed to the progress in computer and information technology which makes these large-scale models feasible to solve.

[15] Cf. Davies (2004) for an overview. Most of these models deal with trade liberalization in developing countries.

[16] Cf. Anderson (1990).

[17] See Orcutt (1967) or Conrad (1991) for Germany.

There are two general possibilities for linking the models. On the one hand, one can completely integrate both models into a joint model[18] or on the other hand, one could combine two separated models via interfaces (layered approach).[19] The first approach requires the complete micro model to be included in the CGE model which demands high standards for the database and the construction of the integrated model. This often results in various simplifying assumptions.

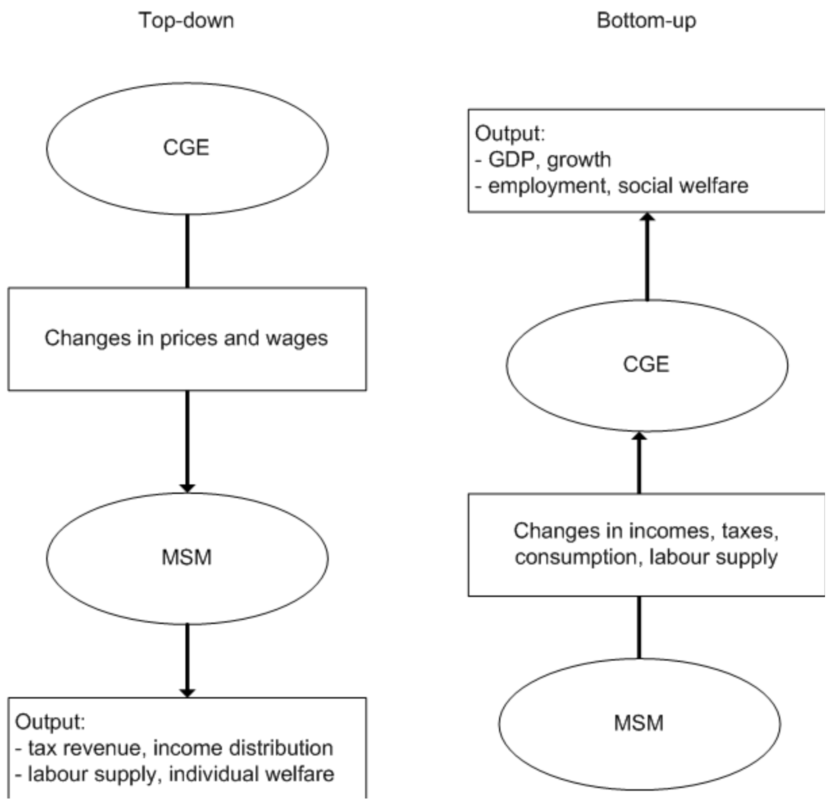

Figure 2.2.2: Top-down and bottom-up

The layered approach can be differentiated into "top-down" (see Figure 2.2.2, left-hand side), "bottom-up" (see Figure 2.2.2, right-hand side) or "top-down

[18] Cf. Cogneau and Robilliard (2000) or Cororaton, Cockburn and Corong (2005). See also Arntz, Boeters and Gürtzgen (2006) for description of how to integrate a discrete choice labour supply into a CGE model.

[19] Cf. Bourguignon, Robilliard and Robinson (2003).

bottom-up" (see Figure 2.2.3) approaches.[20] The top-down approach computes the macroeconomic variables (price level, growth rates) in a CGE model as input for the micro model which is adjusted to match an exogenous macro aggregate. The bottom-up approach works the other way around and information from the micro model (elasticities, tax rates) is used in the macro model (e.g. for calibration of the representative agents). Both approaches suffer from the drawback that not all feedback is used. The top-down bottom-up approach combines both methods to a recursive approach. In an iterative process one model is solved, information is sent to the other model, which is solved and gives feedback to the first model. This iterative process continues until the two models converge. Böhringer and Rutherford (2006) describe an algorithm for the sequential calibration of a CGE model to use the top-down bottom-up approach with micro models with large numbers of households.

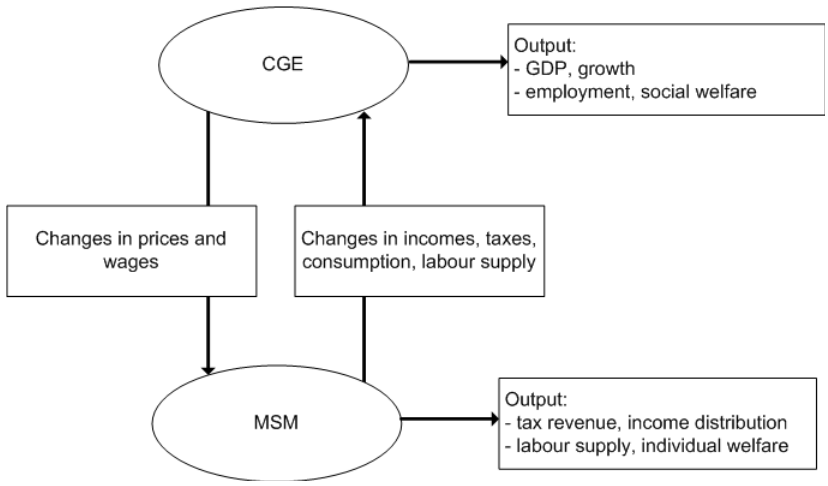

Figure 2.2.3: Top-down bottom-up

To be able to successfully link MSM and CGE models there have to be some common variables through which the two models can exchange information. Usually, it is necessary to aggregate or disaggregate these variables to be comparable with the variables in the other model. Of course, the less variables have to be (dis)aggregated the more of the underlying heterogeneity in the data will be re-

[20]Cf. Savard (2003) or Böhringer and Rutherford (2006).

tained. Furthermore, it has to be checked if the same variable in both models represents the same population (e.g. household consumption in the micro model vs. aggregated total consumption including government in the macro model). In addition, it has to be checked if one run of each model represents the same time horizon. Usually, a MSM computes short-term effects, whereas a CGE models aims at the long-run equilibrium. Therefore, the information exchange between both models has to take into account these temporal differences. If, for example, a given labour supply shock from the MSM model has not fully equilibrated within the CGE model and information is passed back and forth again, a second labour supply shock might overlap the first one and either foil or fortify the first shock.

Applications

So far, the application of linked micro macro models to analyse tax reforms is rather limited.[21] Boeters, Feil and Gürtzgen (2005) use the bottom-up approach to calibrate the three representative households of a CGE model to analyse different hypothetical reform proposals of the social assistance benefit system in Germany.[22] A similar approach is chosen by Fuest, Peichl and Schaefer (2005a) to evaluate a tax reform proposal for Germany with respect to fiscal, employment and growth effects. Arntz, Boeters, Gürtzgen and Schubert (2006) use the recursive top-down bottom-up approach to analyse reform proposals designed to encourage labour supply at the lower end of the wage distribution in Germany. However, various simplifying assumptions regarding the aggregation and disaggregation of information on labour supply responses that is passed between the models have to be made.

Aaberge, Colombino, Holmøy, Strøm and Wennemo (2007) use an integrated micro macro model of Norway to analyse the impact of population ageing on fiscal sustainability with endogenous labour supply. Although their model is integrated, they use an iterative approach. Labour supply responses are computed using the MSM model and are then used in the CGE model to estimate changes in wage rates.

[21] There are, however, more applications to trade reforms (see e.g. Davies (2004) for a survey). More recent applications include Hérault (2005), who uses the top-down approach to analyse the effect of trade liberalisation on poverty in South Africa.

[22] The same model and approach is also used by Boeters, Gürtzgen and Schnabel (2006).

Rutherford, Tarr and Shepotylo (2005) link a CGE model to the Russian Household Budget Survey (representing 55,000 households) in order to analyse the distributional effects of Russia's WTO accession. They use the information of the micro model to calibrate the representative agent of the CGE model and iterate both models until they converge in terms of price changes and aggregate demand equalling aggregate supply.

2.2.5 Summarising comparison of model types

The method of simulation analysis can be seen as an economic quasi-experiment for the ex-ante evaluation of policy reforms to analyse and compare the impacts of different reform scenarios before they are implemented in real life. Different types of simulation models evolved over time. The three most common and appropriate models for the analysis of fiscal reforms, microsimulation models (MSM), computable general equilibrium models (CGE) and linked micro macro models have been described in this section. The main research questions for these categories are presented in Table 2.2.1.

	CGE	MSM	Micro-Macro
Framework	total	partial	total
Data	macro	micro	both
Research questions:			
- Growth	✓		✓
- Allocation / Efficiency	✓	(✓)	✓
- Labour supply	(✓)	✓	✓
- Labour demand	✓		✓
- Revenue		✓	✓
- Distribution		✓	✓

Table 2.2.1: Comparison of model types

CGE models excel through their outstanding theoretical foundation and the consideration of various interdependencies. They allow estimating various behavioural responses and adjustments on several markets, e.g. modelling labour supply and demand on the labour market. In contrast, microsimulation models take only the labour supply side into account. Nevertheless, these models allow for a much more detailed mapping of the complex rules of the tax benefit system and account for a much greater heterogeneity than CGE models could ever do because of the aggregated data they are based on. Furthermore, the need to specify and calibrate functional forms and key parameters gives rise to various critiques against CGE models because of limited econometric foundations of the calibration technique in general. During the last years, a tendency of linking micro and macro models has emerged to utilise the complementary advantages of MSM and CGE models.

So far, the linked micro macro models which have been used for the analysis of tax benefit reforms do not sufficiently use all the possibilities stand-alone MSM and CGE models offer. The further development of computational power and more powerful algorithms (see e.g. Rausch and Rutherford (2007)) should allow for a complete integration of both types of models. This in turn will then enable to analyse the complex interdependence of various policy measures with respect to fiscal, distributional, employment and growth effects within the same econometric framework. Further development on the microsimulation modelling of the corporate sector is also desirable. This, of course, crucially depends on the availability of corporate micro data. Such a corporate MSM could then be linked with a household MSM and integrated into a CGE model which would then be based on micro data for both sides of the economy.

When conducting a simulation analysis or interpreting its results one should be aware of potential errors or biases. According to Betson (1990) "sampling errors", "imputation errors", "ageing errors", "individual response errors" and "environmental errors" can be distinguished. Sampling errors can always occur when subsamples from the whole population are used in an empirical analysis which can increase or decrease the variation in the data. Thus, estimates from the simulation model might differ from estimation based on the whole population. If the sample was not drawn randomly, the assumptions of statistical procedures might be violated and special corrections have to be used in the analysis. Furthermore, there might be also "non-sampling errors" in the dataset, resulting e.g. from non-response and reporting or data processing mistakes. The weighting of the individual records with population weights to estimate aggregated values for the whole population can reduce these errors, as the weighting factors are chosen to ensure that the sample estimates conform to macroeconomic indicators of the whole population. However, when these population factors are modified, e.g. using static ageing techniques of reweighting, this can give rise to ageing errors if the modification itself is biased. Imputation errors arise when data from different sources are used for the imputation of missing values or variables. As a consequence, distributional assumptions might be violated leading to biased estimations. But not only the data is error-prone but also the modelling of the benchmark or the counterfactual scenario itself gives rise to potential mistakes. Individual response errors can arise from simplifying and/or behavioural assumptions in the model. Simplifying assumptions are always subject to errors, but have to be used to overcome data limitations or to make the model operational. Behavioural assumptions are necessary for the estimation of behavioural responses. To do so, functional forms and co-variables of the econometric model have to be specified based on beliefs of the underlying behaviour of the individuals. Incomplete or imperfect beliefs can lead to misspecifications and biased results. Environmental errors can e.g. arise from the negligence of the broader economic environment or individual reactions to policy changes.

When building and using a simulation model, a researcher should be aware of these potential errors and should try to avoid them if possible or at least to document the possible biases in the analysis. Extensive sensitivity analyses should be conducted when building a model or simulating a new scenario. When interpreting the results of a simulation study, one has to be aware of these potential errors and has to take a closer look at the underlying data, methods and assumptions. Furthermore, estimations from simulation models should not be used as an exact forecast of a single number but to compare and rank different scenarios according to various dimensions. Despite all these potential errors, simulation models nevertheless provide a powerful tool for the ex-ante evaluation of fiscal policy reform proposals.

2.3 Measuring distributional effects

2.3.1 Introduction

Reforms of the welfare state usually affect the structure of tax burdens, the amount of benefits received and thus the distribution of disposable incomes. Since in a democratic political system, such reform proposals need to win the majority of votes before they can be implemented, it appears crucial to analyse who may gain or lose and how the distribution and redistribution of incomes and burdens may change as a consequence of such reforms. The purpose of this section is to provide an overview of how to analyse the distributional effects of fiscal reforms.[23] Thereby, distributional effects shall be differentiated by four subconcepts, i.e. 1.) the traditional concept of inequality, 2.) the rather novel concept of polarisation, 3.) the concept of progression in taxation, and 4.) the concept of income poverty and complementarily richness.[24]

Before starting with the description, some definitions and clarifications are necessary. Firstly, it appears reasonable to limit an analysis of distributional effects to incomes, primarily due to a better availability of data on incomes compared to data on total assets of people.[25] Secondly, it appears necessary to define an appropriate concept of income. Considering incomes as they have actually been generated on markets, yields a concept of *pre-government income*. Thereby, the sum of earnings generated from independent and dependent personal services, private assets as well as private transfers is called the *market income*. Based on market incomes, post-government incomes in economic terms are derived by taking governmental payments into consideration. On the one hand income tax liabilities and social security contributions are deducted, and on the other hand pensions from the statutory pension insurance as well as social transfers are added. The resulting difference between market incomes and *post-government incomes* may be interpreted as the result of governmental redistribution. However, it appears

[23] This section is based on Ochmann and Peichl (2006) and Peichl, Schaefer and Scheicher (2006).

[24] One should note that, the methods and measures described in this section can be used in any empirical analysis, i.e. in both ex-ante and ex-post studies of fiscal reforms. They are not limited to the application of simulation models.

[25] However, this does not imply that the methods and measures introduced in the following subsections cannot be applied to different concepts like wealth or welfare.

relevant to take into account that income units in tax statistics usually represent incomes of more than one person together, so that an analysis should allow for differences in the income units' needs. In general, equivalence scales reflect both, economies of scale in household size, and differences in household characteristics, such as needs, location, age, number and age of children, and health. The most widely applied concepts of equivalence scales exhibit simple scale parameters that attach weights to household members in relation to their age.[26]

The setup of this section is organised as follows: subsection 2.3.2 opens up the distributional analysis with the concept of inequality. Subsection 2.3.3 then follows with polarisation, whereupon subsection 2.3.4 subjects progression in taxation, and subsection 2.3.5 deals with the measurement of poverty and richness. In these four subsections, various indices of measurement are derived, compared to each other, sensitivities are discussed, and advantages as well as disadvantages derived. Subsection 2.3.6 concludes.

2.3.2 Measuring Inequality

Descriptive Measures / Measures of Dispersion

Let an income distribution be a random variable $X = (x_1, x_2, ..., x_n)$, where $x_i \geq 0$ is the income of individual i, $i = 1, ...n$.[27] A first index of dispersion may be derived with the help of the concept of the Lorenz curve. The Lorenz curve may be displayed as an increasing convex frequency polygon of n pieces running from $(0, 0)$ to $(1, 1)$, indicating how many percent of the sum of all values belong to the F-% smallest values of X. Relating the area located between the Lorenz curve and the diagonal to the area of the triangle beneath the diagonal of the unit square yields the **Gini (1914) coefficient** of inequality:

[26] Cf. Buhmann, Rainwater, Schmaus and Smeeding (1988).

[27] In the following, we focus on discrete values of X due to lack of space. The continuous case and the corresponding formulas of the various indices is of further subject in the working paper version of this section (see Ochmann and Peichl (2006)).

$$I^G_{Gini} = \frac{A}{\frac{1}{2}} = 2A = \sum_{i=1}^{n} \frac{x_i}{n\mu}\frac{2i-n-1}{n} = \sum_{i=1}^{n} l_i \frac{2i-n-1}{n} = \frac{2\sum_{i=1}^{n} ix_i}{n\sum_{i=1}^{n} x_i} - \frac{n+1}{n} \tag{2.3.1}$$

In case of maximum inequality, I^G_{Gini} corresponds to $1-\frac{1}{n}$, and in the case that all values are equal, I^G_{Gini} corresponds to zero. One may derive a standardised Gini coefficient as $I^*_{Gini} = \frac{A}{\frac{1}{2}(1-\frac{1}{n})} = \frac{n}{n-1}2A = \frac{n}{n-1}I^G_{Gini} = \sum_{i=1}^{n} l_i \frac{2i-n-1}{n-1}$. In case of maximum inequality, I^*_{Gini} corresponds to one, and in the case that all values are equal, I^*_{Gini} corresponds to zero. Although the Gini coefficient became the probably most popular index of inequality, it is by far not the only index that has been applied throughout the literature, and it neither appears to be a perfectly appropriate index in all settings of analysis. For example, the Gini coefficient bears the drawback that it may indicate the same value of inequality for two distinct distributions in the case of intersecting Lorenz curves, since the Gini coefficient is a measure of overall dispersion, which gives no information about dispersion in the upper or the lower level of the distribution. The simplest measure that considers the fact that values deviate from each other, is **the range**. It calculates the maximum spread of the distribution, i.e. $Range = x_{\max} - x_{\min}$. However, this measure takes only two values into consideration and neglects everything that takes place in between. In order to further elaborate the matter of deviation, one may apply **the relative mean deviation (RMD)** which relates the deviation of each value x_i from the mean of the distribution $\overline{x}$ to $\overline{x}$ itself: $RMD = \frac{\sum_{i=1}^{n}|x_i-\overline{x}|}{n\overline{x}} = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{x_i}{\overline{x}}-1\right|$. RMD corresponds to the maximum deviation of the Lorenz curve from the diagonal line of absolute equality, i.e. $RMD = \max_{p\epsilon(0,1)}[p - L(p)]$. As done usually when measuring dispersion of any frequency distribution, one may simply apply **the variance (VAR)** of the distribution: $VAR = \frac{1}{n}\sum_{i=1}^{n}(x_i-\overline{x})^2$. However, taking simply the variance as a measure of inequality yields the drawback that the degree of inequality is absolute, neglecting the mean around which the values spread. However, relating the variance to the mean of the distribution solves this problem and yields **the coefficient of variation (CV)**:

$$CV = \frac{\sqrt{V}}{\overline{x}} = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \overline{x})^2}}{\overline{x}} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(\frac{x_i}{\overline{x}} - 1)^2}. \qquad (2.3.2)$$

Measures from Information Theory

Another group of indices is derived with the help of a concept of probability of the occurrence of events that is based on information theory. Information theory focuses on messages about the occurrence of a specific event ω_i, out of the set Ω of possible events, with $P(\{\omega_i\}) = p_i$ denoting the probability that event ω_i will actually occur, $\sum_{i=1}^{n} p_i = 1$, $i = 1, ...n$. Before messages about the probability of occurrence come in, one may measure the expected information content of a message $E(p_1, ...p_n) = \sum_{i=1}^{n} p_i e(p_i) = -\sum_{i=1}^{n} p_i \log p_i$, with $e(p_i) = \log \frac{1}{p_i} = -\log p_i$ denoting the information content of a message. It is further defined: $0 \leq E \leq \log n$, with $E = 0$ if there is one i with $p_i = 1$, and all other $p_j = 0$ for $j \neq i$, i.e. minimum entropy, and $E = 1$ if $p_i = \frac{1}{n}, \forall\ i = 1, ...n$, i.e. maximum entropy.[28]

In Theil (1967) the entropy concept is applied to the measurement of inequality. He substitutes the probabilities p_i by income proportions $a_i = \frac{x_i}{n\overline{x}}$. In order to make the measure take its maximum value in case of maximum inequality, Theil (1967) subtracts entropy from its maximum value. Thus, inequality is measured by $\log n - E(a_1, ..., a_n)$. From this approach, he develops two measures:

$$I^0_{Theil} = \log n + \sum_{i=1}^{n} \frac{x_i}{\overline{x}n} \log \frac{x_i}{\overline{x}n} = \frac{1}{n}\sum_{i=1}^{n} \frac{x_i}{\overline{x}} \log \frac{x_i}{\overline{x}}. \qquad (2.3.3)$$

$$I^1_{Theil} = -\frac{1}{n}\sum_{i=1}^{n} \log \frac{x_i}{\overline{x}} = \frac{1}{n}\sum_{i=1}^{n} \log(\frac{\overline{x}}{x_i}) \qquad (2.3.4)$$

I^0_{Theil} is further on referred to as **the Theil index**, whereas I^1_{Theil} is also referred to as **the mean logarithmic deviation (MLD)**.[29]

In Shorrocks (1980) the entropy concept is also applied to measuring inequality. He introduces a class of inequality measures that deal with the extent to which

[28] Cf. Theil (1967), pp. 24-26.

[29] In case of $x_i = 0$, Theil defines $I(x_i = 0) = 0$. Cf. Theil (1967), pp. 93-95.

inequality in the total population can be attributed to income differences between major population subgroups. He develops a generalisation of Theil's approach of applying the entropy concept, i.e. **the indices of the generalised entropy (GE) family** of inequality:

$$I_{GE}^{c}(F) = \frac{1}{n}\frac{1}{c(c-1)}\sum_{i=1}^{n}[(\frac{x_i}{\overline{x}})^c - 1], \quad -\infty < c < +\infty, \; c \neq 0, 1. \qquad (2.3.5)$$

The constant c is a sensitivity parameter, which may also be interpreted as a parameter of inequality aversion.[30] In case of $c = 0$, the indices of the GE family equal the **MLD**, i.e. I_{Theil}^{1}, in case of $c = 1$, they equal the Theil index, i.e. I_{Theil}^{0}, and in case of $c = 2$, they equal half the squared coefficient of variation, $I_{GE}^{2} = \frac{CV^2}{2}$. In the case of $c = -1$, they are referred to as **the GE index**.

Comparison of Indices

Fulfilment of Axioms and Principles In order to make their results comparable to each other, one may demand indices of inequality to fulfil several basic axioms and principles.[31]: an index of inequality fulfils the *axiom of monotonicity* if it indicates increasing inequality in case of a reduction in low-level incomes and in case of an increase in high-level incomes. The *axiom of normalisation* demands the range of values of an index to be limited to $[0; 1]$. An index is *translation invariant* if inequality remains unchanged in turn of absolute as well as proportional translations to all incomes. The *axiom of symmetry* is fulfilled if inequality remains unchanged at any reordering of incomes, and the *population principle* demands that inequality remains unchanged if the population is replicated. An index is called *additively decomposable* if overall inequality may be decomposed into the sum of between-group inequality and within-group inequality, with the latter term denoting a weighted sum of the sub-group inequality values. The *Pigou-Dalton transfer principle* demands that a progressive transfer, i.e. a transfer from a richer to a poorer person that does not alter the relative ranks of the two, must always

[30] Cf. Shorrocks (1980), pp. 613-614 and 622.

[31] A methodological derivation of these axioms and principles as well as the derivation of the Lorenz dominance and the generalized Lorenz dominance criterion can be found in Ochmann and Peichl (2006).

decrease the degree of inequality, whereas a regressive transfer, i.e. a transfer from a poor to a richer person preserving relative ranks, must always increase the degree of inequality. An extension of this transfer principle - *the principle of diminishing returns* - assigns greater significance to a progressive transfer between two individuals with a given difference in incomes the lower these incomes are. The *principle of positional transfer sensitivity* demands that a transfer from any income to a lower one, with a fixed proportion of all incomes lying between these two, must have more significance at the lower end of the distribution scale than at the higher end.[32] The detailed performance of the various indices at fulfilment of these axioms may be found in Ochmann and Peichl (2006). The results are only briefly summarised in table 2.3.1.

Index	Axioms and Principles							
Notation	Monotonicity	Normalisation	Transl. Inv.	Symmetry	Population	Decomposabil.	Transfer P.	Dimin. Ret.
I^G_{Gini}	yes	on $[0;1]$	yes	yes	yes	no	yes	no
RMD	yes	on $[0;2]$	yes	yes	yes	no	no	no
VAR	yes	no	no	yes	yes	yes	yes	yes
CV	yes	no	yes	yes	yes	yes	yes	no
$LVAR$	yes	no	yes	yes	yes	no	no	no
$VARL$	yes	no	yes	yes	yes	no	no	no
MLD	yes	no	yes	yes	yes	yes	yes	yes
I^0_{Theil}	yes	no	yes	yes	yes	yes	yes	yes
I^{-1}_{GE}	yes	no	yes	yes	yes	yes	yes	yes

Table 2.3.1: Indices of Inequality - Fulfilment of Axioms and Principles

Sensitivity on the Distribution Scale The various indices of inequality moreover vary greatly with respect to sensitivity to transfers along the distribution scale. **The Gini coefficient** is more sensitive in the lower levels of the income scale than in the higher levels, however it attaches the most weight to transfers among incomes in the middle of the scale. Thus it is most sensitive to transfers among mid-level incomes and generally in cases where values lie close to each other; in such cases it is highly sensitive compared to other indices. Similarly, **the relative mean**

[32] Cf. Dalton (1920), p. 351, Chakravarty and Muliere (2004a), pp. 8-12, and Kolm (1976), pp. 87-88.

deviation, especially $\frac{1}{2}RMD$, is highly sensitive around the arithmetic mean income and relatively insensitive everywhere else. **The coefficient of variation** is more than average sensitive among mid-level incomes and extremely sensitive to transfers in the highest levels of the distribution scale. The CV appears to be appropriate for the evaluation of transfers among mid-level incomes and especially at the top of the income scale. **The Piesch index** is also relatively more sensitive to transfers among high incomes. However, **the logarithmic variance** and the **variance of the logarithms** are highly sensitive among low incomes, and they are more sensitive among mid-level incomes than the CV, I^0_{Theil}, and I^G_{Gini}.

Index			Sensitivity on the Distribution Scale
Name	Notation	Formula	
Gini coefficient	I^G_{Gini}	$\sum_{i=1}^{n} \frac{x_i}{n\mu} \frac{2i-n-1}{n}$	mid-level
Relative mean deviation	RMD	$\frac{1}{n}\sum_{i=1}^{n} \left\lvert \frac{x_i}{\overline{x}} - 1 \right\rvert$	mid-level
Variance	VAR	$\frac{1}{n}\sum_{i=1}^{n}(x_i - \overline{x})^2$	highest level
Coefficient of variation	CV	$\sqrt{\frac{1}{n}\sum_{i=1}^{n}(\frac{x_i}{\overline{x}} - 1)^2}$	highest level
Logarithmic variance	$LVAR$	$\frac{1}{n}\sum_{i=1}^{n}(\log \frac{x_i}{\overline{x}})^2$	low-level
Variance of the logarithms	$VARL$	$\frac{1}{n}\sum_{i=1}^{n}[\log(\frac{x_i}{x^*})]^2$	low-level
Mean logarithmic deviation	MLD	$\frac{1}{n}\sum_{i=1}^{n}\log(\frac{\overline{x}}{x_i})$	mid- and low-level
Theil index	I^0_{Theil}	$\frac{1}{n}\sum_{i=1}^{n}\frac{x_i}{\overline{x}}\log\frac{x_i}{\overline{x}}$	high-level
GE index	I^{-1}_{GE}	$\frac{1}{2n}\sum_{i=1}^{n}[\frac{\overline{x}}{x_i} - 1]$	low-level

Table 2.3.2: Indices of Inequality - Notation and Sensitivity on the Distribution Scale

Since it usually violates the Pigou-Dalton transfer principle in the upper level of the scale, the *logarithmic variance (LVAR)* appears to be only adequate for partial analyses in the middle and lower levels. The sensitivity of **the indices of the GE family** varies according to the value of their sensitivity parameter c. For large absolute values of c, I^c_{GE} becomes more sensitive to variations in the tails of the distribution, specifically more sensitive in the upper scale for large positive values of c and more sensitive in the lower scale for large negative values of c. Thus, **the mean logarithmic deviation** is relatively more sensitive in the centre, but also towards lower levels, while **the Theil index** is relatively medium-sensitive in mid- and low-levels and more than average sensitive in high-levels of the scale. Moreover, **the GE index** is relatively more sensitive in the lower levels, and $\frac{CV^2}{2}$

is relatively more sensitive in the upper levels.[33] Table 2.3.2 summarises the most important indices of inequality and their sensitivity on the distribution scale.

2.3.3 Measuring Polarisation

The concept of polarisation has only been recently analysed in literature. Measures of polarisation may be grouped into two categories, i.e. measures based on axioms, and measures based on the concept of ‘a declining middle class‘.

Measures Based on Axioms

The simplest indices of polarisation point out distances between certain ranges of the distribution scale. Such ratios apply the quantile function $Q(F,q) = \min\{x \mid F(x) \geq q\} = x_q$ at two distinct points of the distribution scale and compute the ratio of the values of $Q(F,q)$ at these points. Quantile ratios may be interpreted as the factor with that the incomes in the lower quantile in consideration need to be multiplied, in order to lift them up to the higher quantile, thus indicating a proportional gap between these quantiles. Specifically, mostly applied quantile-ratios are **the 0.75/0.25-quantile ratio** (the quartile ratio) and **the 0.9/0.1-quantile ratio**.

The first class of measures of polarisation is based on axioms similar to the axioms derived for indices of inequality.[34] Following Esteban and Ray (1994), let $x_1, ..., x_n$ be values of a first variable, e.g. income X, that may be grouped into K disjoint groups according to a second variable, e.g. profession Y, with $\overline{x} = (\overline{x_1}, ..., \overline{x_K})'$ denoting the vector of mean incomes of the K groups, while $\overline{x_i} \neq \overline{x_j}$ $\forall$ i, j, i.e. mean incomes of two groups are never equal. The vector of the K groups' fractions of the overall population is denoted by $w = (w_1, ...w_K)'$. Based on this categorisation, Esteban and Ray (1994) characterise polarisation by

[33] Cf. Atkinson (1970), pp. 255-257, Chakravarty (1988), p. 147, Buhmann et al. (1988), p. 125, and Champernowne (1974), p. 805.

[34] These axioms are the monotonicity axiom, the normalization axiom, the axiom of translation invariance, the symmetry axiom, the population principle, and the additive decomposability axiom (see Esteban and Ray (1994)). It should be noted that the Pigou-Dalton transfer principle is, in its original version, not valid for the measurement of polarisation.

the simultaneous occurrence of sufficiently large groups, thereby applying intra-group homogeneity and inter-group heterogeneity.

Intra-group homogeneity is applied by an identification function, $I : \mathbb{R}_+^K \rightarrow \mathbb{R}_+^K$, $w \rightarrow w^\alpha = (w_1^\alpha, ...w_K^\alpha)'$. Thereby, intra-group homogeneity increases in the degree of identification with people in the same group, which in turn increases in the number of people with the same income in this group and with decreasing differences between the incomes in the same group. Polarisation in turn increases in increasing intra-group homogeneity. Thereby, α is a parameter of polarisation sensitivity, with $1 \leq \alpha \leq 1.6$.[35] *Inter-group heterogeneity*, however, is applied by an alienation function, $V : \mathbb{R}_+^{K\times K} \rightarrow \mathbb{R}_+^{K\times K}$, $\overline{X} \rightarrow \left|\overline{X} - \overline{X}'\right|$, where alienation increases in increasing absolute differences between the mean incomes of the K groups. Polarisation in turn increases in increasing alienation. As a result, polarisation increases the more people with equal incomes belong to the same group and the greater are the differences between mean incomes of the groups. The **Esteban and Ray (1994)-index** of income polarisation is derived as:

$$PO_{ER}^\alpha(\overline{X}, w) = \frac{1}{\overline{x}}(w^{1+\alpha})' \left|\overline{X} - \overline{X}'\right| w \tag{2.3.6}$$

with $\alpha \in [1; 1.6]$ and $\overline{x} = \frac{1}{n}\sum_{i=1}^n x_i$. It bears the advantages that it is based on a model approach with two specific partial functions, and that the differences compared to the measurement of inequality are revealed by a parameter of polarisation. Disadvantages of the index are the presumed a priori categorisation into groups by a second variable and its representation by the groups' mean incomes, as well as the lack of representation of deviation of incomes from the mean income *within* groups when regarding intra-group homogeneity, thereby overestimating polarisation. Moreover, the maximum value of PO_{ER}^α characterizes maximum inequality, instead of maximum polarisation. The Esteban and Ray (1994) approach is expanded by Esteban, Gradín and Ray (1999) to include intra-group *in*homogeneity into the analysis and by Duclos, Esteban and Ray (2004) to identify the interaction between identification and alienation.

[35] The greater α, the greater is the difference between polarisation and inequality measured, whereat $\alpha = 0$ yields I_{Gini}^G.

Measures and the Declining middle class

The concept of 'the declining middle class' more closely enlightens the differences between measuring inequality and measuring polarisation. While at the measurement of inequality the Pigou-Dalton transfer principle demands that a progressive transfer must always decrease inequality and a regressive transfer must always increase inequality, at the measurement of polarisation this principle is not valid. In order to derive this result, let income X be uniformly distributed on $[0;1]$, and make two progressive transfers that do not cross the median, with one above and one beneath the median. The graph of $f(x)$ clearly possesses two peaks then, i.e. $f(x)$ turns bimodal, so that polarisation clearly increases, while inequality decreases according to the Pigou-Dalton transfer principle. Thus, this principle is not valid for the measurement of polarisation. When focusing on 'the declining middle class', the following indices of polarisation highlight two matters characterizing polarisation, i.e. bimodality and spreadoutness. The first one characterizes a distribution with one mode above and one mode below the median income, while the latter one simply denotes deviation from the median income.

In Wolfson (1994) and Wolfson (1997) two polarisation curves are derived. Based on the empirical quantile function, they apply one major difference to the derivation of the Lorenz curve: the values are standardised by the median income m, instead of the mean income μ, yielding the *empirical quantile function of the median-standardised incomes*. This curve lies beneath the abscissa for values below the population fraction of 50% and above the abscissa for all values above 50%. Then mirroring the negative part of the empirical quantile function at the abscissa, yields Wolfson's *first polarisation curve*, displaying the deviation of the population fractions from the median income, which is the central benchmark in the concept of 'the declining middle class'. Integrating the first polarisation curve in turn yields the *second polarisation curve*, which maps the cumulated deviations of the incomes from the median income. **The Wolfson index** of polarisation corresponds to four times the area beneath this curve, i.e.

$$PO_{WOL}(F) = 2\frac{\mu}{m}[1 - 2L_F(\frac{1}{2}) - I^G_{Gini}] \qquad (2.3.7)$$

with $L_F(\frac{1}{2})$ denoting the Lorenz curve at the 0.5-percentile, and I^G_{Gini} denoting the overall Gini coefficient.[36] PO_{WOL} bears the advantages that it links the measurement of polarisation with the measurement of inequality in terms of the Lorenz curve, and that polarisation may be easily derived by the median tangent on the Lorenz curve, while highlighting the differences to measuring inequality. Moreover, no groups need to be formed beforehand. PO_{WOL} bears the disadvantages that it is highly sensitive to the definition of the median income, especially in the case of few values, and it is not normalised on $[0;1]$, rather it may take very high values in case of high inequality, when $\frac{\mu}{m}$ is very high.

In Wang and Tsui (2000) the approach of Wolfson (1994) is extended, characterizing polarisation by an increasing spread and by increasing bimodality. They derive **the Wang-Tsui class of polarisation indices**:

$$PO^r_{WTS}(x) = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{x_i - m}{m}\right|^r, \ r \ \epsilon \ [0;1] \tag{2.3.8}$$

m denoting the median income and x_i denoting the increasingly ranked incomes. PO^r_{WTS} thereby measures the weighted relative deviation from the median income. Thus, PO^r_{WTS} is easily calculated and bears room for interpretation. Drawbacks include the fact that PO^r_{WTS} is highly sensitive to m, which thus needs to be clearly defined. PO^r_{WTS} is neither defined for maximum polarisation nor for $m = 0$. In some cases, PO^r_{WTS} yields contradicting results about an increase and a decrease in polarisation, and it takes values greater than one in case of high inequality.

2.3.4 Measuring Progression in Taxation

The idea behind redistribution is to use progression in taxation as a political device, in order to reduce the degree of inequality in an income distribution.[37] In this subsection, the concept of progression in taxation is introduced. According to taxation

[36] This equation holds, since the ordinate of the second polarisation curve may be restandardised with $\frac{m}{\mu}$, yielding the ordinate-scale of the Lorenz curve, and then the abscissa may be shifted to fit the $[1.0; 1.0]$-plane diagonally, resulting in the Lorenz curve.

[37] In the following, it is assumed that tax liabilities are solely income-determined, i.e. other social non-income factors such as marital status, age and home-ownership are neglected for the sake of simplicity.

theory, income tax progression is generally characterised by an increasing average tax rate in percentage of income as income increases, i.e. the higher the income, the greater the *share* of this income that is paid for taxes. Thereby, progressive income taxation is accompanied by two effects, referred to as the *redistributive effect* on the one hand and *disproportionality*, also interpreted as deviation from proportionality, on the other hand.

Following Lambert (2001), let x be the income of a taxpayer and let the twice differentiable function $t(x)$ denote the income tax schedule or tax liability, with $0 \leq t(x) < x$ and $0 \leq t'(x) < 1$. For strict (weak) progression it then holds $\frac{d[\frac{t(x)}{x}]}{dx} > 0, \forall\ x > 0$ ($\frac{d[\frac{t(x)}{x}]}{dx} \geq 0, \forall\ x > 0$). Let $a(x) = \frac{t(x)}{x}$ denote the *average tax rate* and let $m(x) = \frac{dt(x)}{dx} = t'(x)$ denote the *marginal tax rate*. Then, it follows that $\frac{d[\frac{t(x)}{x}]}{dx} = a'(x) = \frac{xt'(x)-t(x)}{x^2} = \frac{m(x)-a(x)}{x}$ and for strict progression $\frac{d[\frac{t(x)}{x}]}{dx} > 0 \Rightarrow m(x) > a(x)\ \forall\ x$, i.e. the marginal tax rate lies everywhere above the average tax rate, as they are both increasing in x and result in a strictly progressive tax system.

A concept that is closely linked to progressivity is the concept of *redistribution*. The overall effects of redistribution of a tax system may be decomposed into two subeffects, the *vertical equity (VE) effect* and the *reranking (RR) effect*. While the concept of *horizontal equity* demands an equal tax treatment of taxpayers in identical circumstances, e.g. identical incomes, the concept of VE calls for an appropriate unequal treatment of unequals, i.e. unequal abilities of earning income, thereby enhancing redistribution.[38] However, if there appears reranking of incomes through taxation the net effect of redistribution of a tax system is counteracted. Thus, $L_{X-T}(p) - L_X(p) = C_{X-T}(p) - L_X(p) - [C_{X-T}(p) - L_{X-T}(p)] = VE - RR$, i.e. redistribution expressed by the difference between the pre-tax and the post-tax Lorenz curves may be decomposed into the subeffects of VE and RR. The concept of *horizontal inequity* is closely linked to the effect of RR: RR of incomes by taxation is a necessary and at the same time sufficient condition for horizontal

[38] The ability-to-pay principle follows the concept of vertical equity when demanding a tax system to equalize everybody's loss in utility of income. Assuming a common increasing, twice differentiable and concave utility-of-income function $U(x)$, $\forall\ x > 0$, this concept of equal loss in utility for all, i.e. $U(x) - U[x - t(x)] = u_0$, u_0 denoting an equal absolute reduction in utility, relates to progressive income taxation, rather than to proportional taxation, cf. Lambert (2001), pp. 174-175 and 183.

inequity. An index of horizontal inequity based on this concept will be introduced later on among the indices of redistribution.

Local versus Effective Progression

Measures of *structural or local progression* measure the degree of income tax progression along the income scale, whereas measures of *effective progression* rather measure the degree of overall progression in a tax schedule's effects, given in a scalar index number[39]. As shown above, for strict progression it must hold that $m(x) > a(x)$. Thus, a first index of local progression corresponds to **the first derivative of the average tax rate**: $PG_{AV}(x) = \frac{d[\frac{t(x)}{x}]}{dx} = \frac{xt'(x)-t(x)}{x^2} = \frac{m(x)-a(x)}{x}$. PG_{AV} serves as a basis for two more important indices of local progression that measure the excess of the marginal tax rate over the average tax rate at income level x. The first one measures *liability progression*, defined as **the elasticity of tax liability to pre-tax income** at any x, with $t(x) > 0$: $PG_{LP}(x) = \varepsilon_{t(x),x} = \frac{dt(x)}{dx}\frac{x}{t(x)} = \frac{m(x)}{a(x)}$. For a strictly liability-progressive income tax system, it holds that $m(x) > a(x) \Leftrightarrow \frac{m(x)}{a(x)} > 1$, i.e. a one per cent increase in pre-tax income leads to an increase in tax liability of more than one per cent. The second index measures *residual progression*, defined at any x as **the elasticity of post-tax income to pre-tax income**: $PG_{RP}(x) = \varepsilon_{x-t(x),x} = \frac{d[x-t(x)]}{dx}\frac{x}{x-t(x)} = \frac{1-m(x)}{1-a(x)}$. It indicates by which percentage the post-tax income increases if the pre-tax income increases by one percent. For a residual progressive tax system it holds that $0 < \frac{1-m(x)}{1-a(x)} < 1$, i.e. the post-tax income increases by less than one percent if the pre-tax income increases by one percent. Moreover the degree of residual progression clearly increases if PG_{RP} decreases. Therefore it makes sense to define $PG^*_{RP}(x) = \frac{1}{PG_{RP}(x)} = \frac{1-a(x)}{1-m(x)}$ so that it holds that the degree of residual progression increases with increasing PG^*_{RP}. Another index of local progression equals **the second derivative of the average tax rate**: $PG_{AV^2}(x) = \frac{d^2[\frac{t(x)}{x}]}{dx^2} = \frac{t''(x)}{x} - 2\frac{m(x)-a(x)}{x^2}$ with $PG_{AV^2} > 0$ indicating accelerated progression, $PG_{AV^2} = 0$ indicating constant progression, and $PG_{AV^2} < 0$ indicating decelerated progression.

In Musgrave and Thin (1948) an index of effective progression is introduced which is independent of the local tax base, but rather considers the overall distri-

[39] Cf. Lambert (2001).

bution of pre-tax and post-tax income:

$$PG^{eff}_{MUT}(x) = \frac{1 - I^{Gini}_{X-T}}{1 - I^{Gini}_{X}} \tag{2.3.9}$$

where I^{Gini}_{X} denotes the Gini coefficient of the pre-tax income distribution, and I^{Gini}_{X-T} denotes the Gini coefficient of the post-tax income distribution. Thereby, I^{Gini}_{X} and I^{Gini}_{X-T} are derived by simply applying I^{G}_{Gini} as defined in equation 2.3.1 to pre-tax incomes, as well as to post-tax incomes, respectively.

Indices of Disproportionality

This section introduces indices that are built on the concept of progressivity, which focuses on diversion from proportionality. Thereby, a taxation schedule exhibits disproportionate effects if tax liabilities are not levied proportionately to incomes (see Kakwani (1977)). Such effects from progressive taxation may be shown again by applying the concept of the Lorenz curve. Next to tax liability $t(x)$, let $F(x)$ denote the distribution function of pre-tax incomes and let $f(x)$ be its density function. Then it follows that $T(x) = n \int t(x)f(x)dx$ may denote total revenue from income taxation, and $g(x) = \frac{T}{X} = \int \frac{f(x)t(x)dx}{\mu}$, $g > 0$ the overall average tax rate or total tax ratio, with n for the number of all taxpayers and $X = n\mu$ for the total pre-tax income. The Lorenz curve for pre-tax incomes follows as $L_X(p) = \int_0^b \frac{xf(x)dx}{\mu}$, the Lorenz curve for post-tax incomes as $L_{X-T}(p) = \int_0^b \frac{[x-t(x)]f(x)dx}{\mu(1-g)}$ and one for tax liabilities[40] as $L_T(p) = \int_0^b \frac{t(x)f(x)dx}{\mu g}$, $0 \leq p \leq 1$. The difference $[L_X(p) - L_T(p)]$ may be interpreted as the fraction of the total tax burden shifted from low incomes, i.e. the bottom $100p$ percent, to high incomes, i.e. the top $100(1-p)$ percent, by progression in the tax schedule. An index of disproportionality based on this difference is also proposed by **Kakwani (1977)**:

$$PG_{KAK}(p) = 2\int_0^1 [L_X(p) - L_T(p)]dp \tag{2.3.10}$$

[40] Precisely, $L_{X-T}(p)$ and $L_T(p)$ are concentration curves cumulating shares by rank. If assumed that no reranking occurs by taxation, they may be regarded as Lorenz curves, as Lambert (1994), p. 23 concludes.

Applying an extended Gini coefficient of the pre-tax income distribution $I_X^{Gini,ext}(v) = 1 - v(v-1)\int_0^1 (1-p)^{v-2} L_x(p)dp$ and an extended concentration coefficient for tax liabilities $C_T^{ext}(v) = 1-v(v-1)\int_0^1(1-p)^{v-2}L_T(p)dp$ an extension of PG_{KAK} can be derived as $PG_{KAK}^{ext}(v) = v(v-1)\int_0^1(1-p)^{v-2}[L_X(p)-L_T(p)]dp = C_T(v)-I_X^{Gini,ext}(v)$ which focuses more on disproportionality towards the lower end of the income scale as v increases. Both, PG_{KAK} and PG_{KAK}^{ext}, increase if liability progression of an income tax system increases at an unchanged pre-tax income distribution. Thus, they satisfy a consistency property, which states that at a given pre-tax income distribution, increasing local progression, in terms of liability progression, implies increasing effective progression, in terms of progressivity.

In Suits (1977) an index analogous to Kakwani's index is derived, in order to measure disproportionality, however, Suits builds on relative concentration curves. Plotting cumulated fractions of tax liabilities on cumulated fractions of pre-tax incomes, yields the relative concentration curve of tax liabilities $C_T^{rel}(q) : q = L_X(p) \Rightarrow C_T^{rel}(q) = L_T(p)$ with $C_T^{rel}(q)$ upward-sloping and convex for a progressive tax schedule. Then **Suits (1977)** measures aggregate disproportionality by:

$$PG_{SUI}(q) = 2\int_0^1 [q - C_T^{rel}(q)]dq = 2\int_0^1 [L_X(p) - L_T(p)]L'_X(p)dp \qquad (2.3.11)$$

Thus, PG_{SUI} can be obtained from PG_{KAK} by attaching the weight $L'_X(p)$ to the difference between the Lorenz curves, which then yields an index of effective progression. $PG_{SUI} \in [-1;+1]$, with $PG_{SUI} = -1$ in case of extreme regression, when the poorest pays all the taxes and $PG_{SUI} = 1$ in case of extreme progression, when the richest does so. However, $PG_{KAK} \in [-(1 + I_X^{Gini});(1 - I_X^{Gini})]$, i.e. its boundaries depend on the degree of inequality in the income distribution, with $PG_{KAK} = -(1 + I_X^{Gini})$ in case of maximum regression and $PG_{KAK} = (1 - I_X^{Gini})$ in case of maximum progression.[41]

[41] Cf. Lambert (2001), pp. 201-204.

Indices of Redistribution

The difference $[L_{X-T}(p) - L_X(p)]$ may be interpreted as the fraction of the total post-tax income shifted from high incomes, i.e. the top $100(1-p)$ percent, to low incomes, i.e. the bottom $100p$ percent, by progression in the tax schedule, indicating effects of overall redistribution of incomes. Moreover, **Reynolds and Smolensky (1977)** introduce an index measuring redistributive effects of progression based on the distance between $L_{X-T}(p)$ and $L_X(p)$:

$$PG_{RSM}(p) = 2\int_0^1 [L_{X-T}(p) - L_X(p)]dp \qquad (2.3.12)$$

which allows a link to residual progression. With C_{X-T} denoting the concentration coefficient for post-tax incomes and I_X^{Gini} denoting the Gini coefficient of pre-tax incomes, it follows that[42] $PG_{RSM} = I_X^{Gini} - C_{X-T}$, i.e. PG_{RSM} measures the reduction in the Gini coefficient resulting from the progressive tax schedule. Again analogously to PG_{KAK}^{ext}, there is: $PG_{RSM}^{ext}(v) = I_X^{Gini,ext}(v) - C_{X-T}^{ext}(v)$.

2.3.5 Measuring Poverty and Richness

Indices of Poverty

Before measuring any kind of poverty, one must make sure that it is precisely defined who should be considered poor. A poverty line helps identifying the poor by representing the level of income necessary to maintain a subsistence level of standard of living. It may be defined either in absolute terms as a plain amount of pre-government or post-government income, adjusted or unadjusted, below which people are considered poor, or it may be defined relatively, e.g. to the mean or median income of the overall distribution. This leads to the classification of poverty indices as either absolute or relative poverty indices.

Following Chakravarty and Muliere (2004b), let $Q(X) = \{i|x_i \leq z\}$ denote the set of poor persons, x_i being person $i's$ income and q denoting the number of people identified as poor, according to their incomes at the income dis-

[42] Cf. Musgrave and Thin (1948), as well as Lambert (2001), pp. 196-198.

tribution of $X \epsilon \mathbb{R}^n_+$, i.e. the cardinality of the set $Q(X)$. Then, relating the number of poor people to the overall number of people in the population yields **the head-count ratio**, i.e. $PV_{HCR}(X,z) = \frac{q}{n}$. It is as well an absolute index as a relative index. Furthermore, relating the average income shortfall of the poor to the poverty line, yields **the poverty-gap ratio**, i.e. $PV_{PGR}(X,z) = \frac{\sum_{i\epsilon Q(X)}(z-x_i)}{qz}$. Combining both indices yields **the normalised poverty deficit**: $PV_{NPD}(X,z) = PV_{HCR}(X,z)PV_{PGR}(X,z)$. Sen (1976) introduces an index that sums up the weighted income gaps among the poor, attaching higher weights to higher deprivation. His index became famous as **the Sen index**:

$$PV_{SEN}(X,z) = \frac{\sum_{i=1}^{q}(z-\widehat{x_i})(q+1-i)}{(q+1)nz} \tag{2.3.13}$$

with $\widehat{x_i}$ denoting the illfare ordering of person i.[43] Blackorby and Donaldson (1980) introduce a generalisation of the Sen index, i.e. **the Blackorby-Donaldson index** of poverty:

$$PV_{BLD}(X,z) = PV_{HCR}[1 - \frac{E^q(X^q)}{z}] \tag{2.3.14}$$

with $E^q(X^q)$ denoting the equally distributed equivalent income of the poor, evaluated according to a regular, homothetic social welfare function. PV_{BLD} measures the relative gap between the poverty line and the equally distributed equivalent income of the poor, times the number of poor people.[44] PV_{SEN} and PV_{BLD} are both sensitive to PV_{HCR}, to the degree of poverty among the poor, and to the degree of inequality among the poor. Also generalizing the Sen index, Kakwani (1980) introduces **the Kakwani index** of poverty:

$$PV_{KAW}(X,z) = \frac{q}{nz\sum_{i=1}^{q} i^r}\sum_{i=1}^{q}(z-\widehat{x_i})(q+1-i)^r \tag{2.3.15}$$

for $r > 0$. For $r = 0$, it follows that $PV_{KAW} = PV_{HCR}PV_{PGR}$ and for $r = 1$ it follows that $PV_{KAW} = PV_{SEN}$. In Chakravarty (1983) the proportionate gap between the poverty line and the equally distributed equivalent income $E^q(X^q)$ is

[43] For large q, the Sen index may be expressed by the head-count ratio, the poverty-gap ratio and the Gini coefficient among the poor: $PV_{SEN} = PV_{HCR}[PV_{PGR} + (1 - PV_{PGR})I^q_{Gini}]$.

[44] An absolute version of PV_{BLD} corresponds to $PV_{BLD} = q[z - E^q(X^q)]$.

applied, based on the censored income distribution. He derives **the Chakravarty index** of relative poverty[45]:

$$PV_{CHK}(X,z) = 1 - \frac{E^n(X^*)}{z} \tag{2.3.16}$$

Clark, Hemming and Ulph (1981) apply the symmetric mean of order k for $E^n(X^*)$ in equation 2.3.16 yielding **the Clark, Hemming, Ulph (CHU) index**:

$$PV_{CHU}(X,z) = 1 - \frac{[\frac{1}{n}\sum_{i=1}^{n}(x_i^*)^k]^{\frac{1}{k}}}{z} \tag{2.3.17}$$

for $k < 1$, $k \neq 0$.[46] As k decreases greater weight is put to transfers at the lower end of the distribution. In Foster and Shorrocks (1991) a group of subgroup decomposable indices is suggested. They define a continuous, decreasing and strictly convex function $f : \mathbb{R}^1_+ \to \mathbb{R}^1$, with $f(t) = 0$, $\forall\ t \geq 1$. **The Foster-Shorrocks indices** result in:

$$PV_{FSH}(X,z) = \frac{1}{n}\sum_{i \epsilon Q(X)} f(\frac{x_i}{z}) \tag{2.3.18}$$

For $f(t) = -\log t, t > 0$ $PV_{FSH}^{n,1}$ becomes **the Watts (1968) index**:

$$PV_{WAT}(X,z) = \frac{1}{n}\sum_{i \epsilon Q(X)} \log(\frac{z}{x_i}) = PV_{HCR}[I^q_{Theil}(X^p) - \log(1 - PV_{PGR})] \tag{2.3.19}$$

where I^q_{Theil} denotes the Theil index of inequality among the distribution of the poor. Foster, Greer and Thorbecke (1984) apply $f(t) = (1-t)^\alpha$, so that PV_{FSH} in equation 2.3.18 becomes **the Foster, Greer, Thorbecke (FGT) index**:

$$PV_{FGT}(X,z) = \frac{1}{n}\sum_{i \epsilon Q(X)} (\frac{z - x_i}{z})^\alpha \tag{2.3.20}$$

The coefficient $\alpha > 1$ may be interpreted as a parameter of poverty aversion, since greater values of α attach increasingly greater weight to large poverty gaps.

All in all, the most popular indices of poverty that appear to be the most

[45] In the absolute version, PV_{CHK} denotes $PV_{CHK} = (z - E^n(X^*))$.

[46] In the case of $k = 0$, the CHU index denotes: $PV_{CHU}(X,z) = 1 - \frac{\prod_{i=1}^{n}(x_i^*)^{\frac{1}{n}}}{z}$.

Index	Axioms and Principles									
Nota tion	Fo cus	Wk. mon.	Strg. trans.	Sym met.	Incr. pov.l.	Cont inuity	Popu lation	Mon. sen.	Dim.tr. sensit.	Subgr. Decom.
PV_{HCR}	yes	no	no	n/a	n/a	yes	n/a	no	no	yes
PV_{PGR}	n/a	yes	no	n/a	n/a	n/a	n/a	n/a	no	n/a
PV_{SEN}	yes	yes	no	yes	yes	no	no	n/a	n/a	no
PV_{BLD}	yes	yes	no	yes	yes	no	no	n/a	n/a	no
PV_{KAW}	n/a	n/a	no	n/a	n/a	no	no	n/a	yes	no
PV_{CHK}	yes	yes	yes	yes	yes	yes	y/n*	n/a	y/n*	y/n*
PV_{CHU}	yes	yes	yes	yes	yes	yes	yes	yes	yes	no
PV_{FSH}	yes	yes	yes	yes	n/a	yes	yes	yes	yes	yes
PV_{FGT}	yes	yes	yes	yes	n/a	yes	yes	yes	yes	yes

* Whether PV_{CHK} does or does not fulfill these axioms depends on the form of the underlying welfare function.

Table 2.3.3: Indices of Poverty - Fulfilment of Axioms and Principles

elaborate ones, are the following: the Sen index and the Kakwani index, which is built on the Sen index, moreover the Chakravarty index, and the CHU index, which is related to the Chakravarty index, and finally the Watts index and the FGT index which are both derived from the Foster-Shorrocks indices. The fulfilment of axioms of these poverty indices is summarised in Table 2.3.3.[47]

Measurement of Richness

While all poverty indices of the previous subsection are well-known, little research has been done on the measurement of richness yet.[48] In a recent paper, Peichl et al. (2006) define a new class of richness measures. Let ρ be the richness line, *e.g.* 200% of median income, and $r = \#\{i|x_i > \rho,\ i = 1, 2, \ldots, n\}$ the number of rich persons. In most studies on income richness, only the proportion of rich persons is used as a measure of richness: $R_{HC}(\mathbf{x}) = \frac{1}{n}\sum_{i=1}^{n} \mathbf{1}_{x_i > \rho} = \frac{r}{n}$. Its definition resembles that one of the head count ratio for poverty. This definition of richness is not a satisfying one, because this index will not change if nobody changes his or her status (rich or non-rich). Therefore, Peichl et al. (2006) define a class of richness measures R by $R(\mathbf{x}) = \frac{1}{n}\sum_{i=1}^{n} v\left(f\left(\frac{x_i}{\rho}\right)\right)$. This approach is more sophisticated because it also takes the dimension of changes and not only the number of people beyond

[47] The derivation of fulfilment of axioms can be found in Ochmann and Peichl (2006).
[48] For an overview of the sparse literature see Medeiros (2006).

a given richness line into account. As the incomes of the rich have only a lower bound ρ, these incomes are transformed relative to the richness line, $\frac{x_i}{\rho}$, to the unit interval by a strictly increasing transformation function f. Where $f : \mathbb{R}_+ \to [0, 1]$ is strictly increasing, $v : [0, 1] \to \mathbb{R}_+$ (in particular $[0, 1]$) is increasing and $v(f(\cdot))$ is at least concave, that is, has a concave restriction on $[a, \infty[$ for some $a \in \mathbb{R}_+$. Peichl et al. (2006) define $f(y) := 1 - \frac{1}{y}$ and $v(y) := y^\alpha$, with $\alpha > 0$, to obtain a richness index which resembles the FGT index:

$$R_\alpha(\mathbf{x}) = \frac{1}{n}\sum_{i=1}^{n}\left(1 - \frac{1}{\left(\frac{x_i}{\rho}\right)\mathbf{1}_{x_i>\rho}}\right)^\alpha = \frac{1}{n}\sum_{i=1}^{n}\left(\left(\frac{x_i-\rho}{x_i}\right)_+\right)^\alpha. \tag{2.3.21}$$

One may also define $f(y) = 1 - \frac{1}{y^e}$, $e > 0$, for $y > 1$ and $v(y) = y$ and obtain an index similar to that one of Chakravarty:

$$R_e(x) = \frac{1}{n}\sum_{i=1}^{n}\left(1 - \left(\frac{\rho}{x_i}\right)^e\right)_+ , \; e > 0. \tag{2.3.22}$$

2.3.6 Summary

In this section, we provided a survey of the distributional analysis of fiscal reforms. Thereby, distributional effects were differentiated by four subconcepts: inequality, polarisation, progression in taxation, and poverty and richness.

When measuring inequality one may apply various indices, either descriptive ones simply measuring dispersion, indices based on an entropy concept from information theory, or indices with a normative background from social welfare indices. Most of the indices presented are sensitive at different ranges of the distribution scale, so that they implicitly measure different features of inequality at the same data set. The most popular indices of inequality applied in empirical analyses are the Gini coefficient, the Atkinson index, and the Theil index. The Theil index appears to be a famous index for decomposition of overall effects into partial effects. It also appears to be highly useful, since its general class of GE indices can be adjusted to sensitivity towards all ranges of the distribution scale by the sensitivity parameter c.

Polarisation subjects the formation of income groups which are moving away from each other, exhibiting the development of two growing peaks at the tails of the distribution and creating a growing gap around the mean income. Such polarisation may be measured on the one hand by indices which are based on axioms, originating from the Esteban-Ray index. These indices measure intra-group homogeneity applying an identification function as well as inter-group heterogeneity applying an alienation function. On the other hand, measures based on the concept of 'the declining middle class' focus on the growing gap between the two peaks on the distribution scale, generally all based on the Wolfson index.

Progressive effects of taxation systems may be grouped by redistributive effects from pre-tax to post-tax incomes, and effects of disproportionality at the determination of tax liabilities. The latter one is characterised by progressivity, which may further be decomposed into effects of vertical equity and reranking effects as well as horizontal inequity. Direct progression may be further differentiated from indirect progression according to the presence or the absence of an absolute tax exemption. Local progression may be differentiated from effective progression, whereas average tax rates may be compared to marginal tax rates, and elasticities may be calculated. Indices can be established as well. They generally consider the relation between certain Lorenz curves and concentration curves: while indices of disproportionality compare pre-tax Lorenz curves to tax-liability Lorenz curves, indices of redistribution compare pre-tax Lorenz curves to post-tax Lorenz curves. Relating these Lorenz curves to each other allows a link between indices of these two concepts of progression, and thereby determine a progressive tax system.

When focusing on the low end of an income distribution one may find the socially undesirable characteristic of poverty. If one then wants to measure a degree of poverty suffered among the very low incomes, one should beforehand make sure that it is precisely defined what one is about to measure, which means identifying who should be considered poor. Thereby an exogenously given poverty line might help determining an appropriate threshold. Indices that may then be applied to data, range from absolute ones simply counting heads below the poverty line, via relative ones accounting for poverty gaps, accounting for the mean income among the poor incomes, attaching weights to higher deprivation, and determining equally distributed equivalent incomes. Indices again vary greatly at performance with respect to fulfilment of desirable axioms and principles. Complementarily to poverty analysis, this section introduced a class of comprehensive measures of richness which allow for a more comprehensive analysis of the top of the income distribution.

Several of these distributional indices from all four subconcepts will be applied to analyse flat tax reforms in the following chapters. In general, there is a need for a differentiated communication of the results of distributional analyses in order to prevent from one-sided and biased public perceptions of necessary public reforms.

2.4 Measuring labour supply and welfare effects

2.4.1 Introduction

Tax reforms affect the behaviour of individuals. To capture these behavioural responses in a simulation analysis, behavioural modules can be linked to a simulation model. In the case of microsimulation, the most important reaction to capture is the change in labour supply. Assuming an utility maximizing behaviour, labour supply models allow the modelling of both the extensive (participation) and the intensive (hours worked) labour supply decision of an individual or household. The change in labour supply (together with effective tax rates) are first measures of the efficiency of a fiscal reform. Based on these utility functions, the concept of distribution analysis - as described in the previous section - can be extended from pure monetary variables to welfare measures.

The computation of welfare measures is another important aspect for the evaluation of efficiency effects of tax reforms. An important finding of the long literature of Welfare Economics is, that it is not informative to compare utility levels between individuals (see e.g. King (1981)). Instead, money metric measures of utility are used to asses the level of (or changes in) welfare. Several methods and measures have been developed including the compensating and equivalent variation.[49] The empirical application of these methods mostly focuses on the ex-post evaluation of consumer demand using time-series data from before and after a tax reform. The application of these measures in the labour supply context allows for a more comprehensive distributional analysis. Instead of looking only at disposable income,

[49] See Slesnick (1998) for a comprehensive survey.

these measures allow to incorporate the preferences (for leisure) of individuals (or households) into the analysis (see e.g. Haan (2007)). Creedy and Kalb (2006) propose a method for the ex-ante analysis of the effects of tax reforms on the labour-leisure decision in the discrete choice labour supply framework set-up by Van Soest (1995)[50] without actually applying it to real micro data.[51]

This section combines the theoretical cognition of welfare measurement with the technique of microsimulation allowing to quantify the welfare effects and the excess burden of tax systems and tax reforms.[52] The remainder of this section is organised as follows: subsection 2.4.2 gives a short review of applied labour supply analysis. Subsection 2.4.3 reviews the theoretical concepts of welfare measurement and subsection 2.4.4 illustrates the incorporation of taxes into these concepts. The empirical application of these concepts is described in the following section 2.5.

2.4.2 Labour supply

To analyse the behavioural responses induced by different tax reform scenarios we estimate the expected labour supply responses. Following Van Soest (1995) we apply a structural discrete choice household labour supply model.[53] Recent surveys of the empirical labour market literature and different kinds of labour supply models are for example provided by Heckman (1993), Blundell and MaCurdy (1999) or Creedy et al. (2002). A major finding of this literature is that labour supply responds rather along the extensive than the intensive margin (see also Immervoll et al. (2007)). Working-hours elasticities are close to zero for men (see Blundell and MaCurdy (1999)) and women (see Mroz (1987), Triest (1990)). In contrast, extensive labour supply responses seem to be much stronger than intensive (Heckman (1993)), especially particular subgroups (at the bottom of the income distribution)

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[50] Aaberge, Dagsvik and Strøm (1995), however, proposed a method for estimating the equivalent variation in the discrete choice labour supply framework of Dagsvik (1994).

[51] However, this method has by now been applied in several studies, including Brenneisen and Peichl (2007b), Haan (2007) and Creedy, Herault and Kalb (2008).

[52] This section is based on Brenneisen and Peichl (2007a) and Brenneisen and Peichl (2007b).

[53] The Van Soest (1995) approach is essentially a special case of a more general class of discrete choice models introduced by Dagsvik (1994) (see also Aaberge et al. (1995) and Aaberge, Colombino and Strøm (1999)). In Van Soest (1995) it is assumed that every individual respectively household has the same choice set. The models by Dagsvik (1994) and Aaberge et al. (1999) allow for choice sets to vary across households and individuals.

have rather high participation elasticities (see Eissa and Liebman (1996), Meyer and Rosenbaum (2001) and Immervoll et al. (2007)).

In the standard continuous model (see Hausman (1985)), labour supply responds only along the intensive margin: an infinitesimal change of the marginal tax rate changes the working hours only a little, whereas participation responses cannot be analysed within this framework satisfactorily (Blundell and MaCurdy (1999)). Discrete choice labour supply models allow to analyse both the extensive (participation) and the intensive (hours worked) labour supply decision within the same modelling framework (Blundell and MaCurdy (1999), Van Soest and Das (2001) and Van Soest, Das and Gong (2002)). The intensive decision depends on the effective marginal tax rate, whereas the extensive participation decision depends on the tax wedge between gross (pre-tax) labour costs and the after-tax net income of workers (see Kleven and Kreiner (2003)).

The continuous model "appears not to capture the data, in the sense that the number of part-time jobs is strongly overpredicted" (Van Soest (1995)). There seems to be a lack of part-time jobs because of fixed costs of hiring workers or increasing returns to scale of the worker's production. Furthermore, because of fixed costs of working (Cogan (1981)) individuals are not willing to work below a minimum number of hours. In addition, there are working time regulations that limit the number of possible working hours to a discrete set. Therefore, a discrete choice between distinct categories of working time seems to be more realistic than a continuum of infinitesimal choices. Using a discrete choice labour supply model has also the advantage to model nonlinear budget constraints as a result of, for example, nonlinear taxes, joint filing and unemployment benefits (see MaCurdy, Green and Paarsch (1990), Van Soest (1995) or Blundell and MaCurdy (1999)). Furthermore, a richer stochastic specification in terms of unobserved wage rates of non workers and random preferences can be incorporated into a discrete choice model.

2.4.3 The effects of taxation on welfare

Consumer surplus as a basic concept

Changes in welfare have often been measured through the basic concept of measuring changes in consumer surplus which can be tracked back to Dupuit (1844). At that time, the predominant belief was that the value of each good was equivalent to its market price. Contrary to the common belief, Dupuit argued that the market price solely represents the minimum level of value for a specific good.[54] This observation later evolved to become the common definition for *consumer surplus (CS),* illustrated in figure 2.4.1 "Consumer surplus measures the extra value that consumers receive above what they pay for a commodity".[55]

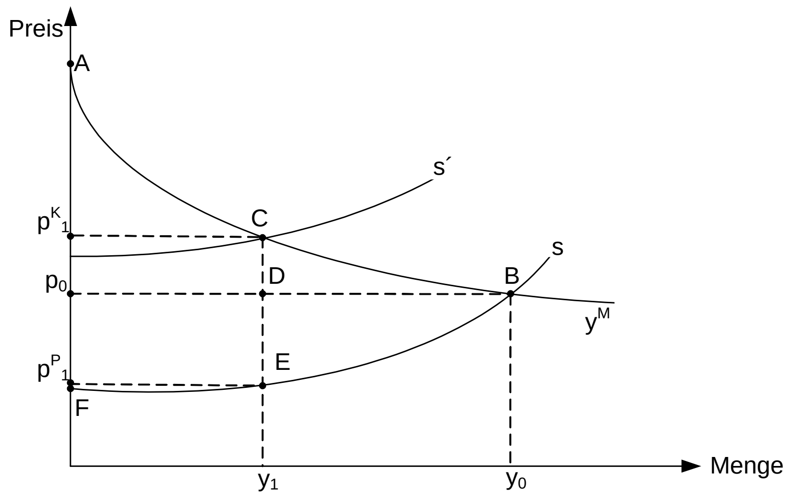

Figure 2.4.1: Consumer and producer surplus

With the help of the aforementioned definition, *Marshall's demand curve*[56] (y^M) could be interpreted as the maximal price that a consumer is willing to pay for a specific good or the utility of a certain commodity in monetary units. Consequently, the area (ABp_0) between the market price (p_0) and the demand

[54] Cf. Hines (1999).
[55] Samuelson and Nordhaus (2005).
[56] The demand function of Marshall represents the utility maximizing consumption supposed that the budget depending on the prices of the commodities is constant (see Mas-Colell, Whinston and Green (1995)).

curve can be interpreted as the consumer surplus. In analogy, producer surplus can be interpreted as the area between the market price and the producer's variable costs (p_0BF). Combining both areas (ABF) would correspond with an increase in utility in the economy as a whole as it is the difference between the maximal price that a consumer is willing to pay for a specific commodity and its variable costs of production.[57]

Not only can the general welfare of an economy, due to the trade of a certain good, be determined through the use of consumer and producer surplus, but the effects of taxation could also be identified. If one compares the situation in a market with or without taxation, a direct effect of taxation on welfare will become evident. Due to taxation the market price will rise from p_0 to p_1^K. In consequence, not only does the quantity (from y_0 to y_1) of the traded good decrease but both consumer and producer surplus.[58]

This decrease provides a basis for an initial estimation of welfare losses. These could be interpreted on a monetary basis and divided in to three areas.[59] The actual tax revenue can be identified as the size of the area ($p_1^K CE p_1^P$) which is generated through the levy of a quantity tax ($p_1^K - p_1^P$). This effect varies according to different tax rates. Nevertheless, it is evident that next to the pure tax revenue, both, producer and consumer surplus, decrease. In the above graph, these losses are represented by the triangles (CBD) and (DBE). In particular, the loss of consumer surplus (CBD) has been commonly known as the *Harberger Triangle* or as the tax induced *dead weight loss*.[60]

As seen above, both consumers and producers are negatively influenced by taxes. However, it is the elasticity of the demand and supply curves that determ-

[57] Cf. Samuelson and Nordhaus (2005).

[58] In figure 2.4.1 a quantity tax, which has to be paid by the producer, is examined. The type of levy has neither an effect on the price the consumer has to pay nor on the revenue per unit that remains for the supplier.

[59] Cf. Rosen (1978).

[60] Cf. Auerbach and Hines (2002). Although this type of welfare loss is connected by name to Arnold Harberger, there have been many popular economists before him like Hotelling (1938), Hicks (1946), Debreu (1951) and Johnson (1960) who contributed to the development of this indicator. The essential contribution of Harberger, that lead to the naming, was the broad empirical application of the existing theory. In an open letter in Harberger (1971), he asked for a common measure for the evaluation of welfare effects and suggested the consumer surplus. The area of the deadweight loss is still called Harberger Triangle due to the linear demand functions that were common at that time.

ines the extent of which a certain market side is burdened.

Until today, the estimation of welfare losses on the basis of consumer surplus has been the basis of many calculations, which is due to its simplicity and moderate information requirements.[61] To determine the loss of consumer surplus one merely needs Marshall's demand curve for the subsequent calculation. This function is easily estimated with the help of econometric methods. Consequently, the integral of the demand function between consumer prices with (p_1^K) and without (p_0^K) taxation is calculated. To highlight welfare losses, a negative prefix is commonly used.

$$\Delta\text{CS} = -\int_{p_0^K}^{p_1^K} y^M(p^K)dp^K \tag{2.4.1}$$

Based on the above integration, the dead weight loss can be easily estimated by adding the actual tax revenue to the calculation.

Compensating and Equivalent Variation

An alternative indicator for the estimation of taxation induced welfare losses has been developed by Hicks (1942) and is commonly known as the *compensating variation* (CV). This indicator is based around the question, how much monetary compensation a household should get after a tax reform to counterbalance the tax induced price changes.

Consider the following scenario: A household's main goal is to maximise its utility under the constraint of fixed income. It can choose between two commodities x and y.[62] The household's actual choice is modelled by maximizing its utility according to its preferences and the fixed price relation ($\frac{p_y}{p_x}$) of the two chosen commodities. If the household would decide to only buy one commodity, it would only be able to do this according to its budget. Therefore there is a maximal amount of x (x^{Max}) that can be purchased. But the household must not only be restricted to purchasing one commodity, a further possibility is to buy both commodities under

[61] Cf. Hines (1999).

[62] In this context, the commodity x can be interpreted as a composed commodity that comprises every other commodity. It fulfils the function of a referent for the household's budget. The price of x is therefore normalized to one. Such a commodity is called *Numeraire* in current literature (see Mas-Colell et al. (1995)).

the constraint of the household's budget. The resulting consumption possibilities are illustrated in the Figure 2.4.2 below. The slope of the budget constraint $(\overline{x^{Max}, y_0^{Max}})$ determines the negative price relation of x and y. To attain the maximal level of utility for a given budget constraint, the household has to choose the optimal commodity mix. For the household to be on the highest indifference curve possible, it has to find the point of tangency between the indifference curve U_0 and the budget constraint $(\overline{x^{Max}, y_0^{Max}})$. At this point A, the slopes of the two curves are the same, which means that the marginal rate of substitution (the slope of the indifference curve) is equal to the negative price relation of the commodities.

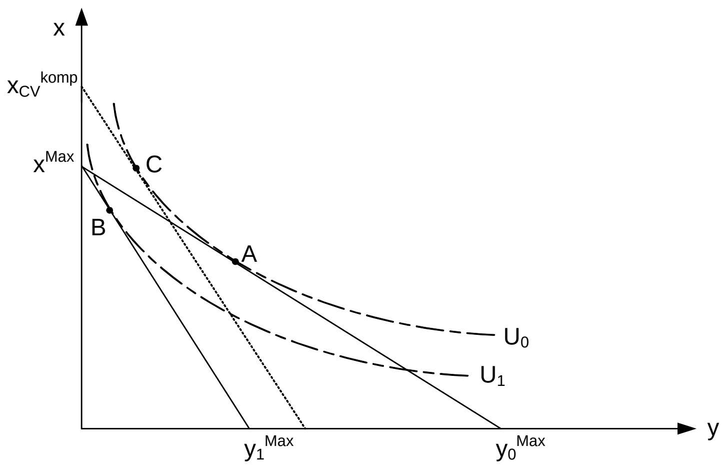

Figure 2.4.2: Compensating Variation

Consider the introduction of a tax on commodity y: In this case, both the price of the commodity and the budget constraint change. The new budget constraint is illustrated as in the graphic above. The household must lower its consumption of commodity y as its price $p_{y,1}$ has increased (both negative substitution and income effects). The effects on the consumption of commodity x, however, are not as clear. This is due to the fact that a positive *substitution effect* - commodity x has become relatively cheaper - is counterbalanced by a decrease of actual income through taxation: the negative *income effect*. In effect, both a reduction and an increase in consumption of x are possible. A possible commodity mix can be found in B. As mentioned above, this is the point where maximal utility under the constraint of fixed income is achieved, where the slope of the indifference curve and the new budget constraint are identical. As seen in the graphic above the household's utility has dropped from U_0 to U_1. Unfortunately the differences in utility $U_0 - U_1$ cannot be used as an indicator for exact measurement in utility changes as they are ordinal.[63] In this case, an instrument needs to be developed that enables a correct estimation of the decrease in utility through interval-scaled variables.

At this point, an *expense function* is extremely useful. It states the minimal amount of budget that is needed to meet a certain utility level ($\widehat{U}$) provided a given transposed price vector $p' = (p_x \; p_y)$,[64] thus enabling us to transform an ordinal variable in monetary units and solve the following optimisation problem:

$$\underset{q}{Min}! \; (E = q \cdot p | U(q) \geq \widehat{U}) \tag{2.4.2}$$

The variable q signifies the units consumed. The notation $E(p_j, \, \widehat{U})$ will be used throughout the following text as it highlights both the analysed utility and price level. Due to a change in prices for commodity y the old budget constraint is no longer applicable. Given the new price vector $p_1 = (p_x, \, p_{y,1})$ the household can no longer achieve the former utility level U_0 with x^{Max} as an axis intercept. To remain on U_0 as a utility level, the household's income must increase. This can be illustrated by the new demand curve which shows the demand for a commodity under the assumption that its price rises and while the household is given sufficient additional income that its level of utility remains unchanged. In the figure 2.4.2, the minimal budget $E(p_1, \, U_0)$ which achieves the former utility level is defined by the new axis intercept x_{CV}^{komp}. The difference between both budgets also defined as the *compensating variation* signifies the amount of compensation money to be transferred to the household by the state as to remain on the former utility level despite the raised prices.

[63] Cf. Creedy and Kalb (2006). Due to the ordinal property of utility, the different consumption alternatives can be sorted according to their utility level but the differences of utility levels cannot be interpreted (see Varian (2001)). In van Praag (1991) the ordinal and cardinal concepts of utility are included.

[64] Cf. Diamond and McFadden (1974).

$$\begin{aligned} CV &= E(p_1, U_1) - E(p_1, U_0) \\ &= x^{Max} - x^{komp}_{CV} \end{aligned} \tag{2.4.3}$$

A different but similar approach for welfare measurement is to ask the household how much money it is willing to pay to avoid the new taxation system. This approach is called *equivalent variation* (EV) approach.[65] The amount of money that they are willing to pay would in effect cause a shifting of the old budget constraint $(\overline{x^{Max},\ y_0^{Max}})$ until it reaches a new point of tangency with the new utility level U_1 as illustrated in the following figure.

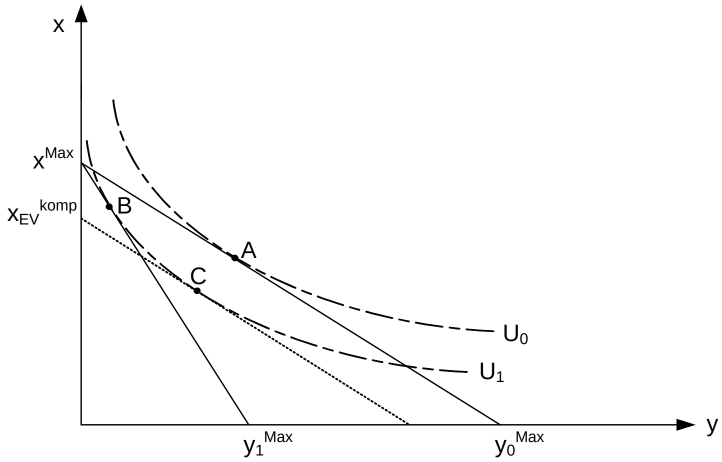

Figure 2.4.3: Equivalent Variation

Using the expense function, one can define the equivalent variation as follows:

$$\begin{aligned} EV &= E(p_0, U_1) - E(p_0, U_0) \\ &= x^{komp}_{EV} - x^{Max} \end{aligned} \tag{2.4.4}$$

In the following section we will focus on comparing the introduced concepts while highlighting their similarities and differences.

[65] Cf. Hicks (1942).

A comparison of the introduced concepts

The easiest approach would be to demonstrate the different concepts in one graphic. Because of the equality of both expense functions $E(p_1,\, U_1)$ and $E(p_0,\, U_0)$ in the considered framework of a commodity tax, equivalent and compensating variations can be transcribed into the price-demand diagram of the Harberger Triangle. In this case, both variables are formulated depending on *Hicks' demand curve*[66] (y^H).[67]

$$\begin{aligned}
\text{EV} &= E(p_0,\, U_1) - E(p_0,\, U_0) \\
&= E(p_0,\, U_1) - E(p_1,\, U_1) \\
&= \int_{p_1}^{p_0} \frac{dE(p, U_1)}{dp} dp \qquad (2.4.5) \\
&= \int_{p_1}^{p_0} y^H(p, U_1) dp \qquad (2.4.6)
\end{aligned}$$

The compensating variation is analogously transformed using the above method. As a result, it only differs in their initial utility level.

$$\text{CV} = \int_{p_1}^{p_0} y^H(p, U_0) dp \qquad (2.4.7)$$

The graphic illustration 2.4.4 of EV, CV and ΔCS shows that the decrease in welfare using the consumer surplus method (p_1ADp_0) engulfs both other welfare measurement methods. More precisely, it is EV (p_1ACp_0) that represents the lower limit of the surplus decrease and CV (p_1BDp_0) which represents the upper limit. The difference between both methods varies with the impact of the income effect on changes in demand. In fact, it is the impact of the income effect that determines the proximity of the two variations in the graphic, which also means that the lower the impact of the income effect, the closer the proximity of the two variations in the graphic and the smaller the difference between them and the loss

[66] Hicks' demand curve minimizes the expenses of the consumers on condition that a given utility level has been reached. The given function specifies Hicks' demand depending on commodity prices (see Mas-Colell et al. (1995)).

[67] Cf. Creedy and Kalb (2006).

of consumer surplus.[68]

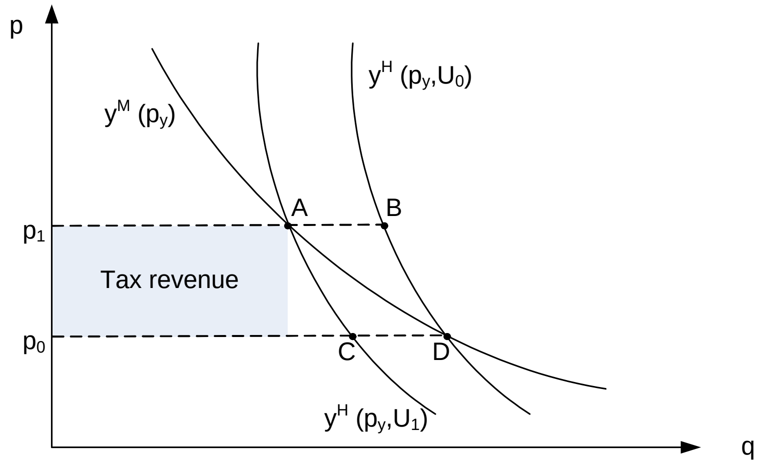

Figure 2.4.4: Comparison of concepts

Consequently, the consumer surplus approach has often been criticised for the fact that it does not differentiate between substitution and income effects. Still, one cannot ignore the fact that a decrease in welfare is also triggered by an unavoidable decrease in relative income due to price changes, which should not be neglected during the choice of optimal taxation.[69]

Another valid critique is the instruments failings in estimating values for a simultaneous tax introduction in two different markets. This is due to the path dependency of consumer surplus. The value of the estimated welfare does not only depend on the extent of price changes but also on the order in which the estimation takes place.[70]

Consequently, the use of consumer surplus changes for the measurement of welfare is not usually recommended. To estimate welfare effects and changes of different policies for a certain individual, it is essential to estimate an exact value

[68] Cf. Willig (1976).
[69] Cf. Leach (2004).
[70] Only in the case of identical cross prices does the problem of path dependency not arise. This is the case with symmetrical cross price effects under the assumption of homothetic preferences. Homothetic preferences can be found, when a consumer always chooses the commodity mix A over commodity mix B, if he would always choose commodity mix λA over commodity mix λB for all $\lambda > 0$ (see Chipman (1974)). In recent years, however, empirical evidence has proven that Marshallian demand functions do not hold this requirement (see Slesnick (1998)).

for the changes and to be able to clearly determine utility losses and gains. Different tax policies should be ranked according to their potentially achievable utility levels.[71] This index will further be referred to as the *Ranking-Criterion.* A correct definition of EV and CV using equations 2.4.3 and 2.4.4 should allow for a correct identification of the direction of changes in utility.[72] A negative prefix signifies utility loss, whereas a positive prefix a utility gain.

Noticeable, are CV's and EV's characteristics for meeting the Ranking Criterion.[73] In contrast to the equivalent variation method, compensating variation rankings are not always utility-consistent. This problem usually arises in policies that include both transfer payments and taxes, which is due to the hypothetical monetary compensation. This fictitious compensation allows for a welfare estimation starting from a hypothetical utility starting point, that in effect can never be reached by the consumer.[74] Utility consistent rankings using compensating variation methods can only be achieved under the assumption of homothetic preferences.[75] In this case, compensating variations suffer under the same flaw that ruled out the use of the Harberger Triangle as a mean of utility loss estimation. Nevertheless, Moore (2007) has stressed that the compensating variations disadvantage in comparison to the EV is eliminated using aggregated data of the total population.

2.4.4 Costs of Taxation

Definitions and applicability of the Harberger Triangle, CV and EV have long been undisputed. Referring to taxation systems, it has also been undisputed that under efficiency aspects a lump sum tax is most advantageous and that other tax reforms induce inefficiency due to their distortionary effects.[76] Still, a discussion evolved in the nineties focusing on the consequences of taxation costs on the cost-

[71] Cf. McKenzie and Pearce (1973).

[72] Equations 2.4.3 and 2.4.4 have been modified. The common definitions of equations 2.4.3 and 2.4.4 for EV and CV imply utility gains in connection with a negative prefix.

[73] Cf. Mas-Colell et al. (1995). An illustration of the compensatory variations breach of the Ranking Criterion can be found in Kay (1980) and Moore (2007). A necessary condition for a ranking consistent with the utility levels is derived in Chipman and Moore (1980).

[74] Cf. Kay (1980).

[75] Cf. Chipman and Moore (1980).

[76] Cf. Hakonsen (1998).

benefit-analysis of the state.[77] Two approaches have been clearly documented in the literature, that highlight the different calculation methods of these costs. In analogy to Ballard (1990), we differentiate between two categories: *Differential effect analysis* and *budget analysis*. The two categories enable a concise calculation of taxation costs with a direct link to their analysis conditions. In the following text we will refer to the differential effect analysis as *excess burden* (EB) and to the budget analysis as *welfare costs* (WC).[78]

Differential effect analysis

This approach defines the costs of taxation through a comparison of different taxation systems under the assumption of fixed government expenditures.[79] For the sake of clarity, we assume fixed production prices and a starting point, where no other taxes exist in the considered market.[80]

To calculate the excess burden using equivalent variation, one compares the tax revenue $T_{EV} = q(p_1, U_1) \cdot (p_1 - p_0)$ to EV, the amount an individual is willing to pay to avoid a distortionary tax. This amount can also be interpreted as a lump sum tax an individual is willing to pay to be on the same utility level U_1 as with the introduction of taxes. The difference between the introduced tax system and the amount the individual is willing to pay, is due to the fact that a lump sum tax would not change the relative prices of the commodities. There are no substitution effects. Consequently, although both fictitious and actual households are on the same utility level, they generate different tax revenues. The difference in tax revenue between the hypothetical lump sum tax and actual tax signifies the excess burden (EB_{EV}):[81]

$$EB_{EV} = EV - T_{EV} \tag{2.4.8}$$

[77] Cf. Usher (2006a).
[78] Cf. Ballard (1990).
[79] Cf. Musgrave (1959).
[80] Under the assumption of varying production prices, the excess burden can be calculated as the loss of producer through a decline in consumer surplus. In this case, one must not distinguish between different welfare loss calculation methods for firms as income effects are not existent (see Hines (1999)). However, varying production prices also effect the calculation of the excess burden on the consumer side. For an all-inclusive overview see Auerbach (1985) and Auerbach and Hines (2002).
[81] This type of calculation has been suggested by Kay (1980) as a definition for the excess burden.

To determine the excess burden of a certain taxation policy using compensating variation (EB_{CV}), one must proceed analogously. In this case, the difference between the amount the individual is willing to accept from the state as means of compensation for a distortionary tax is compared to the achieved tax revenue. The achieved tax revenue, however, is the result of the introduction of the new taxation system after deducting the needed compensation ($T_{CV} = q(p_1, U_0) \cdot (p_1 - p_0)$).

$$EB_{CV} = CV - T_{CV} \tag{2.4.9}$$

Due to different taxation methods that are used for calculating the excess burden, it is no longer possible to rank the different calculated values as it was done before. This calculation can be further developed to engulf situations in which taxation already exists. In this case, one must consider the initial distortion caused by the already existing tax in the excess burden calculation.[82]

$$\begin{aligned} EB_{EV} &= EV - q(p_2, U_2) \cdot (p_2 - p_1) + [q(p_1, U_2) - q(p_2, U_2)] \cdot (p_1 - p_0) \\ EB_{CV} &= CV - q(p_2, U_1) \cdot (p_2 - p_1) + [q(p_1, U_1) - q(p_2, U_1)] \cdot (p_1 - p_0) \end{aligned}$$

It is the assumption of fixed tax revenue that isolates the substitution effect of taxation and that allows for a correct estimation of the excess burden. Nevertheless, it also represents a weak point in this approach, as it cannot accommodate the analysis of an expansion of tax revenue which should also regard the changes in tax revenue due to the income effect.[83] In the next paragraph a budget expansion will be analysed.

Budget analysis

The second approach concerning the costs of taxation remedies the above mentioned weakness of the excess burden calculation method. In the wake of a tax revenue expansion a budget analysis examines the resulting costs of taxation.[84] To

[82] This type of computation is used in Auerbach (1985).

[83] Cf. Fullerton (1991). The differential effect analysis can also be used for a budget expansion under the assumption that the commodities provided by the government are perfect substitutes of income and that the public provision has no effect on tax revenue (see Ballard (1990)).

[84] Cf. Creedy (2000).

determine the beneficiary effects of a tax revenue expansion one must contrast the costs of taxation to the utility increase due to higher investment in public goods. This approach can also be found in the *Samuelson-Rule*, which calculates the optimal investment level in public goods. According to Samuelson (1954), an optimal allocation of public goods is achieved, when the marginal rate of transformation c (marginal costs of public good allocation) and the sum of the marginal rate of good substitution $\sum b_i$ (marginal benefit of allocation) are equal. Governments should expand expenditures in public goods as long as the following formula is applicable:[85]

$$\sum b_i > c \tag{2.4.10}$$

Still, a consensus over the connection between taxation costs, social costs and the benefits of expenditures in public goods was not established. Until now, there is rather confusion concerning the calculation of public good benefits.[86] In most cases, certain assumptions are put. The social costs also include the costs of taxation and they do not affect the level of utility of a chosen project.[87]

To integrate welfare costs in the Samuelson-Rule we expand it by adding the *marginal welfare costs* (MWC) and multiplying it with the marginal costs of public good supply. MWC refers to the costs of expanding tax revenues by one unit.[88]

$$\sum b_i > (c \cdot MWC) \tag{2.4.11}$$

Although the definition of MWC is rather easy to grasp and comprehend, the estimation of its value is rather complex. For this reason, one can find several calculation approaches for this index in the literature. In summary, opinions differ on terminology and the initial reference level.[89] Here, we concentrate on the MWC index that is closest to the aforementioned methods EV, CV and EB. There are

[85] Cf. Usher (2006a).

[86] Using CV or EV to calculate the benefits of public good supply, the difference in value between both methods is not only determined by income elasticity but also by the substitution elasticity between public and private goods (see Liu and Rettenmaier (2005)).

[87] Cf. Lundholm (2004).

[88] Cf. Usher (2006b). A detailed discussion on the effects of distortionary taxes on the optimal level of public goods can be found in Gaube (2000).

[89] Cf. Auerbach and Hines (2002). For an overview of the different definitions see Hakonsen (1998).

seldom fixed functions for the calculation of taxation costs, for this reason marginal welfare costs are calculated in the following manner:

$$\text{MWC} = \frac{\Delta EV}{\Delta T} \tag{2.4.12}$$

In contrast to the differential effect analysis, budget analysis focuses on the change in total tax revenue (ΔT) through a variation of a specific tax, which makes a MWC lower than 1 possible. To understand this, one can think of a tax change that induces a strong income effect that in effect leads to higher labour supply.[90] The increased labour supply would then automatically increase income tax revenues and consequently lower welfare costs further.[91] Naturally, an increase in welfare costs can analogously be achieved through higher consumption taxes.[92]

2.4.5 Summary

This section combined the theoretical literature on welfare measurement with the technique of microsimulation allowing to quantify the welfare effects of fiscal reforms. The change in labour supply is a measure of efficiency of a fiscal reform. Based on the labour supply estimation it is possible to compute welfare measures as another important measure for the evaluation of efficiency effects. Furthermore, the distribution analysis can be extended from pure monetary variables to welfare using these measures allowing to incorporate the preferences of individuals into the analysis. The empirical application of these concepts is described in the following section 2.5 and later applied in chapter 3 for the analysis of flat tax reforms.

[90] Leisure is assumed to be a normal good. In effect, lower income leads to less leisure and more labour supply.

[91] Cf. Ballard and Fullerton (1992).

[92] Additionally to these effects, it is possible to include the costs of defraudation of tax into the concept of MWC because they cause costs higher than the tax revenue similar to the evasion reactions caused by a lower consumption of taxed goods. On this basis Fortin and Lacroix (1994) have done an empirical estimation with the data of the city Quebec. The study demonstrates that MWC are between \$1.39 and \$ 1.50 per dollar additional tax revenue. Furthermore, the results point out that a higher degree of penalty leads to a diminution of defraudation of tax and to a decrease of costs of 14 cent.

2.5 FiFoSiM

2.5.1 Introduction

The aim of this section is to describe FiFoSiM, the integrated tax benefit microsimulation and CGE model which is used for the analyses in this book.[93] FiFoSiM consists of three main parts. The first part is a static tax benefit microsimulation module. The second part adds a behavioural component to the model: an econometrically estimated labour supply model. The third module is a CGE model which allows the user of FiFoSiM to assess the global economic effects of policy measures. Two specific features distinguish FiFoSiM from other tax benefit microsimulation models: First, the simultaneous use of two databases for the tax benefit module and second, the linkage of the MSM with a CGE model.[94]

The basic module of FiFoSiM is a static microsimulation model for the German tax and benefit system using income tax and household survey micro data. The approach of FiFoSiM is innovative insofar as it creates a dual database using two micro data sets for Germany: FAST01 and GSOEP. FAST01 is a micro datafile from the German federal income tax statistics containing the relevant income tax data of nearly 3 million households in Germany. Our second data source, the German Socio-Economic Panel (GSOEP), is a representative panel study of private households in Germany. The simultaneous use of both databases allows for the imputation of missing values or variables in the other dataset using techniques of statistical matching.

[93] This section is based on the English documentation of FiFoSiM (see Peichl and Schaefer (2006)), which is a short version of the detailed German description (see Fuest, Peichl and Schaefer (2005b)). "FiFoSiM" stands for "Simulation model of the Center for Public Economics (CPE) at the University of Cologne" (in German: "*Finanzwissenschaftliches Forschungsinstitut an der Universität zu Köln (FiFo)*"). See also www.cpe-cologne.de for further information.

[94] One should note that both techniques have not been invented for FiFoSiM, but the application to the context of tax benefit reform proposal modelling is insofar original as it has not been done for a peer-reviewed German microsimulation model before. In the last years several tax benefit microsimulation models for Germany have been developed (see for example Peichl (2005) or Wagenhals (2004) for surveys). Most of these models use either GSOEP or FAST data. FiFoSiM is so far the first model to combine these two databases. However, the GMOD model, which is the oldest MSM model still active in Germany, also imputes information from FAST to GSOEP data (see Wagenhals and Buck (2006)), but not the other wax around. Moreover, the ZEW also uses a linked CGE-MSM model (see e.g. Franz, Gürtzgen, Schubert and Clauss (2007)), however their focus is more on CGE than on MSM modelling.

Figure 2.5.1 shows the basic setup of FiFoSiM. The layout of the tax benefit module follows several steps: First, the database is updated using the static ageing technique which allows controlling for changes in global structural variables and a differentiated adjustment for different income components of the households. Second, we simulate the current tax system using the uprated data as the benchmark for different reform scenarios which are also modelled using the modified database.

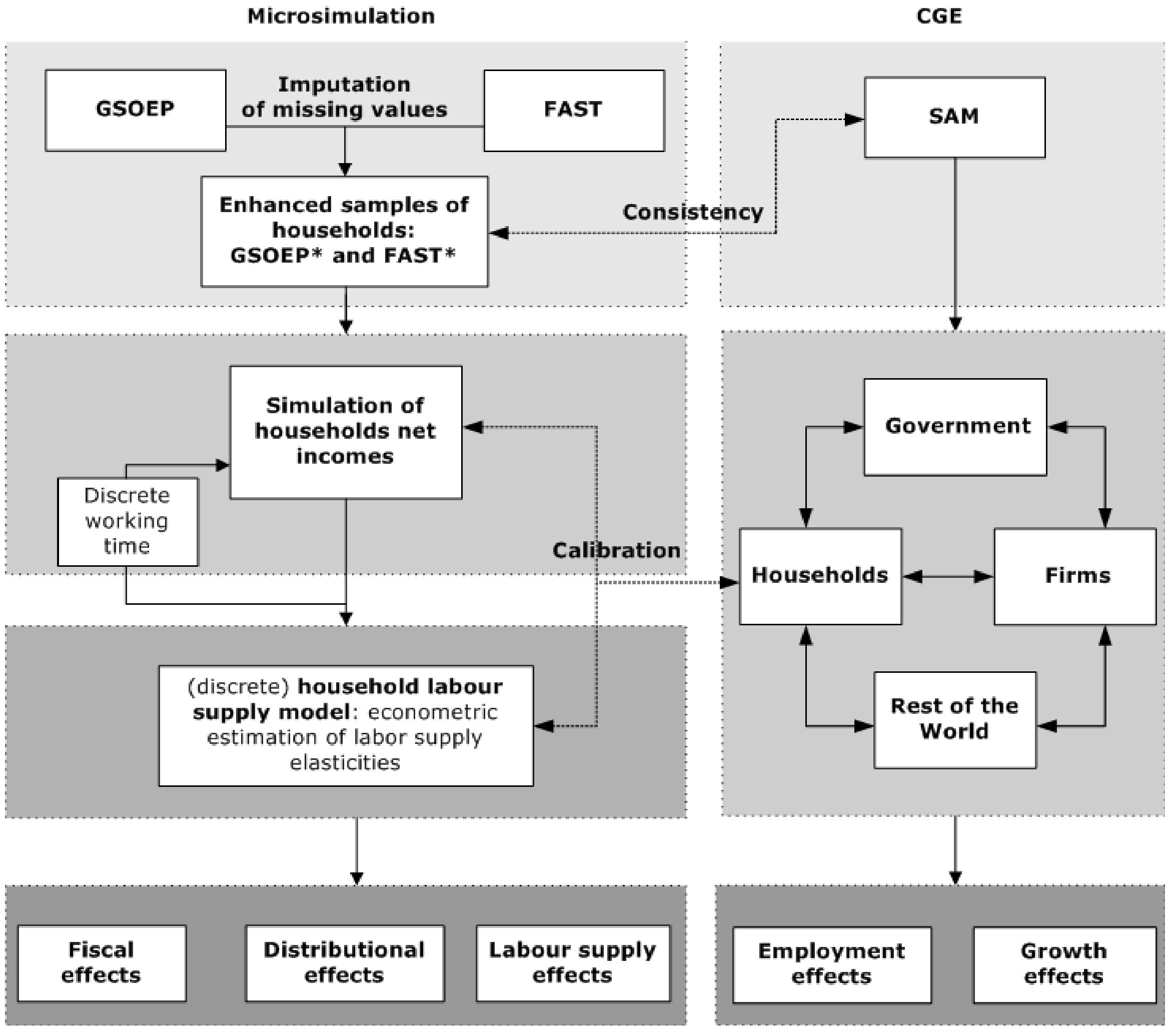

Figure 2.5.1: Basic setup FiFoSiM

The modelling of the tax and transfer system uses the technique of microsimulation. FiFoSiM computes individual tax payments for each case in the sample considering gross incomes and deductions in detail. The individual results are multiplied by the individual sample weights to extrapolate the fiscal effects of the reform with respect to the whole population. After simulating the tax liabilities and benefit entitlements we can compute the disposable income for each household. To derive the disposable income Y from gross income X, received benefits (like unemployment benefit, social assistance, child benefits, etc.) are added and taxes T and social insurance contributions S are subtracted:

$$Y = X + B - T - S$$

Based on these household net incomes we estimate the distributional, labour supply and welfare effects of the analysed reforms. For the econometric estimation of labour supply elasticities, we apply a discrete choice household labour supply model. Furthermore, FiFoSiM contains a CGE module for the estimation of growth and employment effects, which is linked to the tax benefit module. This interaction allows for a better calibration of the model parameters and a more accurate estimation of the various effects of reform proposals.

The setup of this section is as follows. Subsection 2.5.2 describes (the creation of) the dual database of FiFoSiM, while subsection 2.5.3 describes the tax benefit module. Subsection 2.5.4 contains a description of the labour supply model, subsection 2.5.5 describes the computation of welfare measures and subsection 2.5.6 introduces the CGE module. Subsection 2.5.7 concludes.

2.5.2 Database

A specific feature of FiFoSiM is the simultaneous use of two micro databases allowing for the imputation of missing values or variables in the other dataset.[95] Due to the time lags between the census and the availability of the micro data files, the data has to be updated to represent the German economy in the period of analysis. The data sources, the matching and the ageing are described in detail in the following.

[95] Furthermore, a third database is used for the CGE module which is described in section 2.5.6.

Income tax scientific-use-file 2001 (FAST01)

The federal income tax statistic is published every three years but with a time lag of five to six years. This statistic contains all information from the personal income tax form (e.g. source and amounts of incomes, deductions, age, children) for every household subject to income taxation in Germany. For 2001, almost 30 million households are included in the micro database. FAST01 is the income tax scientific-use-file 2001 containing a 10%-sample of the German federal income tax statistics including the relevant tax data of nearly 3 million households.[96]

The FAST micro data is especially suitable for a detailed analysis of the German tax system. All structural characteristics of the taxpayers are well represented and can be used for a differentiating analysis of tax reforms.

German Socio-Economic Panel (GSOEP)

The German Socio-Economic Panel (GSOEP) is a representative panel study of private households in Germany since 1984.[97] In 2006 GSOEP consisted of more than 12,000 households with more than 30,000 individuals. The data include information on earnings, employment, occupational and family biographies, health, personal satisfaction, household composition and living situation. The panel structure of GSOEP allows for longitudinal and cross section analysis of economic and social changes. Bork (2000) certifies GSOEP a rather good mapping of labour income whereas capital and business income are not represented just as well.

GSOEP contains information about the working time and the social environment of the households which is used for the labour supply estimations. Furthermore, the bottom end of the income distribution is better represented in GSOEP than in FAST.

Creating the dual database

A special feature of FiFoSiM is the creation and use of a dual database. To be more precise, FiFoSiM actually consists of two tax benefit microsimulation

[96] Cf. Merz, Vorgrimler and Zwick (2005) for a description of FAST data.
[97] See SOEP Group (2001) or Haisken De-New and Frick (2003) for a more detailed introduction to GSOEP.

models. The first one is based on administrative tax data (FAST), the second on household survey data (GSOEP). The main reason for using the dual database instead of having only one merged database is the huge difference in the number of observations (3 million vs. 30,000). Furthermore, both databases have several shortcomings, as described in the previous sections, but nevertheless, they are the two most appropriate datasets available for the analysis of the German tax benefit system. Therefore, information from one database is used for the imputation of missing values or variables in the second dataset and vice versa. A complete matching of the two databases is also possible but not yet necessary as we only need some of the variables from the second file, which are missing for our analysis in the first file.[98] Hence, the dual database of FiFoSiM actually consists of two enhanced datasets, which allow for a better analysis of tax benefit reforms than two raw datasets. Another aspect is the handling of missing values in existing variables in each dataset. There exist several principal ways for matching datasets or the imputation of missing values.[99] Those used in FiFoSiM are described in the following together with information about their respective implementation.

Imputation of missing values For the imputation of missing values in one variable several concepts exist.[100] In general, the imputation of missing values stands for replacing missing data with "plausible values"[101]. Let K be a variable

[98] There are mainly legal privacy issues in Germany militating against a complete match. Nevertheless, the matching of the anonymised databases does not allow for a deanonymisation of the individuals in the datasets.

[99] This section is based on Rässler (2002), who gives an introduction to statistical matching procedures and imputation techniques, as well as an overview of the vast literature and software packages that exist. Furthermore, see for example D'Orazio, DiZio and Scanu (2006) for an alternative introduction to these well-known techniques which have been developed during the 1970s (see for example Okner (1972) or Radner, Allen, Gonzales, Jabine and Muller (1980)) and applied in other fields of research before (see Cohen (1991) for a survey). As far as we know, the approach of creating a dual database has not previously been adopted by a peer-reviewed microsimulation model.

[100] Cf. Rubin (1987) or Little and Rubin (1987) as additional references for the imputation of missing values. The best but of course most expensive way to impute missing values would be to collect further information on the missing data. But even this solution cannot compensate for shortcomings in historic datasets.

[101] Schafer (1997), p. 1. The alternative to this imputation approach would be to delete (or at least omit) the cases containing missing values. This procedure would lead to biased estimations if the people with missing values share the same characteristics.

from a dataset A with i non-missing values $N = (n_1, n_2, ..., n_i)$ and j missing values $M = (m_1, m_2, ..., m_j)$: $K = (N, M) = (n_1, n_2, ..., n_i, m_1, m_2, ..., m_j)$, and $O = (O_1, O_2, ...)$ a vector of (other) variables without missing values, and H be the same variable as K and P the same as O but from a different dataset B.

Mean substitution In this approach, the missing values M in variable K are either substituted by the mean of the non missing values N:

$$\widehat{K} = (N, \overline{N}) = (n_1, n_2, ..., n_i, \overline{n}, \overline{n}, ..., \overline{n}) \,,$$

or they are substituted by the mean of the same variable H from a different dataset B :

$$\widehat{K} = (N, \overline{H}) = \left(n_1, n_2, ..., n_i, \overline{h}, \overline{h}, ..., \overline{h}\right) \,,$$

If the missing values can be attributed to some specific subgroups, then the missing values for each subgroup are replaced by the mean of each subgroup either from the non missing values or a different dataset.

This procedure reduces the variance of this variable and should therefore be the last option and only considered if other approaches are not applicable. The latter could be the case if there is, for example, no correlation between the variable containing missing values and any other variable. This approach is used in FiFoSiM if a reform proposal includes the taxation of a so far untaxed activity of which no micro data information is available.

Regression In the regression approach, a function for the estimation of the missing values is constructed. A (linear) regression[102] of the non missing values of K, N, on the other (non missing) variables O is done:

$$N = O\beta.$$

Or, as in the case of mean substitution, the similar variable H from a different dataset B is regressed on the other variables P from B :

[102] For categorical variables often logistic regressions are undertaken. A good textbook introduction to the different regression techniques can be found in Greene (2003).

$$H = P\beta.$$

These regression coefficients β are then used to predict the missing values. Often a stochastic random value $\widehat{u}$ is added to the prediction of the missing values M to allow for more variation:

$$\begin{aligned} \widehat{M} &= O\widehat{\beta} + \widehat{u}, \\ & or \\ \widehat{M} &= P\widehat{\beta} + \widehat{u}. \end{aligned}$$

These estimates $\widehat{M}$ are then used to replace the missing values M :

$$K = \left(N, \widehat{M}\right)$$

In FiFoSiM this approach is mainly used for variables originally coming from the FAST-Database. Most of these missing values are due to anonymisation and their values can be restricted to some intervals due to different information.

Multiple imputation In the multiple imputation approach, multiple values for each missing value are simulated. That is, the missing data is filled in m times using the regression approach each time with different draws from the distribution of the stochastic error term to generate m complete data sets. These multiple datasets are generated to better reflect the variation in the estimates and the uncertainty in the imputation procedure itself:

$$\widetilde{M}^i = (\widetilde{m}_1^i, \widetilde{m}_2^i, ..., \widetilde{m}_j^i)$$

Then the average of these estimates for each observation is calculated as the estimator for the missing values[103]:

[103] Hence it is possible to compute the variance, and confidence interval or P value of the missing value.

$$\widehat{M} = \frac{1}{i}\sum_i \widetilde{M}^i,$$

and is used to replace the missing value in the original dataset:

$$K = \left(N, \widehat{M}\right) = \left(n_1, n_2, ..., n_i, \widehat{m}_1^i, \widehat{m}_2^i, ..., \widehat{m}_j^i\right)$$

This approach is used in FiFoSiM for most of the GSOEP variables containing missing values. The relatively small number of cases in the GSOEP allows the use of several simulation runs for the imputation in a few minutes, whereas for the FAST data this method takes noticeably longer.

Statistical matching The idea of combining two existing datasets to create a joint dataset was developed during the 1970s.[104] The general principle is to merge two (or more) separate databases through the matching of the individual cases. This matching is done on common variables that exist in both databases (for example gender, age and income).

Figure 2.5.2 illustrates this basic idea of statistical matching. To put it more analytical[105]: We have three sets of variables X, Y, Z and two samples $A = (X, Y)$ and $B = (X, Z)$. X are the common variables in both samples (for example gender, age and income), Y and Z are sample specific (for example hourly wages and working hours from GSOEP, special tax deductions from FAST). We can now create a new, joint sample $C = (X, Y, Z)$ by merging a recipient sample (lets say A) with observations from a donor sample (B) with exact (or close) values of X.[106] In doing so, one assumes the Conditional Independence Assumption (CIA)[107] holds: Conditionally on X, Y and Z are independent.[108]

[104] Cf. Okner (1972), Radner et al. (1980) or Cohen (1991).
[105] This is based on Sutherland, Taylor and Gomulka (2002).
[106] Which sample should be chosen as the recipient and which as the donor depends on the particular matching question.
[107] See Sims (1972a), Sims (1972b) and Sims (1974). The CIA means that the X variables contain all information about the relationship between Y and Z. If we know X, Y (Z) contains no additional information about Z (Y).
[108] This can "in practice [...] rarely be checked" (Sutherland et al. (2002)). If the CIA does not hold, one can still use methods of statistical matching if the relationship between Y and Z can be estimated from other sources and incorporated into the matching process (see Paass (1986)).

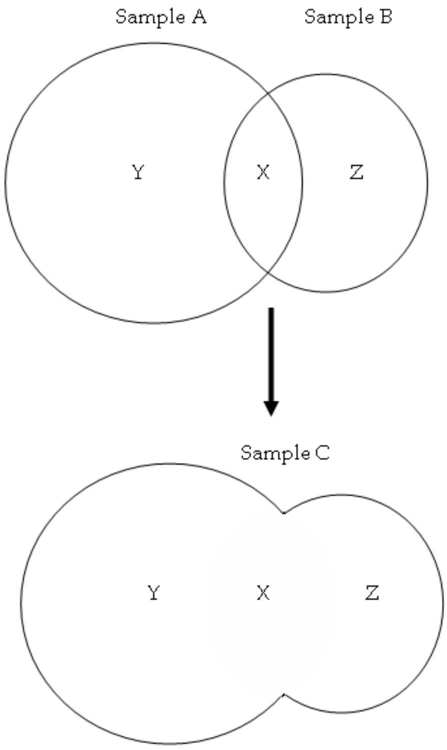

Figure 2.5.2: Basic idea of statistical matching

Of course, one would like to find perfect matches all of the time.[109] But without corresponding identification numbers and large numbers of variables, a perfect match may not always be possible.[110] In our case, an exact matching is not possible, therefore we have to use methods of statistical matching to match close (instead of exact) observations that share a set of common characteristics. The idea underlying this matching approach is that if two people have a lot of things in common (like for example age, sex, income, marital status, number of children), then they are likely to have other characteristics (like for example expenses) in common. The statistical matching of two databases can either be done by regression or by methods of data fusion.

[109] This would be possible, if one had variables (name, address, date of birth, social security number) which uniquely identify an individual. Due to privacy reasons researchers are not allowed to gain access to raw micro data that include these information without anonymisation.

[110] If many common variables are continuous, a perfect match seems to be impossible (see Rässler (2002), p.18).

Regression In the regression approach, the specific variable from the donor dataset Z is regressed on the vector of common variables X:

$$Z = X\beta.$$

Often a stochastic random value $\widehat{v}$ is added to the prediction to allow for more variation:

$$\widehat{Z} = X\widehat{\beta} + \widehat{v},$$

The estimated coefficients β from the donor dataset are then used to predict the values of Z in the joint dataset:

$$C(X, Y, \widehat{Z}(\beta)).$$

A strong correlation between X and Z is important for a successful merging. This approach is rather easy to perform, but it has the drawback that information in terms of variation is lost in the second dataset.

Data fusion The data fusion approach can be distinguished into two similar approaches: nearest neighbour and propensity score matching. The general idea of both approaches is related, as they only differ in the first step.

The first step in the *nearest neighbour* approach is to weight and norm the common variables, whereas in the *propensity score* approach[111], the propensity score is estimated. To do so, a dummy variable I is introduced into the pooled dataset D, containing the common variables X from both samples A, B, indicating 1 if the observation is from the recipient dataset and 0 if it is from the donor dataset:

$$I = \begin{cases} 1 & \text{if observation is from the recipient file} \\ 0 & \text{if observation is from the donor file} \end{cases}$$

[111] Cf. Rosenbaum and Rubin (1983). In general, the propensity score is defined as the conditional probability of treatment given (the common) background variables. Therefore, the propensity score is used as a predictor of the probability of being in the treatment group versus being in the control group. In our case, an observation is in the treatment (control) group if it comes from the recipient (donor) sample.

Then a logit or probit estimation of the probability of the observation being from the recipient sample (that is of the dummy indicator variable being 1) conditional on the common variables X is done:

$$P(I = 1|X) = f(X\beta).$$

The function $f(X\beta)$ is called the propensity score and indicates the probability of the observation belonging to the treatment group (the recipient sample).

The second step is similar for both approaches. The distance between the observations from both datasets is computed using a distance function[112]. In the nearest neighbour case, the distance is based on the weighted common variables, in the propensity score case, the distance is based on the estimates for the propensity scores, which can be interpreted as some sort of implicit weighting function.

In the third step, the joint database $C = (X, Y, Z)$ is created by merging the observations from the two datasets A and B with the minimal distance between them. Three ways of merging are possible: Either one observation from the donor dataset is merged to one observation from the recipient dataset (one-to-one merging), or one observation from the donor dataset is merged to multiple observations from the recipient dataset (one-to-n merging) or multiple observations from the donor dataset are merged to multiple observation from the recipient dataset (n-to-m merging).

In FiFoSiM several of these approaches are used due to the difference in the number of observations (3 million vs. 30,000). In general, information from the smaller GSOEP dataset is matched to the FAST data using the regression approach. FAST information is merged to GSOEP data using propensity score matching. Missing values in both datasets are imputed using different approaches

[112] See Cohen (1991). In general, three different distance functions can be used to determine similarity between the two samples: the absolute, Euclidean or Mahalanobis distance. Let x_i^A denote the common variables of unit i in sample A and x_j^B those of unit j in sample B.

The absolute distance is defined as $d_{ij}^{abs} = \left(x_i^A - x_j^B\right)$.

The Euclidean distance is given by $d_{ij}^{E} = \sqrt{\left(x_i^A - x_j^B\right)' \left(x_i^A - x_j^B\right)}$.

The Mahalanobis distance (see Mahalanobis (1936)) is based on the correlation matrix S_X^{-1} between the two sets of variables: $d_{ij}^{M} = \sqrt{\left(x_i^A - x_j^B\right)' S_X^{-1} \left(x_i^A - x_j^B\right)}$.

depending on the specific circumstances in each case.

Updating the data samples

The database is updated to the year of analysis (i.e. 2007) using the static ageing technique[113] which allows controlling for changes in global structural variables as well as a differentiated adjustment for different income components of the households. Especially the income tax data sample needs to be updated as it describes the situation of 2001. The GSOEP data only needs to be adjusted from 2006. Furthermore, the use of different ageing factors for each database and the reweighting of the weighting factors ensure the consistency of the two databases.

The first step is to reproduce the fundamental structural changes of the population. This is done according to the following criteria: age (in 5 year categories), assessment for income tax (separate or joint) and region (East/West Germany). The method applied here follows Quinke (2001): The cases from the FAST sample are compared to aggregated statistical data for the whole population regarding the above named criteria to calculate the degree of coverage. Assuming that this degree remains stable over the years, the actual aggregate population statistics and prognosis for the year 2007 times the coverage degree allows for an approximate adjustment of the database to account for the basic structural changes. Technically, the sample weights need to be adjusted. The weighting coefficients indicate how many actual cases of the real population are represented by each case in the sample. Using the software package Adjust by Merz, Stolze and Imme (2001) the sample weights are adjusted according to 52 possible combinations of the attributes (13 age categories times 2 assessment types times 2 regions). Now, the extrapolation of the sample using the adjusted weights represents the actual population structure better.

In the second step, the taxpayer's incomes are updated with respect to the varying development of different income types. Also different income growth rates between West and East as well as for positive and negative incomes are taken into account. This allows for a differentiated estimation of the income development. Based on empirical research of the DIW (see Bach and Schulz (2003)) different

[113]Cf. Gupta and Kapur (2000) for an overview of the techniques to modify the data for the use in microsimulation models.

coefficients for positive and negative incomes are applied on each case's income. For the simulation model this means that each income value is multiplied with the specific coefficient and thus extrapolated to the current income level. Of course, the coefficients only represent the average development, but regarding the whole population this method provides a satisfying approximation to the income structure of today.

Strength and limitations of the dual database

The use of the dual database and the two tax benefit microsimulation models based on the two enhanced datasets (FAST* and GSOEP*) allows us on the one hand to check consistency between the two models and on the other hand to choose the model which is most appropriate for each particular problem we want to analyse. However, these methods cannot guarantee the resulting datasets to retain all advantages of both databases. Beside the huge difference in size using methods of statistical matching leads to the loss of case-specific information. Nevertheless, both datasets are each enhanced through external information while maintaining their specific advantages. If the datasets were merged to one single database, lots of details and the huge number of cases in FAST would be lost. Table 2.5.1 presents some aggregated results for the revenue of the status quo personal income tax system for the years 2005-7 and for some selected variables that are merged into the other dataset.

	Ref.	FAST	FAST*	GSOEP	GSOEP*
PIT 2005	181.00	178.75	181.16	185.85	180.69
PIT 2006	192.85	190.02	192.64	197.27	192.23
PIT 2007	200.67	198.71	201.46	206.51	200.30

Table 2.5.1: Strength and limitations of the dual database
Notes: The reference value (Ref.) for the personal income tax is based on the estimation of the federal government for each year. * indicates the enhanced dataset.

The GSOEP values would overestimate the personal income tax in each year mainly because of missing information about deductions. On the contrary, the FAST simulations underestimate the tax revenue especially because of missing information about pension payments which are more heavily taxed since 2001.

These shortcomings can be overcome using the enhanced datasets FAST* and GSOEP* which are part of the dual database of FiFoSiM.[114]

The creation of this dual or enhanced database with information from administrative tax data and a household survey gives the users of FiFoSiM a powerful tool for the analysis of various questions regarding the German tax benefit system.

2.5.3 Tax benefit module

In this section, the modelling of the German tax benefit system is described. As it is very complex, we focus on the major parts of the model in this description.[115]

Modelling the German income tax law

Individuals are subject to personal income tax. Residents are taxed on their global income, non-residents are taxed on income earned in Germany only.

Income sources The basic steps for the calculation of the personal income tax under German tax law are according to the scheme of table 2.5.2 as follows.[116] The first step is to determine a taxpayer's income from different sources and to allocate it to the seven forms of income. The German tax law distinguishes between seven different categories of income: income from agriculture and forestry, business income, self employment income, salaries and wages from employment, investment income, rental income and other income (including, for example, annuities and certain capital gains). For each type of income, the tax law allows for certain income related deductions. In principle, all expenses that are necessary to obtain, maintain or preserve the income from a source are deductible from the receipts of that source. The second step is to sum up these incomes to obtain the adjusted gross income. Third, deductions like contributions to pension plans or charitable

[114] However, because of further differences between the enhanced datasets, the results still differ between the two enhanced models.

[115] A more detailed description can be found in the German version of this documentation (see Fuest et al. (2005b)).

[116] The reference period in FiFoSiM can be either "weeks", "months" or "years". The default period for the status quo is "years".

donations are taken into account, which gives taxable income as a result. Finally, the income tax is calculated by applying the tax rate schedule to taxable income.

	Sum of net incomes from 7 categories (receipts from each source minus expenses)
=	adjusted gross income
-	deductions (social security and insurance contributions, personal expenses)
=	taxable income x
·	tax formula
=	tax payment T

Table 2.5.2: Calculation of the personal income tax

Taxable income The subtraction of special expenses (*Sonderausgaben*), expenses for extraordinary burden (*außergewöhnliche Belastungen*), loss deduction and child allowance from adjusted gross income gives taxable income.

The special expenses consist of:

- alimony payments (maximum of 13,805 € per year)
- church tax
- tax consultant fees
- expenses for professional training (up to 4,000 € per year)
- school fees of children (up to 30%)
- charitable donations (up to 5% of the adjusted gross income)
- donations to political parties (up to 1,650 €)
- expenses for financial provision, i.e. insurance premiums (pension schemes up to 20,000 € per person, health/nursing care/unemployment insurance

The insurance contributions are normally equally split between employer and employee. Each premium is calculated as the contribution rate times the income that is subject to contributions up to the according contribution ceiling. Current (2007) contribution rates are 19.9% for old age insurance (5,200 € ceiling in West Germany / 4,400 € in East Germany), (an assumed average of) 14.2% for health insurance (3,525 € ceiling), 4.5% for unemployment insurance (ceilings: 5,200 €/4,400 €) and 1.7% for nursing care insurance (same ceiling as health insurance) plus various special supplements.

The expenses for extraordinary burden consist of:

- expenses for the education of dependants, expenses for the cure of illness, expenses for home help with elderly or disabled people, commuting expenses caused by disability in certain cases
- allowances for disabled persons, surviving dependants and persons in need of care
- child care costs
- tax allowances for self used proprietary, premises and historical buildings

Furthermore, negative income of up to 511,500 € income from the preceding assessment period [loss deduction carried back] is deductible from the tax base.

Each tax unit with children receives either a child allowance (2904 € per parent deduction from taxable income) or a child benefit (154 € per month for the 1st to 3rd child, 179 € as from the 4th child) depending on which is more favourable. In practice, each entitled tax unit received the child benefit. If the child allowance is more favourable, it is deducted from the taxable income while in this case the sum of received child benefits is added to the tax due. The model includes this regulation as it compares allowance and benefit for each case.

Taxable income is computed by subtracting these deductions from the adjusted gross income.

Tax due The tax liability T is calculated on the basis of a mathematical formula which, as of the year 2007, is structured as follows:

$$T = \begin{cases} 0 & if\ x \leq 7,664 \\ (883.74 \cdot \frac{x-7664}{10000} + 1500) \cdot \frac{x-7664}{10000} & if\ 7,664 < x \leq 12,739 \\ (228.74 \cdot \frac{x-12739}{10000} + 2397) \cdot \frac{x-12739}{10000} + 989 & if\ 12,739 < x \leq 52,151 \\ 0.42 \cdot x - 7914 & if\ 52,151 < x \leq 250,000 \\ 0.45 \cdot x - 15414 & if\ x > 250,000 \end{cases}$$

where x is the taxable income. For married taxpayers filing jointly, the tax is twice the amount of applying the formula to half of the married couple's joint taxable income.

Modelling the benefit system

To simulate the labour supply effects, the calculation of net incomes has to take the transfer system into account as well. Federal transfers such as unemployment benefit, housing benefit, and social benefits are modelled in FiFoSiM.

Unemployment benefit I Persons who were employed subject to social insurance contributions at least 12 months before getting unemployed are entitled to receive the so-called unemployment benefit I (according to the German SGB III). The amount to be paid depends on the average gross income of a certain period. This is reduced by 21% for social contributions and the individual income tax. The unemployment benefit I amounts to 60% of the resulting net income (or 67% for unemployed with children).

The benefit period depends on age and seniority (as shown in the following table 2.5.3). The GSOEP panel data contains information about previous unemployment benefit payments, employment periods, etc. When modelling a person's working time categories it has to be examined whether the person might get unemployment benefits in certain working time categories. This is assumed for persons who received unemployment benefits or who were employed subject to social insurance contributions at least 12 month within the last 36 month. The amount of benefit paid is calculated as described above. The remaining net income is deducted from the unemployment benefit.

old regulation until 31.01.2006			**new regulation from 01.02.2006**		
employment	age	benefit period	employment	age	benefit period
12		6	12		6
16		8	16		8
20		10	20		10
24		12	24		12
30	45	14	30	55	15
36	45	18	36	55	18
44	47	22			
52	52	26			
64	57	32			

Table 2.5.3: Duration of unemployment benefit entitlement

Unemployment benefit II The unemployment benefit II replaced the former system of unemployment support and social benefits in the course of the so-called Hartz reform. All employable persons between 15 and 65 years and the persons living with them in the same household are entitled to receive unemployment benefit II, as soon as they are no longer entitled to receive unemployment benefit I.

In contrast to the latter, unemployment benefit II depends on the neediness of the recipient and is therefore means-tested. Needy is a person who, by his own household's income, is not able to satisfy his own elementary needs and those of the persons living in his household. The unemployment benefit II corresponds to the former social benefits system plus housing and heating costs if necessary.

This basic amount for each person is means-tested against the household's net income.

Social benefits Persons who are not able to take care of their subsistence are entitled to receive social benefits. Since unemployment benefit II (see above) was introduced, only non employable persons can receive social benefits. Further on, social benefits are paid in extraordinary circumstances such as impairment of health.

Analogously to unemployment benefit II the basic amount for each person and their respective household net income are taken into account to determine the amount of social benefits actually paid.

Housing benefits Housing benefits are paid on request to tenants as well as to owners. The number of persons living in the household, the number of family members, the income and the rent depending on the local rent level determine if a person is entitled to receive housing benefits.

First, summing up the individual incomes considering the basic allowances gives the chargeable household income. Then, due to missing information about local rent levels, the weighted averages of rents up to the maximum support allowed are taken into account to determine the housing benefits.

2.5.4 Labour supply module

We use a discrete choice labour supply model to simulate the effects of different tax reforms on the supply of labour.[117] Following Van Soest (1995) we assume that the household's head and his partner jointly maximise a household utility function in the arguments leisure of both partners and net income.[118] Household i ($i = 1, ..., N$) can choose between a finite number ($j = 1, ..., J$) of combinations $(y_{ij}, lm_{ij}, lf_{ij})$, where y_{ij} is the net income, lm_{ij} the leisure of the husband and lf_{ij} the leisure of the wife of household i in combination j. Based on our data we assume that a household is limited to a set of discrete working hours categories. An individual can choose between the status of being unemployed and 6 different working hour categories. The possible working hours (a) are categorised in identical intervals, which comprise of eight hours each: $a \in \{0, 8, 16, 24, \ldots, 48\}$. The combination of all possible working hour categories results in 49 different alternatives that a household can choose from.

We model the following translog[119] household utility function

$$V_{ij}(x_{ij}) = x'_{ij} A x_{ij} + \beta' x_{ij} \tag{2.5.1}$$

[117] See section 2.4 for a discussion of the continuous vs. discrete labour supply literature.

[118] This approach is known as the Unity Approach in the literature. Research in the field of household decision has developed different modelling methods for this particular case. Vermeulen (2002) and Vermeulen (2005) present an introduction for the different modelling approaches and shed a light on the newest developments in this field. According to Browning, Chiappori and Lechene (2006) the unity approach can be used in microeconomic simulation models in which the Slutzky matrix of the labour supply is symmetrical and negative semi-definite. In this case, a couple household can be treated as one consumer.

[119] Cf. Christensen, Jorgenson and Lau (1971).

where $x = \begin{pmatrix} \ln y_{ij}, & \ln lm_{ij}, & \ln lf_{ij} \end{pmatrix}'$ is the vector of the natural logs of the arguments of the utility function. The elements of x enter the utility function in linear (coefficients $\beta = (\beta_1, \beta_2, \beta_3)'$) and in quadratic and gross terms (coefficients $A_{(3\times3)} = (a_{ij})$). Using control variables z_p $(p = 1, ..., P)$[120] we control for observed heterogeneity in household preferences by defining the parameters β_m, α_{mn} as

$$\beta_m = \sum\nolimits_{p=1}^{P} \beta_{mp} z_p \tag{2.5.2}$$

$$\alpha_{mn} = \sum\nolimits_{p=1}^{P} \alpha_{mnp} z_p \tag{2.5.3}$$

where $m, n = 1, 2, 3$.

Following McFadden (1973) and his concept of random utility maximisation[121] we add a stochastic error term ε_{ij} for unobserved factors to the deterministic utility level V_{ij}:

$$\begin{aligned} U_{ij}(x_{ij}) &= V_{ij}(x_{ij}) + \varepsilon_{ij} \\ &= x'_{ij} A x_{ij} + \beta' x_{ij} + \varepsilon_{ij} \end{aligned} \tag{2.5.4}$$

Assuming joint maximisation of the households utility function implies that household i chooses category k if the utility index of category k exceeds the utility index of any other category $l \in \{1, ..., J\} \backslash \{k\}$, if $U_{ik} > U_{il}$. This discrete choice modelling of the labour supply decision uses the probability of i to choose k relative to any other alternative l:

$$P(U_{ik} > U_{il}) = P\left[(x'_{ik} A x_{ik} + \beta' x_{ik}) - (x'_{il} A x_{il} + \beta' x_{il}) > \varepsilon_{il} - \varepsilon_{ik}\right] \tag{2.5.5}$$

Assuming that ε_{ij} are independently and identically distributed across all categories j to a Gumbel (extreme value) distribution, the difference of the utility index between any two categories follows a logistic distribution. This distributional assumption implies that the probability of choosing alternative $k \in \{1, ..., J\}$ for

[120] We use control variables for age, children, region and nationality , which are interacted with the leisure terms in the utility function because variables without variation across alternatives drop out of the estimation in the conditional logit model (see Train (2003)).

[121] Cf. McFadden (1981), McFadden (1985) and Greene (2003).

household i can be described by a conditional logit model[122]:

$$\begin{aligned} P\left(U_{ik} > U_{il}\right) &= \frac{\exp\left(V_{ik}\right)}{\sum_{l=1}^{J} \exp\left(V_{il}\right)} \\ &= \frac{\exp\left(x'_{ik} A x_{ik} + \beta' x_{ik}\right)}{\sum_{l=1}^{J} \exp\left(x'_{il} A x_{il} + \beta' x_{il}\right)} \end{aligned} \quad (2.5.6)$$

For the maximum likelihood estimation of the coefficients we assume that the hourly wage is constant across the working hour categories and does not depend on the actual working time.[123] For unemployed people we estimate their (possible) hourly wages by using the Heckman correction for sample selection.[124] The households' net incomes for each working time category are computed in the tax benefit module of FiFoSiM.

The labour supply module of FiFoSiM is based on GSOEP data, which is enriched by information taken from the FAST data as described in section 2.5.2. The sample of tax units is then categorised into 6 groups according to their assumed labour supply behaviour. We distinguish fully flexible couple households (both spouses are flexible), two types of partially flexible couple households (only the male or the female spouse has a flexible labour supply), flexible female and flexible male single households, and inflexible households. We assume that a person is not flexible in his/her labour supply, meaning he or she has an inelastic labour supply, if a person is either

- younger then 16 or older then 65 years of age,
- in education or military service
- receiving old-age or disability pensions
- self employed or civil servant.

[122] McFadden (1973). Cf. Greene (2003) or Train (2003) for textbook presentations.

[123] This assumption is common in the literature on structural discrete choice household labour supply models (see Van Soest and Das (2001)).

[124] Cf. Heckman (1976) and Heckman (1979). A detailed description of these estimations can be found in Fuest et al. (2005b).

Every other employed or unemployed person is assumed to have an elastic labour supply. We distinguish between flexible and inflexible persons, because the labour supply decision of those assumed to be inflexible (e.g. pensioners, students) is supposed to be based on a different consumption leisure decision (or at least with a different weighting of the relevant determinants[125]) than that of those working full time.

	married male	married female	single male	single female
participation	0.14	0.15	0.17	0.13
working hours	0.20	0.38	0.28	0.28

Table 2.5.4: Estimated labour supply elasticities
Source: own calculations based on FiFoSiM

After estimating the coefficients of the conditional logit model the labour supply elasticities can be derived with respect to a one percent change in gross wages. Following the method of McDonald and Moffitt (1980) the total hours effect can be decomposed into a working hours effect (i.e. the change in working hours of currently employed people) and a participation effect (i.e. the change in labour force participation). The results are summarised in Table 2.5.4. The elasticity of labour market participation (extensive margin) is close to 0.15 whereas the elasticities with respect to working hours (intensive margin) are slightly larger. These results are in line with other findings for Germany.[126]

2.5.5 Calculation of welfare effects

To evaluate the welfare effects of different tax systems one must determine the consumption/leisure combinations and the budget constraint for all working hour categories.[127] In case of discrete choice labour supply simulations and under the assumption of non-linear budget constraints a standardised process for the calculation of welfare costs due to tax changes is not sufficient. An easy comparison of the minimal budgets would not encompass the existing working hour constraints

[125] Therefore, it is not possible to assume the same econometric relationship for these persons.
[126] See e.g. Haan (2007) or Arntz, Clauss, Kraus, Schnabel, Spermann and Wiemers (2007).
[127] See Brenneisen and Peichl (2007a) for an extensive documentation of the welfare module und a more detailed specification of the used utility function and the budget constraint.

and would imply unrealistic working hours. More so, the standardised process also ignores the non-linearity of the budget constraint, which would result in difficulties especially if using CV.[128] A transfer payment to the household induces a positive income effect, which leads to a decrease in labour supply. However, if this decrease overpasses a kink in the budget constraint, it would lead to suboptimal compensation schemes. The household can in fact only achieve its new working hour category, if it accepts a lower income. This means that the state compensation is no longer sufficient.[129]

The applied approach is based on the works of Creedy and Kalb (2006) and it incorporates the curve of the budget constraint and labour supply restrictions.[130] Due to the fact that the literature distinguishes two different calculation methods for welfare costs, the marginal and average welfare costs, we will highlight each method separately.

Average Welfare Costs

The *average welfare costs* (AEB) of a tax system are defined as the amount of money the households are willing to pay to forego the implementation of the tax system. This amount of money is contrasted to the total tax revenue ($\mathrm{T}= \sum_{i=1}^{I} g_i \cdot \mathrm{T}_i$) expected from the tax system. In this case, one cannot neglect the fact that the data used is nothing but a sample and the following results should be weighed with g_i and extrapolated for the total population.

$$\mathrm{AEB}_{EV} = \frac{\sum_{i=1}^{I} g_i \cdot \mathrm{EV}_i}{\mathrm{T}} \tag{2.5.7}$$

To estimate the equivalent variation for each household i, one must determine its specific utility level after the introduction of the taxation system. In this case the choice probability of the households working hour category $j \in \{1, \ldots J\}$ are calculated using the equation 2.5.6 and compared to one another. The working

[128] This is due to the fact, that EV uses a hypothetical flat tax and the initial utility level without government intervention, which leads to a linear budget constraint in all cases. For the case of CV, however, the negligence of this characteristic would lead to faulty welfare cost estimations.

[129] Cf. Creedy and Kalb (2006).

[130] Their described method is especially easy and flexible in its application, which enables a adequate analysis of different government policies.

hour category k with the highest choice probability is calculated for each household and marked using a binary variable $\gamma_{i,j}$.

$$\gamma_{i,j} = \begin{cases} 1 & \text{if } P(U_{i,k} > U_{i,-k}) > P(U_{i,j} > U_{i,-j}) \ \forall \ k \neq j \\ 0 & \text{else} \end{cases} \tag{2.5.8}$$

The benefit for this alternative is calculated when we insert for each household its characteristic working hour category, which in effect calculates the deterministic utility level. This utility level is the basis for the calculation of the indifference curve und consequently the household's income, which in reference to the household working hour category leaves its utility level unchanged (fixed utility level $ekn|_{U_1}$).

To determine the equivalent variation one must compare all viable income levels in our *reference system* ekn_j^O, where there are no taxes, to the income level $ekn|_{U_1}$ under the consideration of all working hour categories. The EV represents the maximum between these differences and can be interpreted as their maximal willingness to pay.

$$\text{EV}_i = \max\left(ekn_j^O - ekn_j|_{U_1}\right) \quad \forall j \in \{1, \ldots, J\} \tag{2.5.9}$$

While using this calculation method one implicitly assumes that differences between the households' choices are due to their different working hour categories. The actual utility level differences due to differences in income are only visible through the examination of each working hour category at a time.

For determining the average welfare costs using CV one must sum over all compensating variations of the different households in the database (amount: I). The estimated value should then be extrapolated to represent the total population and contrasted to the tax revenue that can be hypothetically realised after deducting government transfer payments to the households ($\text{T}_{CV} = \sum_{i=1}^{I} g_i \cdot \text{T}_{CV,i}$).

$$\text{AEB}_{CV} = \frac{\sum_{i=1}^{I} g_i \cdot \text{CV}_i}{\text{T}_{CV}} \tag{2.5.10}$$

In the case of compensating variation one must forecast the working hour category of each household before taxation. Subsequently, one must determine the utility level U_0, which enables us to compute fixed utility income $ekn|_{U_0}$ and by analogy compared to EV ekn_j^1. In this instance, it is the minimum of these differences that represents the CV, which can also be interpreted as the minimum compensation a household is willing to accept for the introduction of a new taxation system.

$$\text{CV}_i = \min\left(ekn_j|_{U_0} - ekn_j^1\right) \quad \forall j \in \{1, \ldots, J\} \tag{2.5.11}$$

The calculation of EV and CV integrated in the welfare module differs from the calculation used by Creedy and Kalb (2006). Their estimation method relies on the compensating variation. They analyse the different income components in equation 2.5.11, which comprises a virtual work income and a residual income. However, their focus on the difference between the correct and standardised estimation of CV and EV is not of any advantage to our calculation, which is why we will not further concentrate on their results.

Marginal and absolute welfare effects

To compute the marginal and absolute welfare effects one must proceed differently than in the previous sections. The first change is in identifying a *base system* (a starting point without taxation) for comparison, This approach enables us to integrate the until now unobserved preferences, which is extremely advantageous while using the FiFoSiM database as each household represents a certain group of consumers with identical socio-economic characteristics. Williams (1977) and Small and Rosen (1981) have shown that under the assumption of an extreme value distribution of tastes, the average, actual utility level of a group can be determined.[131] With the aid of this observation, one can calculate the actual utility level (WU_i), of each representative household.

$$\text{WU}_i = \ln\left(\sum_{j=1}^{J} \exp V_{i,j}(m_{i,j})\right) + C \tag{2.5.12}$$

The variable C is actually a constant with an unknown value, which is actually

[131] Cf. Train (2003). The approach of Williams (1977) and Small and Rosen (1981) is restricted to linear utility functions and has been adjusted for non-linear functions by Dagsvik and Karlstrom (2005).

used to highlight the fact that the utility levels cannot be observed. Subsequently, it is this weighed index which will be used for determining the EV. The maximal difference between the fixed utility income and the reference income again represents EV:

$$\mathrm{EV}_i = \max\left(ekn_j^O - ekn_j|_{WU_i}\right) \quad \forall j \in \{1, \ldots, J\} \tag{2.5.13}$$

To determine the *absolute welfare effects* (TE) of a change in taxation systems, one must calculate the EV for both the new and the existing taxation system of every household in the database. Transitional effects can be identified via the difference of the accumulated welfare measurement instruments. Because of these effects one can easily isolate and neglect the constant C, which is the main hurdle that had to be overtaken to enable the use of weighted utility.

$$\mathrm{TE}_{EV} = \sum_{i=1}^{I} g_i \cdot (\mathrm{EV}_i|_{Alternative} \text{ - } \mathrm{EV}_i|_{Basis}) \tag{2.5.14}$$

In comparison to the estimation of the absolute welfare costs, the marginal welfare cost is estimated by analogy.[132] The system in which the marginal welfare costs should be estimated serves as the basis system. The alternative is the same situation but with an increased tax by one percentage point.[133] The calculated individual values are later aggregated and brought in to be compared to the higher tax revenue ($\Delta\mathrm{T}=\sum_{i=1}^{I} g_i \cdot \Delta\mathrm{T}_i$).

$$\mathrm{MWC}_{EV} = \frac{\sum_{i=1}^{I} g_i \cdot (\mathrm{EV}_i|_{Alternative} - \mathrm{EV}_i|_{Basis})}{\Delta\mathrm{T}} \tag{2.5.15}$$

The aforementioned results can naturally also be used for the calculation of the compensating variation. In this case one would also use the change in tax revenue under the assumption that the household would be compensated ($\Delta\mathrm{T}_{CV}=\sum_{i=1}^{I} g_i \cdot \Delta\mathrm{T}_{i,CV}$).

[132] The marginal welfare costs of a tax system have already been defined and introduced in subsection 2.4.4.

[133] The marginal costs are calculated via discrete changes in the tax system.

2.5.6 CGE module

The tax benefit and labour supply modules of FiFoSiM only account for the household side of the economy. The computable general equilibrium (CGE) module allows us to simulate the overall economic effects of policy changes including the production side.[134] Therefore effects on labour demand, employment and economic growth as well as wage and price levels can be assessed. The static CGE module of FiFoSiM models a small open economy with 12 sectors and one representative household.[135] The CGE module is programmed in GAMS/MPSGE[136].

The model

Households The representative household maximises a nested CES utility function according to figure 2.5.3.

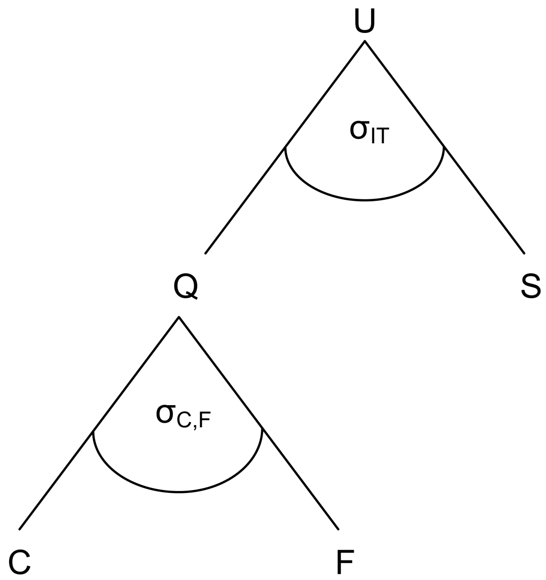

Figure 2.5.3: Household level FiFoSiM

[134]This section is based on Bergs and Peichl (2006).

[135]The expressiveness of this simple CGE module as a stand-alone model is rather limited. In combination with the state-of-the-art microsimulation module it becomes a powerful tool, though.

[136]See Brooke, Kendrick, Meeraus and Raman (1998) and Rutherford (1999).

At the top nest the household chooses between aggregated consumption (including leisure) today Q or in the future S. The result of this optimisation is the savings supply. On the second level, the present consumption leisure (or labour leisure) decision takes place. The household maximises a CES utility function U (C, F) choosing between consumption C and leisure F:

$$U\ (C, F) = \left[(1 - \beta)^{\frac{1}{\sigma_{C,F}}}\ C^{\rho_{C,F}} + \beta^{\frac{1}{\sigma_{C,F}}} F^{\rho_{C,F}} \right]^{\frac{1}{\rho_{C,F}}}. \tag{2.5.16}$$

where β is the value share, and $\sigma_{C,F} = \frac{\rho_{C,F}-1}{\rho_{C,F}}$ the elasticity of substitution between consumption and leisure. The budget constraint is:

$$p^C C = w \left(1 - t^l\right) (E - F) + r \left(1 - t^k\right) K + \overline{T}_{LS}, \tag{2.5.17}$$

where p^C is the commodity price, w the gross wage, t^l the tax rate on labour income, E the time endowment, r the interest rate, t^k tax rate on capital income and K the capital endowment. Consumption $p^C C$ is financed by labour income $w\left(1 - t^l\right)(E - F)$, capital income $r\left(1 - t^k\right) K$ and the lump sum transfer $\overline{T}_{LS}$, that ensures revenue neutrality. Optimising (2.5.16) subject to (2.5.17) yields the demand functions for goods and leisure. From the latter we calculate the labour supply of the household.[137]

Firms A representative firm produces a homogenous output in each production sector according to a nested CES production function. Figure 2.5.4 provides an overview of the nesting structure.

At the top level nest, aggregate value added (VA) is combined in fixed proportions (Leontief production function) with a material composite (M). M consists of intermediate inputs with fixed coefficients, whereas VA consists of labour (L) and capital (K).[138] The optimisation problem at the top level in each sector i can be written as:

[137] So far, the CGE module models only one type of labour. This rather strong assumption limits the expressiveness of the household side even more and is subject to future improvements.

[138] The CGE module allows for sector-specific wages and capital costs (although the latter is rarely used) depending on the context of the simulated reform.

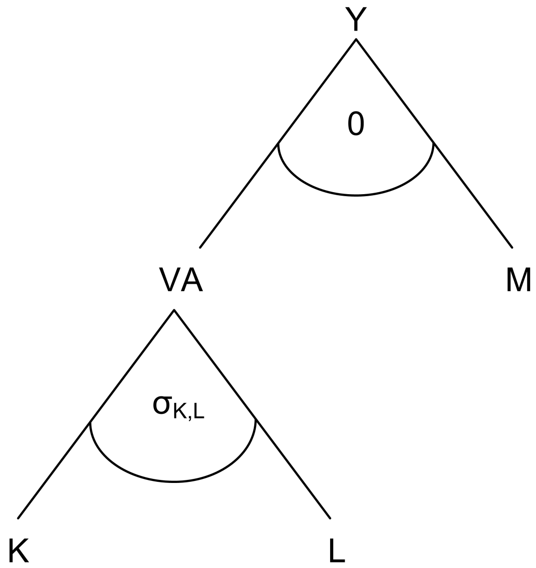

Figure 2.5.4: Production structure of FiFoSiM

$$Y_i = \min\left[\frac{1}{a_{0i}} f_i(L_i, K_i); \frac{M_{1i}}{a_{1i}}; ...; \frac{M_{12i}}{a_{12i}}\right] \tag{2.5.18}$$

In the bottom nest, the following CES function is used:

$$f_i(L_i, K_i) = \left[\alpha_i L_i^{\rho_i} + (1-\alpha_i)\, K_i^{\rho_i}\right]^{\frac{1}{\rho_i}} \tag{2.5.19}$$

where $\sigma_i = \frac{1}{1-\rho_i}$ is the constant elasticity of substitution between labour and capital.

The flexible structure of the model allows for different levels of aggregation ranging from 12 to 7 to 3 to 1 sectors.

Labour market To account for imperfections of the German labour market, a minimum wage $w_i^{\min}$ is introduced as a lower bound for the flexible wages in each sector[139]. The labour supply is therefore rationed:

$$L_i^S\,(1-\mu) \geq L_i^D. \tag{2.5.20}$$

[139] It is possible to model different minimum wages for each activity.

The minimum wage is calibrated so that the benchmark represents the current unemployment level of Germany.

Government The government provides public goods (G), which are financed by input taxes on labour and capital t^l and t^k. A lump sum transfer to the households completes the budget equation:

$$G + \overline{T}_{LS} = t^l wL + t^k rK. \tag{2.5.21}$$

Foreign trade Domestically produced goods are transformed through a CET-function into specific goods for the domestic and the export market, respectively. By the small-open-economy assumption, export and import prices in foreign currency are not affected by the behaviour of the domestic economy. Analogously to the export side, we adopt the Armington assumption[140] of product heterogeneity for the import side. A CES function characterises the choice between imported and domestically produced varieties of the same good. The Armington good enters intermediate and final demand.

Data and calibration

The model is based on a social accounting matrix (SAM)[141] for Germany which is created using the 2004 Input-Output-Table[142] and the static ageing technique to transform the data to 2007.

The elasticities for the utility and production functions are calibrated based on empirical estimations. The sectoral Armington elasticities are based on Welsch (2001), the elasticity of substitution between labour and capital is assumed to be 0.39 according to Chirinko, Fazzari and Meyer (2004). The elasticity of intertemporal substitution is assumed to be 0.8 (Schmidt and Straubhaar (1996)) as well as the elasticity of substitution between consumption and leisure (Auerbach and Kotlikoff (1987)).

[140] Vgl. Armington (1969).
[141] See Pyatt and Round (1985) for an introduction into the process of creating a SAM.
[142] The German IOT is provided by Statistisches Bundesamt (2005).

Linking the MSM and the CGE module

FiFoSiM so far uses either the top-down or the bottom-up approach to combine the microsimulation and the CGE module. In the bottom-up linkage the representative household (income, labour supply, tax payments) in the CGE module is calibrated based on the simulation results of the microsimulation modules. For the top-down linkage changes of the wage or price level are computed in the CGE model and used in the microsimulation modules for the calculation of net incomes and the labour supply estimation. The top-down bottom-up approach used for this analysis is so far only executed manually and not automatically.

In the first step, the fiscal effects are analysed in the tax benefit module without taking into account the behavioural reactions of the economic agents (first round effects). In the second step, we allow for behavioural reactions by estimating the labour supply responses (second round effects). In the third step, the labour demand and wage changes (third round effects) are computed in the CGE module. In the fourth step, the micro data information is used to calibrate the representative household in the CGE module for the computation of the overall employment and growth effects (general equilibrium).

2.5.7 Further Development and conclusion

FiFoSiM is a state of the art tax benefit simulation model for Germany. FiFoSiM consists of three main parts: a static tax benefit micro simulation model, an econometrically estimated labour supply model and a CGE model. Two specific features distinguish FiFoSiM from other tax benefit models: First, the simultaneous use of two databases for the tax benefit module and second, the linkage of the tax benefit model with a CGE model. FiFoSiM can be used to analyse various policy reforms of the complex German tax and transfer system.

Nevertheless, several ideas for the further improvement of FiFoSiM exist. One major aspect of improvement is the modelling of indirect taxes. For this reason, expenditure data is needed and a third data source has to be included into the FiFoSiM database. The micro macro linkage between the microsimulation and the CGE module shall be improved using the top down bottom up approach. Furthermore, the CGE module is to be improved as well, for example by allowing for more different household types or a more sophisticated modelling of the labour market. Moreover, dynamic modules are planned. A small Ramsey type dynamic version of the CGE module exists, but has not been used for any publication yet. This module shall be improved and used in the future. The development is not settled yet. We expect new issues of the FAST and GSOEP data, which have to be implemented in the model, soon.

To sum up, the creation of the dual database and the linkage of the tax benefit model with a CGE model give the users of FiFoSiM a powerful tool for the analysis of various questions regarding the German tax benefit system.

2.6 EUROMOD: model and database

The second microsimulation model we use is EUROMOD[143], a static, non-behavioural tax-benefit model for the EU-15. The uniqueness of EUROMOD lies in it being a research tool that is relevant both on the national and the European level. EUROMOD uses the microsimulation technique to simulate taxes, benefits and disposable incomes under different scenarios for a representative micro-data sample of households covering the EU-15 countries.

The main stages of the simulations are the following. First, a micro-data sample and tax-benefit rules are read into the model (for each country under observation). Then for each tax and benefit instrument, the model constructs corresponding units of assessment, ascertains who is eligible for that instrument and determines the amount of benefit or tax liability. The result is then assigned to either an individual or allocated to the persons sharing the tax unit. Finally, after all taxes and benefits in questions are simulated, disposable income is calculated.

EUROMOD is characterised by greater extent of flexibility compared to usual national models in order to accommodate a range of different tax-benefit systems. For instance, the model can easily handle different units of assessment, income definitions for tax bases and benefit means-tests, the order and structure of instruments. Overall, a common framework with standardised definitions allows making comparisons between countries in a consistent way. Further on, most analyses

[143] For further information on EUROMOD, see e.g. Sutherland (2001), Lietz and Mantovani (2006) and Sutherland (2007).

can be applied on a hypothetical "EU-15-land". Moreover, the integrated multi country model design allows for specific analyses like cross-country comparisons of certain instruments or policies, policy or system swapping, impact of national policies at the EU level or of EU policies at the national level.

EUROMOD covers only monetary incomes, excluding unrealised or irregular capital gains/losses and irregular incomes. It can simulate most of the direct taxes and benefits except those based on previous contributions as this information is usually not available from the cross-sectional data the EUROMOD input datasets are based on. The model assumes full benefit take-up and tax compliance. Although the latter is an important aspect of flat tax reforms, we do not consider changes in compliance here and limit our analysis to the first-order static effects only.

	Input dataset for EUROMOD	No of households	Date of collection	Reference time period for incomes
AT	Austrian version of EU-SILC	4,521	2004	annual 2003
BE	Panel Survey on Belgian Households	2,975	2002	annual 2001
DK	European Community Household Panel	7,044	1995	annual 1994
FI	Income distribution survey	10,736	2001	annual 2001
FR	Budget de Famille	29,158	1994/5	annual 1993/4
GE	German Socio-Economic Panel	11,303	2002	annual 2001
GR	Household Budget Survey	6,555	2004/5	annual 2003/4
IR	Living in Ireland Survey	14,585	1994	month in 1994
IT	Survey of Households Income and Wealth	23,924	1996	annual 1995
LU	PSELL-2	2,431	2001	annual 2000
NL	Sociaal-economisch panelonderzoek	4,329	2000	annual 1999
PT	European Community Household Panel	4,588	2001	annual 2000
SP	European Community Household Panel	5,048	2000	annual 1999
SW	Income Distribution Survey	33,223	2001	annual 2001
UK	Family Expenditure Survey	6,634	2000/1	month in 2000/1

Table 2.6.1: EUROMOD input datasets (version C13)

Table 2.6.1 gives an overview of the input datasets for EUROMOD. Their sample size varies from less than 2,500 to more than 33,000 households across countries. All monetary variables are updated to 2003 using country-specific uprating factors, as the reference time period for incomes varies from 1994 to 2003.

Where net incomes were recorded in the original data, gross incomes have been also imputed.

2.7 Summary

In this chapter, the methodology for the analysis of flat tax reforms has been described. Simulation models are necessary to provide data for the ex ante evaluation of the outcomes of hypothetical fiscal reforms. We apply these techniques in the following chapters to answer several flat tax questions. We use static tax benefit models, without and with allowing for behavioural responses, as well as a linked MSM and CGE model. We compute values for several distributional measures to analyse all aspects of income distribution. Behavioural responses include labour supply effects and account for changes in welfare. All in all, these models provide powerful tools for the ex ante analysis of the likely impacts of hypothetical flat tax reforms in Western Europe.

Chapter 3

Simplification and flat tax in Germany

3.1 Introduction

The recent success of flat taxes in Eastern Europe has not yet reached the grown-up welfare states of "Old Europe". Nevertheless, flat tax reform proposals are high on the political agenda in various Western European countries. If the flat tax continues creeping westwards, geographically, Germany would be the next and the first Western country to adopt a flat tax. Recently, the council of economic advisors to the ministry of finance proposed a flat rate tax for Germany.[1]

Given that flat taxes have not yet been implemented in Western Europe, the effects of flat tax reforms in these countries can only be studied on the basis of simulation models. In the literature, there are several simulation studies on efficiency and equity aspects of flat tax reforms.[2] One focus of these studies is the impact on employment and growth. A second group of studies focuses on the distributional effects of flat tax reforms. In summary, the main result of this literature is that a flat tax can increase the efficiency in terms of employment and growth but will most likely lead to redistribution in favour of high income

[1] Cf. Wissenschaftlicher Beirat beim Bundesministerium der Finanzen (2004). Furthermore, the reform proposals of Kirchhof (2003) and Mitschke (2004), which have been controversially discussed before the election in 2005, chose (almost) flat schedules.

[2] See 1.2.4 for a brief review of this literature.

households. All previous studies support the existence of a trade-off between equity and efficiency, i.e. either inequality and employment both increase or decrease but it is not possible to decrease inequality while increasing employment.

The present chapter provides a simulation analysis of three different flat tax reforms for Germany to further investigate their economic effects. First, we analyse the consequences of simplifying (and broadening) the tax base when introducing a flat tax. Second, we analyse two revenue neutral flat tax scenarios with different parameters without changing the tax base. Third, we allow for a loss in revenue and implement a comprehensive cash flow flat tax in the tradition of Hall and Rabushka (1985). Our analysis is based on a simulation model for the German tax and transfer system (FiFoSiM)[3] using income tax micro data and household survey data. This allows us to study both equity and efficiency effects in terms of the distribution of after tax income, the effective marginal income tax rates, the supply of labour and the welfare of the households within the same microeconometric framework. The change in effective marginal income tax rates may be considered as rough indicators for the distortions caused by the tax system. The labour supply responses and the welfare effects can be seen as more comprehensive indicators for the efficiency effects. Furthermore, the linked MSM-CGE model allows to incorporate general equilibrium effects into the analysis of the cash flow flat tax proposal.

With its socio-economic and demographic structure, Germany can be seen as a typical Western European democracy. Therefore, the qualitative results of our analysis are of interest to a wider range of countries.[4] Our analysis shows that, when taking the general equilibrium effects into account, a flat tax can overcome the fundamental equity efficiency trade-off. However, due to their limited efficiency effects and their problematic distributional impact, flat tax reforms are unlikely to spill over to the grown-up democracies of Western Europe.

The layout of this chapter is as follows. First, in section 3.2, we analyse the effects of simplifying the tax base by comparing a flat tax scenario with a progressive adjustment of the rate schedule. Second, in section 3.3, we analyse the

[3] See chapter 2.5 for a detailed description of the simulation model.

[4] It has to be taken into account, though, that the structures of the tax benefit systems do vary considerably among the countries of Western Europe.

effects of two revenue neutral flat tax scenarios with different marginal tax rates without changing the tax base. Third, in section 3.4, we analyse the introduction of a cash flow flat tax on corporate income. Section 3.5 concludes the analyses.

3.2 Simplification

3.2.1 Introduction

The simplification of the tax system is a key objective of many income tax reform proposals in various countries.[5] This is not only because complexity leads to high compliance costs for taxpayers and to tax evasion. Beyond this, the complexity of the income tax system is also widely seen as an obstacle to fairness and efficiency beyond costs of administration and compliance. For instance, complexity is thought to be a barrier to achieving a fair distribution of the tax burden because it might allow taxpayers with high incomes to use tax loopholes and reduce their tax burden. Therefore, simplicity of the income tax is generally seen as an important feature of tax systems. Simplification makes it easier for taxpayers to understand and pay taxes, and makes it also easier for tax authorities to collect taxes in a fair way.

Given the importance attributed to simplification in tax reform debates, there is surprisingly little empirical research on the impact of tax simplification on equity and efficiency of the tax system. To some extent, this may be due to the fact that the theoretical and empirical analysis of tax simplification faces considerable conceptual problems. In particular, tax simplification itself is not a clearly defined concept. Explicit measures are seldom defined, but seem rather randomly picked as part of reform proposals. It is also not clear a priori, whether changes in the tax law increase or decrease the complexity of the tax system. In many cases, measures which broaden the tax base are considered to be simplifications. But in some cases (e.g. the taxation of the imputed rent of owner occupied housing)

[5] Cf. Gale (2001) for the U.S., James, Sawyer and Wallschutzky (1997) for Australia, New Zealand and the United Kingdom, Tran-Nam (2000) for Australia or Wagner (2006) and Fuest, Peichl and Schaefer (2007c) for Germany. This section is based on Fuest et al. (2007c) and Fuest, Peichl and Schaefer (2008).

tax base broadening may also complicate the system.[6] Despite these difficulties, it is important to investigate whether the basic idea that income tax simplification through eliminating special loopholes does indeed lead to a more equitable and efficient tax system and if it can be supported empirically.

In the literature, quantitative studies of the impact of tax simplification on the efficiency of the tax system and the distribution of income exist for the US. The debate on tax simplification in the US in the beginning of the 1980s (see e.g. Pechman (1987) or Slemrod (1984)) was followed by the Tax Reform Act of 1986 which introduced a "tax rate cut cum base broadening"-reform with the aim of simplifying the income tax system (see Slemrod (1992) for an economic evaluation). Slemrod (1989) estimates the reduction in compliance costs from alternative simplification options. In a recent contribution, Gale and Rohaly (2003) study the effect of different tax simplification proposals. Among other things, they consider the introduction of a flat rate income tax, combined with a value added tax reform. They find that such a tax reform would increase the tax burden of the middle class and reduce the tax burden for very high and very low incomes. This study does not distinguish between the effects of tax base variation and tax rate changes, though. As far as we know, there is no empirical analysis of the direct distributional and efficiency effects of tax simplification for the German tax system. However, von Loeffelholz and Rappen (2003) analyse the compliance costs of the German tax system. But there are several studies on the effects on revenue and distribution of tax reform proposals including the objective of tax simplification. For example, Wagenhals (2001b) examines the incentive and distributional effects of the reform proposal by Kirchhof et al. (2001).

We model income tax simplification as the abolition of a set of deductions from the tax base included in the current income tax system. We find that this form of tax base broadening leads to a more equitable income distribution and, not surprisingly, an increase in tax revenue. If these measures are combined with a reduction of income tax rates to preserve revenue neutrality, the distributional impact depends on the type of rate schedule adjustment. The combination with a flat rate tax implies that the reform redistributes in favour of the very high and very low incomes, while overall income inequality increases. The combination with

[6] Cf. Slemrod (1984).

a less radical rate schedule adjustment, which preserves the directly progressive rate schedule, yields a tax reform which reduces the inequality of after tax incomes. The employment effects also depend on the type of schedule adjustment. The progressive combination decreases aggregate labour supply, whereas the flat tax slightly increases it. The welfare effects are negative for the progressive combination but positive for the flat tax. In this respect, the data confirms the idea that tax reforms inevitably face a trade-off between equity and efficiency.

The setup of the section is organised as follows: Section 3.2.2 presents the reform scenarios. Section 3.2.3 illustrates the effects on distribution. Section 3.2.4 presents the effects on the marginal tax rates, labour supply and household welfare as measures for efficiency. Section 3.2.5 concludes.

3.2.2 Tax simplification scenarios

A simpler income tax system can appear in the form of tax base simplification, the simplification of the tax rate schedule or both. We focus mainly on tax base simplification. Tax rates are then adjusted to control for revenue neutrality. Among other things, we consider the introduction of a flat rate tax schedule, which is also an element of tax simplification. Tax base simplification is modelled as the abolition of a set of specific deductions from the tax base included in the German income tax system. Our choice of simplification measures is influenced by the ongoing German policy debate about existing tax breaks, deductions and simplification of the income tax system.[7] Naturally, the analysis is restricted by the availability of data. The key idea is to make fewer distinctions across economic activities and personal characteristics. Taxes should be imposed on a broad base at relatively low rates that do not vary by income source or expenditure type.[8]

The chosen measures can be differentiated into two categories: measures concerning the determination of earnings (category A) and those concerning the calculation of the taxable income (category B). Concerning the determination of

[7] See e.g. Kirchhof (2003), DIHK (2004), Bach (2005), Fuest et al. (2007c) or Wagner (2006). In principle, the general debate is similar as in various countries: the income tax shall be simplified through tax base broadening via the abolition of tax breaks and specific deductions. Nevertheless, the specific debate in each country depends on the country-specific tax system and cannot be easily compared across countries.

[8] See Burman and Gale (2001).

earnings (category A), we focus on labour income related expenses. According to § 19 EStG (German income tax law) labour income consists of gross wages minus related expenses; there is a lump sum amount of 920€ unless higher expenses can be claimed. An integral part of these expenses are commuting costs. The applicable law allows for a deduction of 0.3€ per kilometre. Furthermore, we examine the abolition of tax free bonuses for night, weekend and holiday labour. Concerning capital income we look at the reduction and abolition of the saver's allowance (*Sparerfreibetrag*: current system 1370€ for a single, 2740€ for a couple household). In category B, we look at several tax allowances for age, single parents, children[9] and deductions for tax accountancy costs, church tax and donations (charitable and for political parties).

Tax simplification in terms of tax break abolition generates additional revenue. As we intend to design a potential tax reform without revenue effects, we model the following progressive tax schedule according to the current tax law:

$$T(x) = \begin{cases} 0 & \text{if } x \leq G \\ \left(\frac{t_m - t_e}{2(M-G)}\,(x-G) + t_e\right)(x-G) & \text{if } G < x \leq M \\ \left(\frac{t_s - t_m}{2(S-M)}\,(x-M) + t_m\right)(x-M) + (M-G)\frac{t_m+t_e}{2} & \text{if } M < x \leq S \\ t_s\,(x-S) + \frac{t_s+t_m}{2}(S-M) + \frac{t_m+t_e}{2}(M-G) & \text{if } x > S \end{cases}$$

where x indicates the tax base, $T(x)$ the tax payment, G is the basic personal allowance, M the upper limit of the first progression zone, S the lower limit applicable to the top rate t_s, t_e the lowest tax rate and t_m the highest tax rate of the lower progression zone (i.e. the lowest tax rate of the upper progression zone). To ensure revenue neutrality in combination with tax simplification through base broadening, we model two forms of schedule adjustment. First, we adjust the rate schedule to the right (progressive adjustment) and second, we introduce a flat tax rate, which is chosen with a marginal tax rate of 30% to correspond to the proposal by the council of economic advisors to the Ministry of Finance.[10] The progressive

[9] Child benefits are still paid.

[10] Cf. Wissenschaftlicher Beirat beim Bundesministerium der Finanzen (2004). We have also computed various scenarios with different flat tax parameters. The empirical results for the flat tax in comparison to the progressive adjustment remain robust. Nevertheless, inequality

adjustment is chosen to have the same basic allowance as the flat rate adjustment. The parameters for the reform scenarios can be found in table 3.2.1. A graphical comparison of the different rate schedules can be found in figure 3.2.1.

	G	M	S	t_e	t_m	t_s
status quo	7664	12739	52151	0.15	0.2397	0.42
progr. adjustm.	9500	14575	53987	0.1480	0.2365	0.4144
flat tax	9500	9500	9500	0.3	0.3	0.3

Table 3.2.1: Tax rate parameters

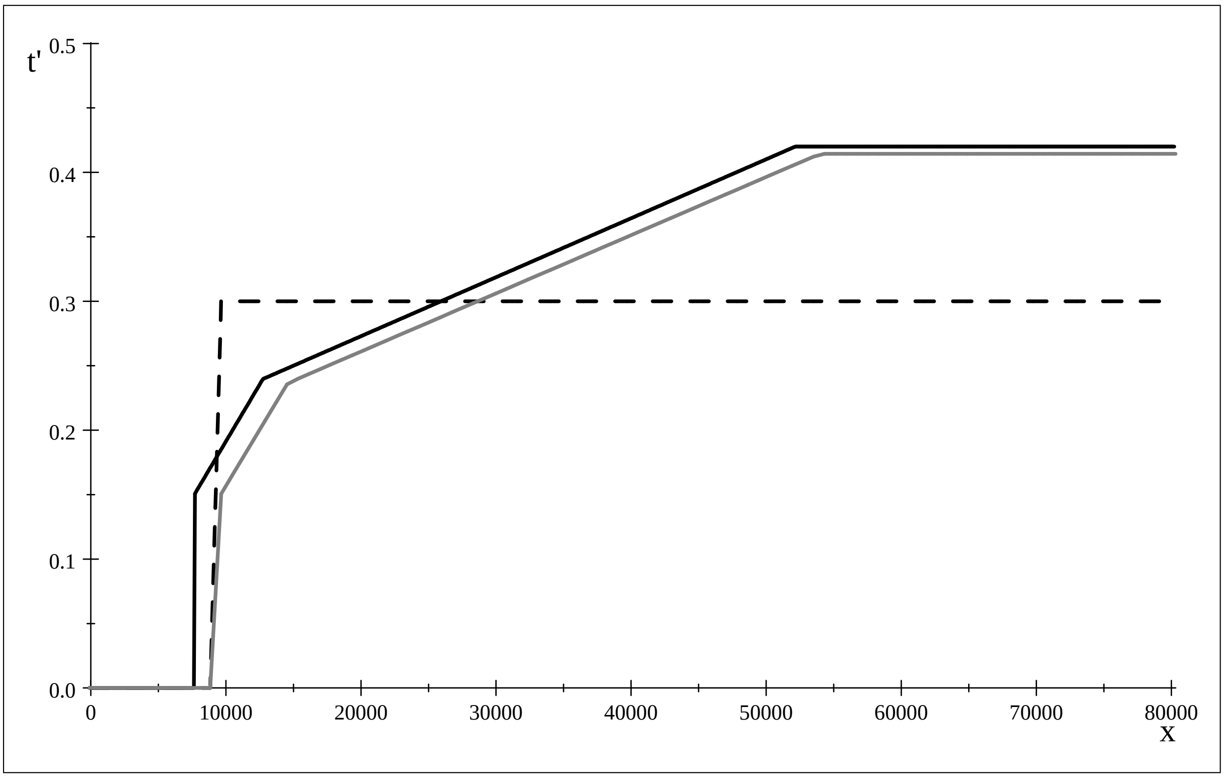

Figure 3.2.1: Marginal tax rates

The effects of these various scenarios are calculated with the microsimulation model FiFoSiM by changing the policy parameters or switching off the appropriate

is decreasing whereas the efficiency effects are decreasing with increasing flat tax parameters (see also Fuest, Peichl and Schaefer (2007d)).

module. In the first step, we abstract from behavioural adjustments, i.e. we assume that the economic agents do not change their behaviour in response to tax reforms. In the second step, we consider the effects on labour supply. In the following we concentrate on the simplification and combination bundles for the sake of clarity.[11]

3.2.3 Distributional effects

The introduction of a revenue neutral tax reform always yields winners and losers.[12] To analyse the distributional effects of different reform scenarios we compute different distributional measures based on equivalised household net incomes[13]. Furthermore, we estimate the polarisation effects of each alternative. Generally speaking, polarisation is the occurrence of two antipodes. A rising income polarisation describes the phenomenon of a declining middle class resulting in an increasing gap between rich and poor. The proportion of middle income households is declining while the shares of the poor and the rich are both rising.

We compute the Gini coefficient as an inequality measure and the polarisation index of Schmidt (2004). The main results are presented in table 3.2.2. We simulate the percentage changes of the mean income in each decile and of the distributional and polarisation indices compared to the status quo for the tax base adjustment[14], each tax rate schedule adjustment and the combinations of rate

[11] The segregated effects of every single measure of tax simplification are presented in Fuest et al. (2008). The distributional effects of the single measures yield some interesting results. For instance, abolishing the tax free bonuses for night, weekend and holiday labour results in an increase of income equality which seems to be counter-intuitive. The burden of this simplification particularly affects middle and high incomes. The same results apply to the abolition of the deduction for commuting costs. This measure also burdens middle and higher incomes more heavily than lower income categories. A detailed analysis of the fiscal effects of different parts and deduction rules of the German income tax system 1995 can also be found in Müller (2004).

[12] The distributional effects in this section differ slightly from the results presented in Fuest et al. (2007c) because of a newer version of the database. Furthermore, we also analyse the fraction of people gaining and losing in terms of disposable income.

[13] We use the modified OECD-scale which weights the household head with a factor of 1, household members over the age of 14 with 0.5, and under 14 with 0.3. The household's net income is divided by the sum of the individual weights of each member (=equivalence factor) to compute the equivalence weighted household income.

[14] The complete tax base adjustment bundle (kumAB) consists of bundles A (kumA) and B (kumB). All category B measures are combined in bundle B, bundle A contains the abolition of deductibility of commuting costs (A1: noKm), the abolition of the saver's allowance (*Sparer-*

schedule reforms and tax base simplification.

	tax base adj.	schedule adj.		combinations	
	kumAB	progr.	flat rate	progr.	flat rate
1. Decile	-0.01	0.00	0.00	-0.00	-0.01
2. Decile	-0.12	0.16	0.04	0.05	-0.06
3. Decile	-0.67	0.96	0.39	0.52	-0.22
4. Decile	-1.06	1.54	0.02	0.74	-1.11
5. Decile	-1.31	1.84	-0.48	0.76	-1.90
6. Decile	-1.47	2.05	-0.91	0.75	-2.49
7. Decile	-1.60	2.14	-1.09	0.66	-2.78
8. Decile	-1.57	2.11	-0.83	0.44	-2.61
9. Decile	-1.57	1.96	-0.02	-0.05	-1.96
10. Decile	-1.72	1.37	6.32	-0.75	4.68
Gini	-0.38	0.13	2.86	-0.55	2.54
PolS	-0.98	0.72	-0.56	-0.20	-1.69
Winners	0.00	47.94	43.02	30.07	19.94
unchanged	53.19	51.63	52.14	55.12	55.44
Losers	46.82	0.43	4.84	14.81	24.62

Table 3.2.2: Percentage change of household equivalence weighted net income
Source: own calculations based on FiFoSiM

The first column of table 3.2.2 shows the cumulated effects of the tax base adjustment (kumAB). The accumulated measures of tax simplification burden the higher incomes more heavily than the middle and the lower incomes. Inequality and polarisation are both reduced. The separate examination of each bundle yields the same qualitative results. The abolition of several tax rule exemptions in both categories A (determination of adjusted gross income) and B (calculation of taxable income) affects the high incomes more than the middle and low incomes.

The isolated effects of changes in the tax schedule are as follows. The adjustment to the right of the current schedule (column 2) increases inequality as well as polarisation. The flat rate tax strongly increases inequality while the polarisation index decreases. The obvious winner of a flat tax rate is the 10th decile due to lower statutory and effective marginal rates and to some extent the first deciles while the middle to upper deciles suffer from an increased tax charge due to the flat

freibetrag, A4: noSpfb) and the restriction of labour income related expenses to 1000 € (A8: wkfix).

tax reform. These effects result in an overall increase in the Gini index. The decrease in polarisation is surprising at first glance, but this result can be attributed to the following two effects: The heterogeneity between the two groups decreases because of the higher tax burden for most people above the median income and because of a decrease of the tax liability of some people below the median. The homogeneity within the upper group decreases because of the opposite directions of the effects in those deciles. Both effects lead to a decrease in the polarisation index. The increase of the polarisation index for the adjusted current schedule can be explained by the relatively larger relief for people above the median income resulting in an increasing heterogeneity between the two groups.

The revenue neutral combination of the tax base bundle with a tax schedule adjustment to the right (column 4) decreases both the inequality and the polarisation indices, whereas the combination with a flat tax (column 5) increases the inequality but reduces the polarisation. The explanation is analogous to the effects of the pure tariff reforms. Given these results, we can conclude that revenue neutral tax simplification does not necessarily lead to redistribution from poor to rich. The combination with the adjustment of the current tax schedule even leads to a decrease of inequality, i.e. the simplification of the tax system can lead to a more equal distribution of after tax income. More inequality only arises if tax base adjustment is combined with the introduction of a flat rate tax.

The fractions of households winning or losing disposable income[15] yield the expected results for the tax base and schedule adjustments. The progressive combination yields a majority of people gaining whereas with flat rate combination more people are losing disposable income than gaining. Because of the large fraction of people losing disposable income, the implementation of a revenue neutral flat tax reform proposal in the political process seems unlikely.

3.2.4 Efficiency effects

There are many ways in which tax reforms affect the efficiency of the tax system. In this section, we analyse the effects of the flat tax reform scenarios on the effective

[15] Households whose disposable income does not change more than 50 euros in either direction are regarded as „unchanged“.

marginal tax rates, the labour supply decision and the welfare of households.

Effective marginal tax rates

In this subsection, we analyse the effect of the reform scenarios on the effective marginal income tax rate faced by different groups of taxpayers. The underlying idea is that the marginal income tax rate affects the labour supply and saving incentives. Here, we focus on the marginal labour income tax rate. The results are summarised in table 3.2.3.

	status quo	tax base adj.	schedule adj.		combinations	
	E06	Δ kumAB	Δ progr.	Δ flat rate	Δ progr.	Δ flat rate
1	0.00	0.00	-0.00	-0.00	-0.00	-0.00
2	3.01	0.90	-2.25	-1.26	-2.05	-0.68
3	15.29	1.66	-3.07	1.99	-0.92	4.64
4	20.79	0.95	-1.71	1.70	-0.62	2.54
5	23.22	1.11	-1.81	0.03	-0.77	0.79
6	24.27	1.22	-1.90	0.27	-0.63	1.43
7	25.66	1.05	-1.44	1.02	-0.27	1.94
8	27.62	0.76	-0.93	0.95	-0.08	1.37
9	29.81	0.63	-0.65	-0.46	-0.00	-0.34
10	35.06	1.21	-0.40	-5.66	0.74	-5.58

Table 3.2.3: Changes in effective marginal tax rates in percentage points
Source: own calculations based on FiFoSiM

It turns out that tax base broadening without tax rate adjustments increases the marginal tax rate for all taxpayers. This is not surprising, given the progressive nature of the income tax schedule. Combining these measures with a reduction of tax rates over the entire income tax schedule reduces the marginal tax rate for almost all taxpayers with the exception of the highest income decile. The combination with a flat rate tax, in contrast, reduces the marginal tax rate considerably (by five percentage points) for the highest income decile. For the middle income deciles, the marginal tax rate increases, especially for the third and the fourth income decile. This suggests that the efficiency gains that can be achieved through tax simplification, combined with the introduction of a flat rate tax, are limited. This is mainly due to the fact that revenue neutrality requires a flat tax rate of

30%. If the broadening of the tax base goes beyond the measures considered here, revenue neutrality can be achieved at a lower statutory tax rate. In this case, it would be possible to attain lower marginal tax rates for more households.

Labour supply effects

Table 3.2.4 contains the additional full time equivalents as results of our labour supply estimations.

		couple		single		
		male	female	male	female	Σ
tax base adj.	Δ kumAB	-68,423	-25,925	-52,599	-51,832	-198,779
schedule adj.	Δ progr.	56,295	18,374	57,738	44,761	177,168
	Δ flat rate	60,853	14,717	51,442	44,077	171,089
combinations	Δ progr.	-6,729	-5,863	10,138	-2,56	-5,014
	Δ flat rate	2,661	-911	9,325	2,573	13,648

Table 3.2.4: Labour supply effects (full time equivalents)
Source: own calculations based on FiFoSiM.

On average, married men react stronger than women. For couple households, this can be explained by the German system of joint taxation. In this system it is quite attractive if only one of the spouses works. The higher tax burden resulting from the tax base adjustment leads to an overall decrease of labour supply, while the relief of the tax payers resulting from the schedule adjustments increases the labour supply. Both schedule adjustments yield similar labour supply responses. The combinations of tax base and schedule adjustment yield overall labour supply responses which do not significantly differ from zero. Nevertheless, the different directions of the effects indicate responses one would expect intuitively: the flat rate rather increases labour supply, whereas the progressive adjustment decreases it.

Welfare effects

Table 3.2.5 presents the results of the estimation on the aggregated welfare changes for the revenue neutral combinations. For a more comprehensive analysis, the distribution of the welfare changes together with the changes in tax payments and the labour supply effects for the income deciles are presented. The variable $\triangle T^0$ stands for changes in tax payments before labour supply reactions (LS) and $\triangle T^1$ is the change in tax payments after behavioural adjustment. It is important to distinguish between, on the one hand, the effects of a reform on the welfare of households in a given income decile as measured by the equivalent variation (EV), and, on the other hand, the overall welfare effect generated by a given decile (W).

Decile	Δ progressive combination					Δ flat rate combination				
	$\triangle T^0$	$\triangle T^1$	$\triangle LS$	$\triangle EV$	$\triangle W$	$\triangle T^0$	$\triangle T^1$	$\triangle LS$	$\triangle EV$	$\triangle W$
1	-1.7	-4.8	1,171	19.5	14.7	-2.0	-7.8	1,419	32.4	24.6
2	-5.3	-5.2	3,719	33.1	28.0	-5.6	-10.3	2,506	71.0	60.8
3	-34.4	-42.5	7,524	94.1	51.6	-45.1	-63.2	8,302	136.1	72.9
4	-189.7	-148.0	11,771	221.1	73.1	-233.7	-241.9	6,869	323.7	81.8
5	-428.3	-386.0	7,711	457.9	71.9	-655.4	-616.7	-4,487	599.9	-16.9
6	-631.8	-551.0	4,681	599.3	48.3	-766.3	-630.4	-1,425	541.1	-89.4
7	-645.9	-638.1	3,326	653.1	15.1	-201.0	-311.9	5,640	132.1	-179.8
8	-642.7	-553.5	-970	487.1	-66.4	874.5	439.9	-8,057	-677.4	-237.6
9	-356.7	-249.4	-9,856	43.3	-206.0	2,294.0	1,419.9	-29,231	-1,686.5	-266.6
10	2,939.2	2,190.8	-34,087	-3,105.7	-914.9	-1,279.1	-63.6	32,115	1,467.4	1,403.8
Σ	2.9	-387.6	-5,010	-497.2	-884.8	-19.9	-86.1	13,651	939.7	853.6

Table 3.2.5: Distribution of labour supply (fulltime equivalents), tax payments and welfare changes (in million €)

Source: own calculations based on FiFoSiM.

The overall welfare effects are negative for the progressive adjustment but positive for the flat tax adjustment. The tax increase induced by the tax base measures increases the distortion of the labour-leisure decision and results in negative labour supply reactions (see previous section). For the progressive combination, this effect dominates the positive labour supply effects induced by the schedule adjustments. Therefore the overall welfare effects of the revenue-neutral combinations are still negative, whereas for the flat tax adjustment the latter effects prevail.

The differences in the welfare effects can be best explained taking into account the distribution of the labour supply effects and changes in the tax payments. The welfare effects of the tax base measures are unequally distributed across the deciles. The strongest reactions of our money metric welfare measure can be found in the deciles with the highest incomes. Households in these deciles pay most of the income taxes and face the highest marginal excess burden. Therefore, the reaction of these households is crucial for the welfare effects of the reform for the economy as a whole. In particular the highest income decile plays a key role. The progressive combination increases the tax payments of this decile by three billion Euros before labour supply adjustments. Since the positive effects of the tax rate reduction are weak, overall labour supply declines. This increases the labour supply distortion, so that the overall welfare effect generated in this decile is negative. In the case of the flat rate combination, the reform reduces the taxes paid by the highest income decile before labour supply adjustment. As a result, labour supply increases. The increase in labour supply reduces the tax revenue losses almost to zero. This explains why the overall welfare effect in this decile is positive. One should note, though, that the overall magnitude of welfare gains and losses is limited. For the flat rate combination, we find a welfare gain of approximately 0.5 per cent of overall income tax revenue whereas the progressive combination yields a loss of the same magnitude.

3.2.5 Summary and conclusion

In this section, we have examined the effects of tax simplification on the income distribution, effective marginal income tax rates, labour supply and welfare. All effects were simulated for each single simplification measure, for bundles A (determination of earnings) and B (computation of taxable income) and for the complete tax base adjustment package using FiFoSiM. The abolition of exemptions and deductions increases tax revenue. Therefore our tax base adjustment was combined with tax rate reforms to analyse the joint effects on distribution while controlling for revenue neutrality.

The main results are:

- Tax simplification concerning the determination of income for tax purposes (cat. A) and the determination of taxable income (cat. B) reduces inequality and polarisation.

- Simplification through the abolition of tax exemptions increases tax revenue. A tax reform with overall revenue neutrality implies tax rate changes with separate distributional effects. The adjustment of the current schedule to the right slightly increases inequality and polarisation while a flat tax leads to a distinct increase of inequality and decreases polarisation.

- The combination of the tax base measures with a progressive tax rate adjustment reduces inequality and polarisation, because the highest incomes suffer most. The marginal income tax rate for middle income households is also reduced.
- If the tax base adjustment is combined with a flat rate tax, inequality increases while polarisation decreases, as the upper middle class is particularly affected. Hence, the tax rate effect is stronger than the simplification effects on distribution and labour supply incentives of middle income households.
- The progressive combination decreases labour supply, whereas the combination with a flat tax increases labour supply. In both cases, the overall labour supply effects are rather small.
- The welfare effects are negative for the progressive combination, but positive for the flat tax. In both cases, the magnitude of the effects is approximately 0.5 per cent of overall income tax revenue.

Summing up, revenue neutral tax simplification can increase or decrease both inequality and efficiency depending on the form of rate schedule adjustment. Tax base simplification in combination with a directly progressive tax rate schedule can reduce inequality. If inequality is regarded as an indicator for fair taxation, more fairness through tax simplification is possible. Furthermore, our results suggest that flat tax reforms combining tax base broadening with a single tax rate are likely to increase inequality at the expense of the upper middle class. This might be the reason for the limited success of flat tax proposals in the political process in Germany or other Western European countries. Hence, it seems advisable to separate the tax base simplification objective from tax rate schedule issues. The effects of flat tax reforms without base broadening will be analysed in the next section 3.3.

However, income distribution is only one relevant aspect of tax reforms. If a higher national income, more efficiency or better incentives can be achieved through an income tax reform, higher inequality of income distribution might be deemed acceptable. Our results suggest that the effects of a (revenue-neutral) flat tax rate reform on efficiency in terms of effective marginal tax rates, labour supply and household welfare are slightly positive. One may argue that a flat rate tax is also likely to reduce tax distortions in the corporate sector. This may lead to further efficiency gains due to higher investment and labour demand. These effects are beyond the analysis of this section but will be explored in section 3.4.

Our results have been derived using German micro data. Nevertheless, the qualitative effects should not differ very much from other (Western European) countries with a similar socio-economic structure. To conclude, one can state that whether tax simplification leads to more fairness in terms of higher after-tax income equality and more efficiency in terms of employment and welfare depends on the way in which tax base simplification is combined with tax rate adjustments. The tax base adjustment package considered here, combined with an adjusted direct progressive tax rate (flat tax rate) reduces (increases) inequality as well as labour supply and welfare. Unfortunately, none of the reforms considered here are able to overcome the trade-off between equity and efficiency objectives.

3.3 Flat rate tax

3.3.1 Introduction

Flat rate tax systems differ considerably in their design. Usually, a flat rate personal income tax is regarded as an indirectly progressive tax schedule with a basic tax allowance and a uniform marginal tax rate. In this section, we only consider reforms of the income tax schedule (tax rate(s) and basic allowance).[16] We abstract from reforms of the tax base which have been analysed in the previous section.[17] For the selection of our reform scenarios and the choice of tax parameters we follow the systematic approach developed by Davies and Hoy (2002), which is explained

[16] This section is based on Fuest, Peichl and Schaefer (2007b) and Fuest et al. (2007d).

[17] An earlier version of this analysis included various measures to broaden the tax base (see section 3.2 and Fuest et al. (2007d)). The results were qualitatively similar to the results derived here. Furthermore, to be able to apply the approach of Davies and Hoy (2002), it is necessary for the flat tax to have the same tax base as the progressive rate schedule.

in section 1.2.5. We focus on two flat rate tax systems, which differ in the tax rate and the basic allowance. Both are revenue neutral and the parameter values are chosen as follows: The first scenario (LL = low tax rate, low allowance) holds constant the existing basic allowance (7,664 Euros) and therefore corresponds to the lower bound t_F^l in terms of Davies and Hoy (2002). Revenue neutrality then implies a tax rate of 26.9 per cent. The second flat tax scenario (HH = high tax rate, high allowance) is constructed such that the inequality of after tax incomes as measured by the Gini coefficient remains constant (corresponding to the critical value t_F^*).[18] This requires a rather high tax rate (31.9 per cent) and, accordingly, a large basic allowance (10,700 Euros).[19] The premise of ex-ante revenue neutrality is chosen for a better comparability of the different scenarios.[20] Table 3.3.1 presents the parameter values for the two scenarios.

	tax schedule parameters	
	basic allowance	marginal tax rate
2007	7,664	15-45
LL	7,664	26.9
HH	10,700	31.9

Table 3.3.1: Reform scenarios

The simulation analysis yields the following results. The low tax rate reform does have positive efficiency effects, but these effects are quite small. The welfare gain equals 1.8 per cent of overall income tax revenue and employment increases

[18] It would also be possible to construct this scenario with any other measure of inequality satisfying the Pigou-Dalton principle of transfers. Extensive sensitivity analyses with measures of the Generalized Entropy family (including both Theil coefficients) yield similar results in qualitative terms with respect to the flat tax parameters and therefore the economic effects. We choose the Gini coefficient as it is probably the most popular inequality measure used in the literature.

[19] We do not report the results for the upper bound here because such a scenario requires a marginal rate of about 45%. Such a reform is not discussed under the heading of flat tax reforms, and it would give rise to negative effects on welfare and employment while reducing inequality per definition.

[20] If the scenarios were chosen to be revenue neutral ex-post, i.e. after labour supply reactions, the marginal tax rates could be lower (higher) in case of increasing (decreasing) labour supply but the underlying research question would be different. Our aim is to analyse scenarios that are equal ex-ante and to reveal the ex-post differences by analysing the economic effects of the scenarios in terms of equity and efficiency.

by 0.3 per cent. However, this rather modest efficiency gain comes at the cost of an increase in income inequality. In particular, the top income decile benefits while the upper middle class suffers losses. The number of losers exceeds the number of winners. The second scenario, the high tax rate reform, by definition avoids a change in (Gini) income inequality. But the higher tax rate reduces the efficiency gains. Employment remains constant and the aggregate welfare effect is also close to zero. Again, the households in the top income decile benefit at the cost of the upper middle class. A difference to the low tax rate reform is that households in the six lowest income deciles also benefit, albeit not very much. These results suggest that flat tax reforms cannot avoid the fundamental equity efficiency trade-off which dominates the tax policy debate.

The setup of this section is organised as follows: Subsection 3.3.2 illustrates the distributional effects in terms of inequality, polarisation, winners and losers. Subsection 3.3.3 presents the efficiency effects in terms of effective marginal tax rates, labour supply reactions and welfare effects. Subsection 3.3.4 concludes.

3.3.2 Distributional effects

The introduction of a revenue neutral tax reform always yields winners as well as losers. To analyse the distributional effects of the two reform scenarios, we compute different distributional measures based on equivalised disposable incomes[21]. The main results are presented in table 3.3.2, which displays the changes of the mean disposable income for each decile, the measures of inequality and polarisation[22], and the fractions of households winning or losing disposable income[23] in per cent for each scenario before and after labour supply reactions (LS).[24]

Without taking labour supply reactions into account (before LS), the highest decile, which generates the largest part of the overall tax payments, gains in both

[21] We use the new OECD equivalence scale which weights the household head with a factor of 1, household members over the age of 14 with 0.5, and under 14 with 0.3.

[22] Schmidt (2004) creates a polarisation index which in analogy to the Gini index (Lorenz curve) is based on a polarisation curve for better comparability of the results and their interpretations.

[23] Households whose disposable income does not change more than 50 Euros in either direction are regarded as „unchanged“.

[24] We have also computed various indicators of poverty and richness. These measures, however, do not differ significantly from the status quo values.

	before LS		after LS	
	LL	HH	LL	HH
Decile	changes in per cent			
	disposable income			
1	0.20	0.13	54.68	56.08
2	-0.03	-0.01	5.45	6.03
3	-0.50	0.37	-0.02	1.57
4	-1.15	0.89	-0.97	1.09
5	-1.63	0.56	-2.60	-0.45
6	-1.78	-0.02	-2.76	-1.50
7	-1.74	-0.51	-3.62	-2.76
8	-1.29	-0.82	-2.58	-2.67
9	-0.39	-0.96	0.03	-1.44
10	3.85	0.94	4.41	0.61
	Inequality			
Gini	2.11	0.00	3.41	0.47
Theil	5.58	1.14	7.28	1.21
Polarisation	0.62	-1.19	1.13	-1.81
	Winners / Losers			
Winners	10.93	23.00	9.66	20.92
unchanged	43.71	45.78	51.47	53.22
Losers	45.37	31.22	38.87	25.86

Table 3.3.2: Distributional effects based on equivalised disposable incomes
Source: own calculations based on FiFoSiM

flat tax scenarios. In case of a low basic allowance (LL), the tax burden on middle income deciles increases strongly. Households in the lowest deciles seldom pay taxes in the status quo. Overall, the LL reform leads to redistribution from poor and middle income households to the 'rich': All other deciles finance the relief of the 10% richest taxpayers. This result is reflected in an increase of both the Gini and the Theil coefficient of disposable incomes.[25] If a higher tax rate is combined with a higher basic allowance, as in the HH scenario, the gains for the highest decile decline while the upper middle class loses less. In this case, not only the highest

[25] The Gini coefficient of the distribution of tax payments (not shown in the table) is decreasing in both scenarios indicating less redistribution through the income tax system. This prediction is confirmed when looking at more comprehensive measures of tax progressivity and redistribution. These measures report a decrease in both dimensions for both scenarios with the decrease being larger in scenario LL than in HH.

but also some of the lower deciles benefit. The Gini coefficient does not change by construction of the reform, but the top sensitive Theil index still indicates a small increase in inequality.

When taking labour supply reactions into account (after LS) without changing the decile classification, the picture changes. Especially the lowest deciles gain above average in relative terms in both scenarios. These high relative changes can be explained by the low absolute values for disposable incomes in these deciles, which consist mostly of transfers. If some of these persons start working, they often earn a multiple of their previous income. Still, for low parameter values (LL), the highest decile gains most in absolute terms. In contrast, in scenario HH the highest decile remains almost unchanged after labour supply reactions. Inequality is only slightly increased in this scenario, whereas the first scenario yields a strong increase in inequality.

The polarisation of the income distribution and therefore the gap between rich and poor increases in scenario LL but decreases in HH before and after labour supply reactions. Furthermore, the number of winners is higher and the number of losers is lower with the higher tax rate (and basic allowance). Nevertheless, in terms of disposable income, the number of losers exceeds the number of winners in both scenarios.

3.3.3 Efficiency effects

There are many ways in which a tax reform affects the efficiency of the tax system. In this section, we analyse the effects of the flat tax reform scenarios on the effective marginal tax rates, the labour supply decision, and the welfare of households.

Effective marginal tax rates

The changes in effective marginal income tax rates faced by different groups of taxpayers are presented in table 3.3.3. The underlying idea is that the marginal income tax rate affects the labour supply and savings incentives. Therefore, changes in effective marginal income tax rates may be considered as rough indicators for the distortions caused by the tax system.

The introduction of a flat rate tax increases statutory marginal tax rates for

Decile	EMTR 2007	LL	Diff.	HH	Diff.
1	0.00	0.01	0.01	0.00	0.00
2	4.40	6.97	2.57	0.24	-4.16
3	17.25	19.98	2.73	18.09	0.84
4	22.09	22.47	0.38	24.14	2.05
5	24.58	24.09	-0.49	22.99	-1.59
6	25.69	25.37	-0.32	22.95	-2.74
7	26.88	26.17	-0.71	26.71	-0.17
8	28.37	26.56	-1.81	30.04	1.67
9	30.50	26.67	-3.83	31.23	0.73
10	36.36	26.68	-9.68	31.46	-4.90

Table 3.3.3: Effective Marginal Tax Rates (and changes in percentage points)
Source: own calculations based on FiFoSiM

the lowest deciles and decreases those of the highest deciles. Absolute and relative changes of effective marginal tax rates depend on the parameter combinations. Scenario LL yields sharp increases in marginal tax rates for the lower deciles, while the rates faced by the highest deciles decrease strongly. In scenario HH, the magnitude of these effects is smaller. The decrease in the effective marginal tax rate of the highest decile is not as strong as before, while the lower to middle deciles' effective rates increase less or even decline.

As a first conclusion from this section, we can state that the ambivalent effects on effective marginal tax rates do not allow for a clear evaluation of incentive and efficiency effects of these scenarios. In particular, it is obvious that a flat tax reform does not improve incentives at all income levels.

Labour supply effects

The results of our labour supply estimations are presented in Table 3.3.4, differentiating between single and married men and women. The participation effect (extensive decision) and the working hours effect (intensive decision) as well as the total effect are reported in full time equivalents.

The participation effect in total does not significantly differ from zero in both scenarios. Nevertheless, the differences between both scenarios for the different groups are noteworthy. In scenario LL married men reduce their labour supply

	married male	married female	single male	single female	Σ
	full time equivalents participation effect				
LL	-31,401	21,130	-1,469	17,413	5,673
HH	2,480	-11,749	4,784	10,938	6,453
	full time equivalents working hours effect				
LL	9,564	19,750	20,190	34,064	83,568
HH	-4,477	-3,659	4,518	-2,921	-6,539
	full time equivalents total effect				
LL	-21,837	40,880	18,721	51,477	89,241
HH	-1,997	-15,408	9,302	8,017	-86

Table 3.3.4: Labour supply effects (fulltime equivalents)
Source: own calculations based on FiFoSiM

whereas married women increase it. This can be explained by the German system of joint taxation which makes it unattractive for secondary earners to work as both spouses face the same effective marginal tax rate. Therefore, in many households only the husband is employed (often even working overtime) whereas the wife does not work (or more precisely: specialises in household production). Lowering the statutory (and effective) marginal tax rates decreases the incentives for this type of employment division within a given household. As a consequence, women increase their labour force participation whereas men decrease it. In scenario HH, where the marginal tax rate is higher, the opposite occurs. Men increase their participation even further whereas women decrease it.

The working hours effect is significantly positive for scenario LL and slightly negative for scenario HH. It has to be emphasised that this larger intensive reaction does not indicate higher intensive than extensive labour supply elasticities. In line with recent empirical literature (see e.g. Immervoll et al. (2007)) we also find higher extensive elasticities (especially at the bottom of the income distribution). Nevertheless, the intensive reactions are stronger (especially at the top of the distribution, see also Table 3.3.5) because of the higher absolute changes in disposable income at the upper end of the distribution.

To sum up, the variant with a low basic allowance and marginal tax rate (LL) increases total labour supply by approximately 90.000 full time equivalents or 0.3%, while the total labour supply effect of scenario HH (high allowance and marginal tax rate) is roughly equal to zero. These differences are robust to parameter specifications in the sense that revenue neutral scenarios with higher tax parameter values always yield lower labour supply effects.

Welfare effects

Table 3.3.5 presents the estimated aggregate welfare changes for the different scenarios. For a more comprehensive analysis, the distribution of the welfare changes together with the changes in tax payments before ($Tax0$) and after ($Tax1$)[26] the labour supply effects (LS) for the income deciles are presented. It is important to distinguish between, on the one hand, the effects of a reform on the welfare of households in a given income decile as measured by the equivalent variation (EV), and, on the other hand, the overall welfare effect generated by a given decile ($Welfare$). The difference is that households in a decile may be better off because their tax payments decline. But this implies that they do not generate a welfare gain for society as a whole because the tax revenue has to be generated by other households. For instance, in the case of the low tax rate reform (LL), the highest income decile experiences a utility gain which is equivalent to over 8 billion Euros. But part of this utility gain is a consequence of a decline in taxes paid by these households. If this is taken into account, the welfare gain generated in this decile is reduced to just over 3 billion Euros.

What are the overall welfare effects of the two reforms? A low marginal tax rate and basic allowance (LL) yields a welfare gain of 3.6 billion Euros. This is equal to 1.8% of overall income tax revenue. This gain is achieved because the reform slightly reduces the labour leisure distortions caused by the tax system. Table 3.3.5 shows that the welfare effects generated in the different deciles correlate with the employment effects. The efficiency gain goes along with considerable redistributive effects. Table 3.3.5 also demonstrates that the reform reduces the utility of all deciles except the decile with the highest income, which gains as mentioned above.

The high tax rate scenario (HH) avoids this redistribution. Here, all households

[26] The scenarios are designed to be revenue neutral before labour supply reactions (sum of $Tax0$). Therefore they are not revenue neutral when taking into account the labour supply reactions ($Tax1$). Alternatively, the reforms could be designed to be revenue neutral after labour supply reactions. The ex post fiscal and efficiency effects, however, would be similar for both scenarios.

	LL					HH				
Decile	Tax0	Tax1	LS	EV	Welfare	Tax0	Tax1	LS	EV	Welfare
1	-34	10	-3,326	-38	-28	-27	-13	2,625	38	25
2	14	58	-9,114	-136	-78	-11	-20	3,497	82	62
3	180	199	-15,773	-291	-92	-216	-189	10,522	232	43
4	566	537	-22,999	-638	-101	-560	-483	8,053	419	-64
5	1,149	885	-25,796	-946	-62	-673	-574	-4,686	429	-145
6	1,656	1,420	-18,876	-1,460	-40	-290	-396	-14,671	258	-137
7	2,262	1,854	-10,755	-1,880	-26	190	-50	-22,509	-80	-130
8	2,312	1,699	10,547	-1,608	92	1,017	377	-22,841	-508	-131
9	1,842	1,485	41,622	-840	646	1,902	1,135	-18,435	-1,155	-20
10	-10,286	-5,372	143,713	8,664	3,292	-1,489	-412	58,358	1,867	1,455
Σ	0	2,775	89,243	827	3,602	0	-625	-87	1,582	957

Table 3.3.5: Distribution of labour supply (fulltime equivalents), tax payments and welfare changes (in million €)

Source: own calculations based on FiFoSiM.

except for the deciles 6-9 experience utility gains on average (this does not, of course, exclude heterogeneity within deciles), and the magnitudes of gains and losses are smaller. However, this comes at the cost of vanishing aggregate welfare gains. Aggregate labour supply is more or less unaffected, and so is aggregate efficiency. Even if more income inequality is accepted, as in the case of the LL reform, the efficiency gain is not very large. It is a striking aspect of both variants that the middle class seems to be the main loser of flat tax reforms, not just in terms of income but also in terms of their level of welfare.

3.3.4 Summary and conclusion

In this section, we have examined the economic effects of different flat tax reform scenarios for Germany in terms of equity and efficiency. The analysis is based on micro data provided by a behavioural microsimulation model for the German tax and benefit system. In general, the effects of a flat tax reform differ considerably with changes in the marginal tax rate and the basic tax allowance. Table 3.3.6[27] compares both scenarios after labour supply reactions.

[27] Distributional effects in per cent, changes in effective marginal tax rates in percentage points, labour supply effects in fulltime equivalents and welfare effects in million €.

	LL				HH			
Decile	Distribution	EMTR	LS	Welfare	Distribution	EMTR	LS	Welfare
1	54.68	0.01	-3,326	-28	56.08	0.00	2,625	25
2	5.45	2.57	-9,114	-78	6.03	-4.16	3,497	62
3	-0.02	2.73	-15,773	-92	1.57	0.84	10,522	43
4	-0.97	0.38	-22,999	-101	1.09	2.05	8,053	-64
5	-2.60	-0.49	-25,796	-62	-0.45	-1.59	-4,686	-145
6	-2.76	-0.32	-18,876	-40	-1.50	-2.74	-14,671	-137
7	-3.62	-0.71	-10,755	-26	-2.76	-0.17	-22,509	-130
8	-2.58	-1.81	10,547	92	-2.67	1.67	-22,841	-131
9	0.03	-3.83	41,622	646	-1.44	0.73	-18,435	-20
10	4.41	-9.68	143,713	3,292	0.61	-4.90	58,358	1,455
mean/Σ	5.20	-1.12	89,243	3,602	5.66	-0.83	-87	957

Table 3.3.6: Summary of results
Source: own calculations based on FiFoSiM

The LL scenario, which combines a low tax rate (27 per cent) with the basic allowance existing under the status quo (7,664 Euros), leads to an increase in employment of 0.3% and an aggregate welfare gain equal to 1.8% of overall income tax revenue. This goes along with redistributional effects. The households of the highest income decile gain whereas all other deciles lose. The second highest income decile maintains the level of disposable income but can only do so by working more. The two lowest income deciles increase their average income but also lose in terms of utility (see Table 3.3.5). Overall, the LL variant of the flat tax reform achieves rather small efficiency gains which come at the price of a significant increase in inequality.

The redistributional effects are mitigated if a higher tax rate is chosen, as in the HH scenario, which combines a tax rate of 32 per cent with a basic allowance of 10,700 Euros. This reform is constructed such that, before labour supply adjustments, the Gini coefficient of income inequality is the same as in the status quo. This reform also implies that the highest income decile benefits, whereas the tax burden on middle income households increases. But the strength of these effects is much smaller than in the LL scenario. The HH scenario implies that labour supply in the highest income decile and in the four lowest deciles increases, whereas labour supply in the middle income range declines. The overall employment effect does not differ significantly from zero, and the effect on aggregate welfare is also negligible. It thus turns out that the redistributive effects emerging in the LL scenario can be avoided, but only at the cost of sacrificing the modest efficiency gains.

Note that we limit our analysis to revenue-neutral scenarios. If we allowed for a loss of tax revenue (which could be financed through cuts in government spending), the efficiency gains would be larger but inequality would increase as well.[28] Another objection to our analysis could be that we do not take into account the effects of the flat rate tax on investment and capital accumulation. However, Germany and many other countries address this issue by introducing variants of dual income tax systems.[29]

These results suggest that flat rate tax reforms are unlikely to bring about efficiency gains which are large enough to convince the electorate that an increase in inequality implied by this type of tax reform is justified. Although we have derived our results for the case of Germany, we do think that similar patterns would be observed in other countries of Western Europe. Of course, this remains to be shown.[30] If this proves to be correct, it will be hard for flat tax reforms to invade the grown-up welfare states of “Old Europe”.

3.4 Cash flow flat tax and general equilibrium

3.4.1 Introduction

The most popular flat rate tax proposal is the ”Flat Tax“ of Hall and Rabushka (1985) (HR), which combines a cash flow taxation on corporate incomes with the same single marginal tax rate on labour income.[31] This proposal, however, has

[28] For example, a further simulation of the non-revenue neutral combination of high allowance with low marginal rate results in a loss of revenue of about 26.4 billion euros, an increase in labour supply of about 400,000 fulltime equivalents, a welfare gain of about 8 billion and an increase of the Gini coefficient of about 3.5%.

[29] Flat rate taxes for all types of income do not seem necessary to improve investment incentives, although rate differentiation for different types of income clearly has its own problems.

[30] The effects of similar flat tax reforms in other Western European countries are analysed in chapter 5.

[31] This section is based on Peichl (2008).

not been implemented in its pure form in any country yet. Previous reforms considered a flat rate personal income tax as an indirect progressive tax schedule with a basic tax allowance and a uniform marginal tax rate. Reform concepts proposing a flat rate tax generally combine the introduction of a new tax schedule with a broadening and simplification of the tax base to make the tax system more transparent (tax rate cut cum base broadening). These kinds of reforms have been analysed in the two previous sections especially with respect to the immediate short-term effects. We concluded that flat rate tax reforms cannot avoid the fundamental equity efficiency trade-off. However, a HR-type flat tax may lead to further efficiency gains due to more investment and labour demand as it is also likely to reduce tax distortions in the corporate sector. These effects, however, can only be analysed using CGE models.

The introduction of a HR-type flat tax reform has been analysed before, especially for the U.S.. Browning and Browning (1985) estimate an increase in labour supply by 5%. Stokey and Rebelo (1995) compare and summarise different studies for the U.S. and conclude that a flat tax reform would have little effect on the growth rate. Gale, Houser and Scholz (1996) analyse the effects of introducing a HR flat tax in the U.S.. They conclude that high income households profit most while households with low incomes suffer from a flat tax reform. Ho and Stiroh (1998) and Dunbar and Pogue (1998) show that high income households gain whereas especially middle income households are burdened by a flat tax reform for the U.S.. Ventura (1999) finds an increase in capital accumulation and a redistribution in working hours and income in favour of the top of the distribution. Altig et al. (2001) find that output, labour supply and wages increase and that the lowest income households lose through a flat tax. Cassou and Lansing (2004) find that a flat tax reduces growth in the short run if revenue-neutrality is maintained, but increases capital accumulation and therefore growth in the long run. Díaz Giménez and Pijoan-Mas (2006) analyse two different flat tax proposals for the U.S. and find that the reform with the lower (higher) marginal rate increases (decreases) output and inequality, but decreases (increases) aggregate welfare. However, in both scenarios the poor obtain significant welfare gains. Nielsen, Frederiksen and Lassen (1999) find significant efficiency gains but negative distributional effects for a flat tax in Denmark. Heer and Trede (2003) find an increase in employment by

2% in Germany using a macro model.

In this section, we analyse a cash flow flat tax reform of the German corporate and personal income tax system according to the proposal by Mitschke (2004), which is closely related to the Hall-Rabushka proposal.[32] Our focus lies on the effects on tax revenue, income distribution, employment and economic growth. To be able to simulate distributional and growth effects within the same framework, we use the linked MSM-CGE module of FiFoSiM.[33] Microsimulation models (MSM) as well as Computable General Equilibrium models (CGE) have been widely used to ex ante analyse fiscal reforms. CGE models consider various interdependencies and facilitate simulating behavioural responses and adjustments on several markets. In contrast, microsimulation models consider only the household side of the economy, which allows for more heterogeneity and a much more detailed mapping of the complex tax benefit system. Combining these two model types enables the utilisation of the complementary advantages.

Applying the linked model to a not revenue neutral flat tax proposal shows that taking the general equilibrium effects into account indeed increases the expected efficiency gains in the long-run. The overall employment effects are larger than the labour supply reactions because of reduced costs of labour and capital resulting in increasing labour and investment demand. Therefore, a personal flat income tax can indeed overcome the fundamental equity-efficiency trade-off. However, combining this flat tax with a flat cash flow tax on business income still increases inequality due to the large gains at the top of the distribution.

The setup of this section is as follows. Section 3.4.2 briefly describes the reform proposal which is analysed in section 3.4.3 using the linked model. Section 3.4.4 concludes.

3.4.2 Cash flow flat tax proposal

The proposal of Mitschke (2004) in its original version combines an almost flat rate tax (two brackets with different marginal rates) on earned income with a S-base cash flow tax, i.e. income which is invested in firms is tax exempt.Therefore,

[32]See Fuest et al. (2005a), Bergs, Fuest, Heilmann, Peichl and Schaefer (2006) and Fuest, Peichl and Schaefer (2007a) for a detailed analysis of the Mitschke proposal.

[33]FiFoSiM is described in chapter 2.5, the general idea of linking MSM and CGE models in 2.2.4.

the neutrality of the savings and investment decision is achieved through this S-base cash flow tax. In effect, this reform proposal is a switch from an income based tax system to consumption taxation (concept of deferred taxation).[34] In principle, this proposal is close to the "Flat Tax“ idea of Hall and Rabushka (1985) which combines a R-base cash flow taxation on corporate income with the same single marginal tax rate on labour income.[35] Essentially, the HR flat tax is a consumption-type, origin-based VAT with a tax credit for labour income.[36]

In contrast to Mitschke (2004), who chooses a progressive tax schedule with two brackets, we model a single marginal tax rate of 25% for all types of income with a basic allowance of 7,500 Euros. The marginal rate is computed from micro data as an average tax rate of taxpayers under the Mitschke proposal. The Mitschke proposal further distinguishes between an introductory phase (personal income tax reform) and a final phase (personal income tax and cash flow corporate tax). In the first phase, only the personal income tax system is changed to a system with a single marginal rate on all sources of income (including capital and business income). In the final phase, this modified personal income tax is combined with a cash flow corporate income tax with the same marginal rate.[37] Furthermore, an imputed rent on owner occupied housing is also part of the tax base in this phase. For both phases the long-term revenue, employment and growth effects are simulated as well as the distributional effects.

3.4.3 Analysis

In the first step, the fiscal effects are analysed in the tax benefit module without taking into account the behavioural reactions of the economic agents (first round effects). In the second step, we allow for behavioural reactions by estimating the labour supply responses (second round effects). In the third step, the labour demand and wage changes (third round effects) are computed in the CGE module.

[34] See also Auerbach (2006).

[35] See King (1987) and OECD (2007) for an review of the different concepts of corporate cash flow taxes.

[36] See **?**. The tax base is sales minus purchases with capital goods being excluded (R-base). Further on, this origin-based VAT is a tax on domestic production that taxes exports but not imports (in contrast to the destination-based form of VAT).

[37] Note that in contrast to HR, the VAT is not changed in the Mitschke proposal.

In the fourth step, the micro data information is used to calibrate the representative household in the CGE module for the computation of the overall employment and growth effects (general equilibrium). As we use static MSM and CGE models, the behavioural adjustments are computed in the long-run, whereas the first round effects represent the immediate short-run effects the day after the reform.

We estimate the labour supply effects by comparing the estimated labour supply in the current system and in the reform alternatives using the discrete choice labour supply module of FiFoSiM. We find considerable differences in the labour supply reactions between couples and singles as well as between men and women. While married men increase their labour supply the strongest, single women even slightly decrease their labour supply. For the employment and growth effects we link the tax benefit module to the CGE model with a minimum wage to calibrate the current unemployment level (11.5%). We use the microsimulation results to calibrate the representative household in terms of income, labour supply and tax payments. The main results are summarised in table 3.4.1.

Model	Round	Effect	PIT	PIT + CIT
MSM	1	Tax revenue	-2 billion €	-13 billion €
	2	Labour supply	+103,000	+251,000
CGE	3	Labour demand	+370,000	+540,000
Link	4	Tax revenue after adj.	+3 billion €	-6 billion €
	4	Employment	+337,000	+471,000
	4	Δ GDP	+1.1%	+1.7%

Table 3.4.1: Summary of results for the HR type flat tax reform

The Mitschke proposal includes measures to broaden the tax base, therefore it is not clear ex ante if the tax revenue will be higher or lower than in the status quo.[38] The shift from the current German tax regime to the Mitschke proposal would result in revenue losses amounting to € 2 billion in the introductory phase (i.e. flat personal income tax, PIT) respectively € 13 billion in the final phase (i.e.

[38] It would have been possible to construct the scenarios revenue neutral like in the previous sections. However, the HR idea as well as the Mitschke proposal are not designed to be revenue neutral. Furthermore, allowing for a first round loss in revenue might trigger stronger efficiency effects than a revenue neutral scenario. Therefore, the analysis in this section allows for a loss (or increase) in tax revenue.

flat personal income tax and cash flow flat corporate income tax, CIT) without taking the behavioural responses into account (first round effects). These short-run effects indicate that the (not revenue neutral) flat tax reform scenario reduces the average tax burden on labour. As a consequence of this lower tax wedge, the net wage is likely to increase and the gross wage is likely to decrease. These effects imply increasing labour supply as well as increasing labour demand due to reduced user costs of labour. These effects will be simulated in the next step. As mentioned before, the behavioural responses are expectations for the long-run (partial or general) equilibrium as both models are static, i.e. not taking the transition path into account.

Labour supply would increase by 103,000 [251,000] fulltime equivalents. By including those second round effects, revenue increases and revenue losses are lowered. So far, these results are only based on the MSM. This information is now used to calibrate the representative household of the CGE model to derive the third round effects: Labour demand would increase by 370,000 [540,000] due to reduced costs of capital and labour. Taking these effects on wages and prices into account allows us to resolve both models until they converge. This leads to the following results: employment would grow by 337,000 full-time jobs, and GDP would increase by 1.1% in the introductory phase. The overall employment effects are larger than the labour supply reactions because of reduced costs of labour and capital resulting in increasing labour and investment demand.[39] This result indicates the importance of taking general equilibrium effects into account. For the final phase, we calculate a total of 471,000 new full-time jobs and a 1.7% increase in GDP. These results show that a cash flow flat tax leads to further efficiency gains due to more investment and labour demand as a consequence of reduced tax distortions in the corporate sector.

Can such a reform overcome the fundamental equity efficiency trade-off? The distributional effects before any and after the complete (general equilibrium) adjustment process are presented in Table 3.4.2.

Without taking any behavioural responses or adjustments into account (first

[39] These results are in line with results from Aaberge et al. (2007) for Norway. They also derive for a flat personal income tax scenario that the general equilibrium effects are larger than the pure labour supply reactions.

	Short-run		Long-run	
	PIT	PIT+CIT	PIT	PIT+CIT
1	0,67	0,86	77,93	78,18
2	0,00	-0,28	11,68	11,41
3	-0,29	-1,71	6,33	4,70
4	-0,66	-2,54	3,30	1,47
5	-1,27	-2,64	0,73	-0,54
6	-1,89	-2,53	-0,54	-1,00
7	-2,31	-1,75	-2,03	-1,09
8	-2,56	-0,31	-3,35	-0,68
9	-2,27	0,73	-3,24	0,95
10	2,11	5,92	1,69	6,47
Gini	1,16	4,48	-2,75	1,28

Table 3.4.2: Changes in household disposable income (in percent)

round effects) inequality increases in both phases. The main reason is the relief for the top of the distribution. The small gains at the lower end cannot compensate the higher burden in the middle income range and therefore inequality increases. These effects change, however, after the economy has fully equilibrated. The introduction of the personal income flat tax reduces inequality because of the strong behavioural responses at the bottom of the distribution. When combining the personal income flat tax with the corporate cash-flow tax, however, inequality still increases but less than without behavioural adjustment. This is due to the fact that especially the high income households have corporate or business income.

To sum up, taking the general equilibrium effects into account has important implications for the evaluation of a tax reform. The analysis shows that a personal income flat tax can indeed overcome the fundamental equity efficiency trade-off in the long-run while simultaneously increasing the tax revenue. However, this result does not hold for a cash flow flat tax combining a personal income flat tax with a corporate cash flow flat tax, even when allowing for an ex-post loss in revenue.

3.4.4 Summary and conclusion

Applying the linked model to a flat tax proposal shows that the overall employment effects are larger than the labour supply reactions because of reduced costs of labour and capital resulting in increasing labour and investment demand. Therefore, it is important to take these general equilibrium effects into account. In doing so, the analysis shows that a personal income flat tax can overcome the fundamental equity efficiency trade-off, but only in the long-run. The adverse immediate distributional effects still dominate in the short-run. However, combining this flat tax with a cash flow flat tax on business income still increases inequality due to the large gains at the top of the distribution.

A linked MSM-CGE model provides a powerful tool for the ex-ante evaluation of tax benefit reform proposals and is the most appropriate method for a comprehensive analysis of the distributional, employment and growth effects of (flat) tax reforms. When interpreting these results and especially the efficiency effects, it has to be taken into account that we have limited our analysis to static models. Therefore, the effects from our analysis only account for the new long-run equilibrium neglecting the transition path.[40] However, regarding the political feasibility of a flat tax reform, the short-term effects documented in the previous sections are most likely to be decisive.

In addition, the question arises whether the scope of increasing growth and employment through personal income tax reforms is sufficiently large. The user costs of labour and capital, which play an important role in determining the demand for labour and investment, are rather determined by social security contributions and corporate taxes than by the personal income tax. Including the CIT in the analysis does indeed lead to larger efficiency effects, but at the expense of increasing inequality. Therefore, the main problem of implementing a flat tax would be to convince a majority of the population that an immediate redistribution in favour of the highest income deciles is acceptable to achieve (uncertain) future efficiency gains. Furthermore, it is uncertain whether a tax system that abolishes a large number of exemptions and tax reliefs is politically sustainable. The temptation for politicians to serve special interest groups with special deductions will not easily disappear. Moreover, from a political economy perspective, a broad tax base allows the government to increase revenue with small increases in tax rates. Therefore, narrow tax bases might protect the taxpayers from excess taxation by the

[40] Flat taxes are also supposed to have positive dynamic efficiency and growth effects (see e.g. Stokey and Rebelo (1995) or Cassou and Lansing (2004)).

government.[41]

3.5 Conclusion

The success of the flat rate income tax in Eastern Europe suggests that this concept could also be a model for countries of Western Europe. In this chapter, we have conducted a simulation analysis of the economic effects of three different flat tax reforms for Germany.

In a first step, we analysed the effects of simplifying the tax base through a broadening of the tax base by comparing a flat tax scenario with a progressive adjustment of the rate schedule. Our analysis revealed that the effects of revenue neutral tax base simplification depend on the type of rate schedule adjustment. On the one hand, the combination with a flat rate tax increases both inequality and efficiency. On the other hand, the combination with a directly progressive rate schedule reduces inequality and efficiency. Therefore, we conclude that the effects of tax base simplification mainly depend on the type of tax schedule adjustment. Hence, it seems advisable to separate tax base simplification objectives from rate schedule issues.

In a second step, we analysed the effects of two revenue neutral flat tax scenarios with different marginal tax rates without changing the tax base, i.e. we analysed the role of flatness itself. Our analysis showed that a flat rate tax with a low tax rate and a low basic allowance increases labour supply, static welfare and simultaneously inequality. Combining a higher tax rate with a higher basic allowance avoids the increase in inequality but the positive efficiency effects vanish as well. Therefore, the effects do not only depend on the type of rate schedule adjustment (progressive vs. flat) but also on the design of the flat tax schedule. Hence, flatness of the tax schedule itself does not always yield the same effects, they also depend on the respective parameter details.

The first two steps confirm the existence of a trade-off between equity and efficiency. Note that we have limited our analysis to revenue-neutral scenarios. If we allowed for a loss of tax revenue (which could be financed through cuts in

[41] Cf. Brennan and Buchanan (1980).

government spending), the efficiency gains would be larger but inequality would increase as well.[42] Therefore, in the third step, we analysed the introduction of a comprehensive cash flow flat tax in the tradition of Hall and Rabushka (1985). Moreover, using the linked MSM-CGE module, we are able to account for the long-run general equilibrium effects. The analysis showed that the overall employment effects are larger than the labour supply reactions because of reduced costs of labour and capital resulting in increasing labour and investment demand. When taking the general equilibrium effects into account, a not revenue neutral personal income flat tax can indeed overcome the fundamental equity efficiency trade-off in the long-run. However, in the short-run, inequality still increases. This is also true for the combination of this flat personal income tax with a flat cash flow tax on business income with the same marginal rate.

An aspect that is neglected in our analysis is the impact of tax reforms on training and human capital accumulation. The results in Jacobs et al. (2007) suggest that flat tax reforms may increase investment in skill formation and thus change the composition of the labour force in the long term. But the question arises whether the income tax is the best instrument to achieve this. Furthermore, our analysis abstracts from effects of the flat tax reform on compliance. Flat rate tax systems are widely expected to improve taxpayer compliance. The 2001 tax reform in Russia is widely thought to be an example for this effect. Indeed, tax compliance and revenue apparently improved by about one third after the 2001 tax reform (Ivanova et al. (2005)). However, it is not clear whether this can be attributed solely to the flat tax or to improved law enforcement and tax administration which was also part of the 2001 reform (see also Gaddy and Gale (2005) and Gorodnichenko et al. (2007)). Moreover, the case of Russia differs from Germany insofar as the latter has a long tradition of income taxation in a market economy and a well established tax administration to ensure tax compliance. In addition, since we do not change social insurance contributions, the marginal tax rate on labour still remains high. This suggests that positive effects of a flat tax reform on compliance are probably less important in Germany than in the transition countries of Eastern Europe.

To sum up, our analysis shows that the selection of the schedule and tax base

[42] Cf. Diamond (2005) or Gale and Orszag (2002).

parameters are crucial for the effects of flat tax reforms in terms of equity and efficiency. We conclude that, due to their limited efficiency effects and their problematic immediate distributional impact, flat tax reforms are unlikely to spill over to the grown-up democracies of Western Europe. Since our analysis focuses on Germany, the question arises whether the main findings are likely to apply to other countries as well. Existing studies for other countries, mostly Western European countries and the US, partly use different approaches and methods. The finding that flat rate reforms with low tax rates and low tax credits or allowances yield gains in work incentives, employment and output, but only at the cost of significant redistribution in favour of the highest incomes, is in line with simulation studies for the Netherlands (Jacobs et al. (2007)), the United Kingdom (Adam and Browne (2006)), Belgium (Decoster and Orsini (2007)), Finland (Kuismanen (2000))[43] and Spain (González-Torrabadella and Pijoan-Mas (2006))[44]. Overall, these results are broadly in line with our findings and therefore suggest that the case of Germany is to some extent representative for other Western European countries.

Although more (and especially comparative) country studies are required to complete the picture, the pattern that emerges suggests that the flat tax concept cannot overcome the familiar equity efficiency trade-off, at least not in the short or medium term. Another robust result seems to be that flat tax reforms will increase the tax burden of the middle class. This is important from a political economy perspective. A strong and politically powerful middle class is a typical characteristic of most Western European countries. This suggests that it will be hard for flat tax reforms to invade the grown-up democracies of "Old Europe". The following chapters further investigate these issues. Chapter 4 compares European welfare states with a special focus on the relevance of the middle class and chapter 5 conducts a cross-country analysis of similar flat tax reforms.

[43] This study considers a reduction of the marginal tax rates in the two highest brackets from 44% and 37% to 35%, while the rest of the tax schedule remains unchanged. This reform increases labour supply by 4.5% and raises the after tax incomes of the three highest income deciles. Since the reform is not revenue neutral (income tax revenue declines by 13%), the results are not directly comparable to those derived in studies of revenue neutral reforms.

[44] The findings in González-Torrabadella and Pijoan-Mas (2006) differ from the other country studies in the magnitude of the simulated efficiency gains. While most studies find rather small gains, their model predicts an increase in output by more than 5%. They argue that this is driven mostly by an increase in capital formation, not in employment.

Chapter 4

Are European welfare states flat?

4.1 Introduction

The outcome of a (flat) tax reform depends on its design and the country in which the reform will be implemented. Countries worldwide differ with respect to various dimensions including the design of the welfare state, i.e. the tax benefit system.[1] Reasons for the fact that one system does not fit all countries include, among others, the specific socio-economic structure and the preferences of the society.

There have been several previous studies analysing the impact of hypothetical flat income tax reforms especially on equity and efficiency.[2] However, a question neglected in this literature is to what extent existing tax and transfer systems effectively differ from a flat tax system. Or to put in other words: "*How flat is the world?*". The aim of this chapter is to answer this question. We use the deviation of existing tax benefit systems from linearity as a summary measure that allows to compare the design of the welfare state across countries. In the first step of our analysis, we compare European countries regarding their institutional background and the underlying pre-tax income distribution to be able to explain why flat tax reform results do, or do not, differ across countries. Following the seminal contribution of Esping-Andersen (1990), several types of welfare states have been classified in the political sciences literature with respect to its design:

[1] According to Samuelson and Nordhaus (2005), a welfare state is a system that protects individuals against possible contingencies and guarantees a minimum standard of living.
[2] See section 1.2.4.

Anglo-Saxon, Continental, Nordic and Mediterranean countries. We analyse if this typology can also be applied when analysing the outcome of the distribution and redistribution of income through the tax benefit system. For this analysis we rely on several distributional measures described in chapter 2. In a second step, to compare the tax benefit systems using a single measure, we estimate a linear tax benefit schedule and analyse the deviation of the existing tax benefit systems from linearity. Our analysis integrates the income tax with other (direct) taxes, social insurance contributions and benefits. An example of this is a flat tax with a refundable tax credit. We use EUROMOD, a tax-benefit microsimulation model based on real micro data for the EU-15, to compare the results across countries in a common framework.

Our analysis yields the following results. Although European countries differ considerably in their design of tax benefit systems, four rather homogeneous groups of welfare states can be classified with respect to economic indicators resembling the political sciences typology of Esping-Andersen (1990). Therefore, the expected outcome of a flat tax reform should differ across heterogeneous countries but be similar within homogeneous types of countries. Further on, a linear negative income tax system is a good approximation of the existing tax benefit systems in many European countries. However, the goodness-of-fit of the estimated flat taxes varies across the countries, implying that some countries have highly non-linear tax benefit systems. These results crucially depend on the country under observation.

The setup of the chapter is organised as follows: Section 4.2 introduces the typology of welfare states used for the analysis. In section 4.3, the different designs of tax benefit systems in the EU-15 countries are described. Section 4.4 analyses the income distribution in these countries with respect to inequality, polarisation, poverty and richness. In section 4.5, the redistribution of income, i.e. the progressivity of the tax benefit system, is analysed. Section 4.6 answers the question of how far existing tax benefit systems deviate from linearity. Section 4.7 concludes the analysis.

4.2 Characteristics of European welfare states

Although all European countries have an individual design for their tax benefit system, it is possible to classify the EU-15[3] countries into different welfare state regimes with similar institutional structures. The classical typology of welfare states goes back to Esping-Andersen (1990) who differentiates between three types of welfare states: conservative (Continental Europe), social-democratic (Nordic Europe) and liberal (Anglo-Saxon). Ferrera (1996) further adds a fourth category (Southern or Mediterranean) to this typology.[4] The main conceptional features of these welfare state types are summarised in Table 4.2.1.

	Liberal	Conservative	Social-Democratic	Southern
Region	Anglo-Saxon	Continental	Nordic	Mediterranean
Countries	IR, UK	AT, BE, FR, GE, LU, NL	DK, FI, SW	GR, IT, PT, SP
Social security	means-tested	contribution based	universal, equal benefits	contribution based
Social expenditure	low	high	high	low
Tax rates	low	high	high	low
Tax revenue	middle	high	high	low
SIC	low (Beveridge)	high (Bismarck)	middle (Beveridge)	middle (Bismarck)
Redistribution	middle	high	high	low
Participation women	high	low	high	low

Table 4.2.1: Typology of welfare states

Anglo-Saxon countries ("liberal" welfare states) provide a minimum level of social protection (minimal subsistence level) based on universal, mean-tested benefits. People are encouraged to work (e.g. through the working families tax credit) and labour force participation is high. Tax rates and social insurance contributions are rather low. The state encourages private insurance systems through tax exemptions. In this regime, market institutions are preferred to state inter-

[3] Austria (AT), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (GE), Greece (GR), Ireland (IR), Italy (IT), Luxembourg (LU), the Netherlands (NL), Portugal (PT), Spain (SP), Sweden (SW) and the United Kingdom (UK).

[4] See Arts and Gelissen (2002). In Esping-Andersen (1990), these countries are treated as immature conservative welfare states. Due to the EU enlargement, one could also add a fifth category of Eastern European states. They are, however, not part of the analysis in this book.

ventions. *Continental* countries ("conservative" or "corporatist" welfare states)[5] use benefits that depend on the history of paid contributions (rather than on the actual need for the benefit) and aim at replicating the former income of employees (Bismarckian system). These generous schemes are financed through rather high compulsory contributions. Further on, high taxes ensure a rather high level of redistribution through various other public instruments. *Nordic* countries ("social-democratic" welfare states) apply even higher taxes but lower contributions for a similarly high level of redistribution. However, they use universal benefits with equal amounts for every citizen, i.e. not depending on the contribution history (Beveridgean system). These systems aim at providing a high level of social protection while simultaneously encouraging a high labour force participation through various instruments of active labour market policies and the provision of extensive child care. *Mediterranean* countries ("Southern" welfare states) provide a rather low level of social security (comparable to the Anglo-Saxon countries) based on low levels of taxes and redistribution. However, they also use contribution-based Bismarckian social insurance systems providing benefits depending on the level of previously earned income (like the Continental countries).

This typology stems from the political and social sciences literature and is based on the conceptional design of the welfare state. Furthermore, it is possible to apply this typology to economics, as well. In the following sections, the outcome of the welfare state in the EU-15 countries is analysed with respect to several economic indicators.

4.3 Tax benefit systems

European countries differ in the design of their system of social protection and redistribution. In each country, direct and indirect taxes as well as social insurance contributions are used to finance the welfare state (see Table 4.3.1 for an overview). The weight in the tax mix of these components depends on the structural design of the tax benefit system in each country. Denmark, for example, relies almost exclusively on taxes for the financing of the welfare state, whereas

[5] The "conservative" model origins from the influence of the Catholic Church and is further on characterised by the fostering of traditional family structures.

in most Continental countries social insurance contributions are much higher than income taxes. In Mediterranean countries, indirect taxes play the most important role. The level of social protection (in terms of expenditures as % of GDP) is high in Nordic and Continental countries and low in Anglo-Saxon and Mediterranean countries.

	Indirect Taxes			Direct Taxes			Social Contributions			Social expenditures		
	1998	2001	2003	1998	2001	2003	1998	2001	2003	1998	2001	2003
AT	15.49	15.00	14.98	13.62	15.06	13.63	14.92	14.61	14.53	28.90	28.6	29.5
BE	13.55	13.29	13.38	17.73	17.75	17.19	14.22	14.16	14.30	28.70	27.3	29.1
DK	18.35	17.39	17.40	30.10	29.48	29.55	1.02	1.72	1.20	32.50	29.2	30.7
FI	14.49	13.39	14.21	19.02	19.18	18.02	12.56	12.00	11.75	33.80	24.9	26.5
FR	16.42	15.39	15.28	11.79	12.64	11.38	16.06	16.11	16.30	30.20	29.6	30.9
GE	12.04	12.23	12.20	11.43	11.03	10.61	17.42	16.73	16.88	27.70	29.3	30.2
GR	15.06	15.19	13.72	9.80	9.72	8.85	11.49	11.65	12.98	22.10	26.7	26.0
IR	13.77	12.49	12.68	13.81	12.79	11.99	4.13	4.53	4.47	19.70	15.0	16.5
IT	15.62	14.69	14.29	14.65	14.82	14.73	12.19	11.95	12.31	26.00	24.9	25.8
LU	13.11	13.56	12.70	16.12	15.27	14.91	10.16	10.93	10.87	22.90	20.8	22.2
NL	12.27	12.93	12.68	12.20	11.73	10.96	14.97	13.68	13.80	31.70	26.5	28.3
PT	14.26	13.99	15.20	8.94	9.45	8.77	9.95	10.49	11.13	21.30	22.7	24.2
SP	11.52	11.51	11.86	10.33	10.38	10.47	11.88	12.17	12.20	22.80	19.5	19.9
SW	17.59	16.83	17.36	21.35	19.90	18.69	13.79	14.63	14.11	36.80	31.3	33.3
UK	13.87	13.79	13.57	16.68	17.22	15.55	6.16	6.33	6.44	28.60	27.5	26.4

Table 4.3.1: Tax benefit mix (as % of GDP)
Sources: European Commission (2007a), Eurostat (2006)

A perhaps trivial but still interesting observation from Table 4.3.1 is that the level of social expenditures is correlated with the level of taxes and contributions. Figure 4.3.1 plots these expenditures against the sum of all taxes and contributions and reveals an increasing trend (i.e. a positive correlation), as expected.

The existing income tax systems in the 15 countries under consideration offer considerable variety. As of 2003, all have graduated rate schedules with a number of brackets ranging from 2 (Ireland) to 16 (Luxembourg) and the highest marginal tax rate from 38% (Luxembourg) to about 60% (Denmark). All schedules are piecewise linear except that of Germany which has a unique continuous function for tax rates at some income levels. Most countries have a general personal allowance, often integrated into the tax schedule. Italy, the Netherlands and Portugal apply

Figure 4.3.1: Correlation between social expenditures and government revenue

general (wastable, i.e. non-refundable) tax credits and Austria uses both elements. About half of the countries tax capital (and property) income together with other income sources, whereas the second half applies a flat rate on capital income (dual income taxation), in Belgium this is optional.

The countries also differ in the unit of assessment. Again, half of them allow only individual taxation, five countries apply either optional or compulsory joint taxation, France has a family splitting system, whereas Belgium and Denmark provide limited income sharing for married couples. Nevertheless, even systems based on individual taxation often have elements assessed at family level (e.g. family or child allowances) or allow the sharing of non-labour income or household expenditures (e.g. property income, mortgage payments). See Table 4.3.2 for a

	No of brackets	Lowest (pos) rate	Highest rate	Form of the main tax relief	Capital taxation	Tax unit
AT	4	21%	50%	0% bracket, credit	flat tax (25%)	individual
BE	5	25%	50%	tax allowance	optional flat tax (15%)	some sharing
DK	3	32.6%	59.8	tax allowance	dual progr. schedule	some sharing
FI	5	state 12%, local 15%	state 35%, local 19.75%	0% tax bracket (state), tax allowance (local)	flat tax (29%)	individual
FR	4	5.5%	40%	0% tax bracket	integrated	family splitting
GE	Formula	19.9%	48.5%	0% tax bracket	integrated	optional joint
GR	3	15%	40%	0% tax bracket	integrated	individual
IR	2	20%	41%	tax allowance	flat tax (20%)	individual
IT	5	23%	43%	tax credit	flat tax (12.5%)	optional joint
LU	16	8%	38%	0% tax bracket	integrated	joint
NL	4	1.7%	52%	tax credit	flat tax (30%)	individual
PT	6	12%	40%	tax credit	flat tax (20%)	joint
SP	5	15%	45%	tax allowance	integrated	optional joint
SW	2	state 20%, local 31.6%	state 25%, local 31.6%	tax allowance	flat tax (30%)	individual
UK	3	10%	40%	tax allowance	one bracket reduced	individual

Table 4.3.2: Income tax systems, 2003
Sources: European Commission (2007a), European Commission (2007b)

summary of these characteristics.

Overall, although there are few countries with relatively simple income tax systems (e.g. UK), most of them can be characterised as rather complex systems combining many different components and varying tax units. Specific elements can have fixed amounts or either be decreasing or increasing with the level of taxable income. Additional examples of complexities include progression adjustments in Austria and Germany, income taxation both at the state and the local level in Finland and Sweden, and an integrated schedule of social insurance contributions and income tax in the Netherlands.

The effective marginal tax rate (EMTR) shows at which rate an additional unit of income is taxed. We compute EMTRs using the appropriate modules provided by EUROMOD. We calculate this for the working age population (those aged 18-64) with positive employment or self-employment income, by increasing earnings of each individual in the household in turn by 3% while the change in all taxes and benefits (including social insurance contributions) is observed at the household level. We use the following formula: $EMTR_i = 1 - \frac{\Delta Y_j}{d_i}$, where d_i is the income increment for individual i and Y_j disposable income of household j where this individual belongs to.

	1998		2001		2003	
	Mean	Median	Mean	Median	Mean	Median
AT	0.426	0.417	0.425	0.416	0.428	0.414
BE	0.508	0.510	0.528	0.510	0.543	0.524
DK	0.553	0.516	0.548	0.516		
FI	0.436	0.471	0.422	0.456	0.404	0.440
FR	0.310	0.336	0.399	0.337		
GE	0.504	0.507	0.467	0.489	0.475	0.496
GR	0.251	0.270	0.261	0.278	0.239	0.237
IR	0.387	0.362	0.348	0.358		
IT	0.385	0.390	0.381	0.390		
LU	0.355	0.368	0.374	0.395	0.354	0.371
NL	0.437	0.426	0.409	0.444	0.406	0.449
PT	0.304	0.260	0.257	0.235	0.269	0.241
SP	0.257	0.276	0.257	0.280	0.262	0.281
SW	0.453	0.415	0.410	0.399		
UK	0.341	0.314	0.344	0.304	0.365	0.320

Table 4.3.3: EMTRs (in per cent) EU-15
Sources: own calculation using EUROMOD version D1.
Note: EMTR defined as [1 – (change in hh disposable income) / (increase in individual earnings)] and includes individuals aged 18-64 with positive earnings.

Table 4.3.3 presents the results. Again, there are distinct differences between the countries. EMTRs are rather high in Nordic and Continental countries but low in Anglo-Saxon and Mediterranean countries.

4.4 Income Distribution

We compute a number of distributional measures to cover several aspects of distribution: inequality, polarisation, poverty and richness. They are based on equivalised household market income or equivalised household disposable income (DPI).[6]

4.4.1 Inequality

Table 4.4.1 presents the Gini coefficients for market and disposable incomes. In 1998, inequality based on market income (i.e. pre-government income) has been rather high in the Anglo-Saxon and Southern European countries (except Greece) and Sweden, rather low in Austria, Belgium, Denmark and the Netherlands, and medium in Finland, France, Germany, Greece and Luxembourg. Market income inequality has been reduced in most countries in the following years. In 2001 and 2003 only Portugal has a Gini coefficient of greater than 0.5. The reduction was largest in Sweden, Ireland and Spain.

	1998		2001		2003		Δ 1998 - 2001		Δ 2001 - 2003	
	Market	DPI	Market	DPI	Market	DPI	Market	DPI	Market	DPI
AT	0.441	0.235	0.441	0.230	0.451	0.239	0.00	-2.13	2.27	3.91
BE	0.462	0.250	0.492	0.247	0.491	0.247	6.49	-1.20	-0.20	0.00
DK	0.457	0.235	0.457	0.232			0.00	-1.28		
FI	0.482	0.246	0.485	0.265	0.484	0.269	0.62	7.72	-0.21	1.51
FR	0.486	0.289	0.487	0.260			0.21	-10.03		
GE	0.470	0.251	0.469	0.253	0.494	0.268	-0.21	0.80	5.33	5.93
GR	0.484	0.336	0.487	0.329	0.502	0.322	0.62	-2.08	3.08	-2.13
IR	0.516	0.324	0.459	0.309			-11.05	-4.63		
IT	0.497	0.352	0.498	0.348			0.20	-1.14		
LU	0.481	0.256	0.472	0.240	0.472	0.243	-1.87	-6.25	0.00	1.25
NL	0.412	0.250	0.386	0.247	0.386	0.247	-6.31	-1.20	0.00	0.00
PT	0.514	0.358	0.507	0.362	0.507	0.361	-1.36	1.12	0.00	-0.28
SP	0.520	0.327	0.469	0.310	0.469	0.311	-9.81	-5.20	0.00	0.32
SW	0.498	0.295	0.437	0.243			-12.25	-17.63		
UK	0.502	0.313	0.496	0.311	0.496	0.307	-1.20	-0.64	0.00	-1.29

Table 4.4.1: Gini coefficients and changes (in per cent) EU-15
Sources: own calculation using EUROMOD version D1.

In terms of disposable income, similar groups become visible. First of all, it

[6] We use the modified OECD equivalence scale which weights the household head with a factor of 1, household members aged 14 and older with 0.5, and under 14 with 0.3. The household's net income is divided by the sum of the individual weights of each member (=equivalence factor) to compute the equivalence weighted household income.

should be noted that post-government inequality is significantly lower than pre-government inequality indicating some substantial degree of redistribution in every country. In all three years, post-government inequality is rather high in the Anglo-Saxon and Southern European countries, whereas it is rather low in Continental and Nordic Europe.

When looking at the development of inequality at the three observed points in time, it turns out that changes in market income inequality do not (exclusively) determine changes in post-government inequality. Therefore, changes in the redistribution schemes are the most likely causes for differing developments. In France, for example, market income inequality remained constant between 1998 and 2001 but disposable income inequality was reduced by about 10%.

To further decompose the inequality with respect to countries and welfare state groups, we use the Theil index which is additively decomposable as all measures of the generalized entropy family.[7] Consider a population of persons (or households), $i = 1, ..., n$, with income x_i, and weight w_i. The arithmetic mean income is $\overline{x}$. Suppose there is an exhaustive partition of the population into mutually-exclusive subgroups $k = 1, ..., K$. The Generalized Entropy class of inequality indices $I^c_{GE}(F)$ is given by

$$\begin{aligned}
I^c_{GE} &= \frac{1}{c(c-1)} \sum_{i=1}^{n} [\frac{w_i}{\sum_i w_i} (\frac{x_i}{\overline{x}})^c - 1], \ -\infty < c < +\infty, \ c \neq 0, 1. \\
I^0_{GE} &= I^1_{Theil} = \sum_{i=1}^{n} \frac{w_i}{\sum_i w_i} \log(\frac{\overline{x}}{x_i}), \ c = 0 \\
I^1_{GE} &= I^0_{Theil} = \sum_{i=1}^{n} \frac{w_i}{\sum_i w_i} \frac{x_i}{\overline{x}} \log \frac{x_i}{\overline{x}}, \ c = 1
\end{aligned}$$

The constant c is a sensitivity parameter, which may be interpreted as a parameter of inequality aversion. Each I^c_{GE} index can be additively decomposed as

$$I^c_{GE} = I^c_{GE\_}W + I^c_{GE\_}B$$

where $I^c_{GE\_}W$ is within-group inequality and $I^c_{GE\_}B$ is between-group inequal-

[7] Cf. Shorrocks (1980) and Shorrocks (1984). See also section 2.3.

ity and $I_{GE}^{c}\_W = \sum_i \left(\frac{N_k}{N}\right)^{1-c} s_k I_{GE}^{c}(k)$, where $\left(\frac{N_k}{N}\right)$ is the number of persons (i.e. the sum of the weights) in subgroup k divided by the total number of persons (i.e. the total sum of weights), i.e. $\left(\frac{N_k}{N}\right)$ is the subgroup population share and s_k is the share of total income held by k's members (subgroup income share). $I_{GE}^{c}(k)$ denotes the inequality for subgroup k and is calculated as if the subgroup was a separate population. $I_{GE}^{c}\_B$ is derived assuming every person within a given subgroup k received k's mean income, $\overline{x}_k$.

	1998	2001	2003
EU-15	0.199	0.194	0.190
within countries	0.167	0.162	0.162
between countries	0.032	0.031	0.027
within welfare states	0.175	0.168	0.165
between welfare states	0.023	0.025	0.025

Table 4.4.2: I_{Theil}^{1} index decomposed into within and between inequality
Sources: own calculation using EUROMOD version D1.

The results of the decomposition using the $I_{GE}^{0} = I_{Theil}^{1}$ index based on equivalised disposable income are presented in Table 4.4.2.[8] The overall inequality in the EU-15 is reduced between 1998 and 2003 by about 4.5%. About 85% of overall inequality can be attributed to within country inequality. The reduction between 1998 and 2001 can be mainly attributed to within country inequality, whereas from 2001 to 2003 the between countries component declined. To further decompose the results, the Theil indices for each country along with the population share $\left(\frac{N_k}{N}\right)$, the income share s_k (i.e. the economic weight) and the inequality share (i.e. the contribution to within country inequality defined as $q_k = \frac{s_k I_{GE}^{c}(k)}{I_{GE}^{c}\_W}$) of each country are presented in Table 4.4.3.

The results in terms of inequality across countries for the top sensitive Theil index are in line with the results for the middle sensitive Gini index. Inequality is high in Anglo-Saxon and Mediterranean countries, and low in Nordic and Continental welfare states. The different countries contribute in different ways to the within country inequality. When comparing the inequality share with the income share (inequality weight vs. economic weight) and the population share,

[8] Using the $I_{GE}^{1} = I_{Theil}^{0}$ or the I_{GE}^{2} index yields the same results in qualitative terms.

	1998				2001				2003			
	I^0_{GE}	$\frac{N_k}{N}$	s_k	q_k	I^0_{GE}	$\frac{N_k}{N}$	s_k	q_k	I^0_{GE}	$\frac{N_k}{N}$	s_k	q_k
AT	0.093	0.022	0.025	0.014	0.091	0.021	0.022	0.013	0.102	0.035	0.038	0.024
BE	0.118	0.028	0.033	0.023	0.114	0.026	0.028	0.020	0.123	0.040	0.043	0.033
DK	0.114	0.016	0.022	0.015	0.114	0.016	0.020	0.014	.	.	.	.
FI	0.119	0.014	0.015	0.011	0.139	0.014	0.015	0.013	0.140	0.022	0.025	0.021
FR	0.153	0.151	0.179	0.164	0.128	0.155	0.151	0.119	.	.	.	.
GE	0.115	0.221	0.247	0.170	0.117	0.218	0.236	0.170	0.131	0.335	0.356	0.287
GR	0.233	0.028	0.015	0.020	0.230	0.028	0.014	0.020	0.208	0.044	0.026	0.033
IR	0.179	0.009	0.009	0.010	0.163	0.010	0.013	0.013	.	.	.	.
IT	0.228	0.158	0.135	0.185	0.226	0.156	0.129	0.180	.	.	.	.
LU	0.119	0.001	0.002	0.001	0.107	0.001	0.002	0.001	0.110	0.002	0.003	0.002
NL	0.118	0.041	0.045	0.032	0.128	0.041	0.046	0.036	0.127	0.064	0.073	0.057
PT	0.212	0.027	0.013	0.016	0.216	0.028	0.014	0.018	0.214	0.043	0.023	0.030
SP	0.241	0.107	0.064	0.092	0.231	0.107	0.071	0.101	0.231	0.169	0.120	0.170
SW	0.155	0.023	0.025	0.024	0.108	0.023	0.024	0.016	.	.	.	.
UK	0.165	0.154	0.172	0.170	0.171	0.157	0.214	0.225	0.167	0.246	0.294	0.304
EU-15	0.199	1.000	1.000	0.840	0.194	1.000	1.000	0.839	0.190	1.000	1.000	0.857
Anglo-Saxon	0.167	0.163	0.181	0.180	0.171	0.167	0.227	0.238	0.167	0.246	0.294	0.304
Continental	0.127	0.463	0.531	0.405	0.122	0.462	0.485	0.364	0.128	0.476	0.513	0.405
Nordic	0.139	0.053	0.062	0.052	0.122	0.052	0.060	0.045	0.140	0.022	0.025	0.021
Mediterranean	0.255	0.321	0.226	0.346	0.242	0.318	0.228	0.341	0.231	0.255	0.168	0.239

Table 4.4.3: Theil inequality decomposition
Sources: own calculation using EUROMOD version D1.
Note: I^0_{GE} : I^1_{Theil} index of inequality, $\frac{N_k}{N}$ population share, s_k income share, q_k inequality share.

it reveals that for (most) Nordic and Continental countries their contribution to within country inequality is smaller than their population weight which again is smaller than their economic weight. In the Anglo-Saxon countries, the economic weight equals approximately the inequality share which is larger than the population share, whereas for the Southern countries the population share is largest and the contribution to inequality is larger than their economic weight. These relations can be summarised as follows:

$$\begin{aligned} q_k &< \frac{N_k}{N} < s_k, \text{ if } k \in \{\text{Continental, Nordic}\} \\ \frac{N_k}{N} &< q_k = s_k, \text{ if } k \in \{\text{Anglo-Saxon}\} \\ s_k &< q_k < \frac{N_k}{N}, \text{ if } k \in \{\text{Mediterranean}\} \end{aligned}$$

When comparing the values of within and between inequalities for the clustering according to countries and that according to the welfare state typology, a result which is surprising at first glance can be observed: Between country inequality is larger than between welfare state type inequality implying that inequality is smaller within countries than within welfare state types. Therefore, the clustering of countries to welfare states does not lead to four groups that are more homogeneous than the countries themselves. This, however, is not surprising at all, taking into account that clustering into more groups always yields clusters that are less heterogeneous than before.

4.4.2 Polarisation

Generally speaking, polarisation is the occurrence of two antipodes. A rising income polarisation describes the phenomenon of a declining middle class resulting in an increasing gap between rich and poor. The proportion of middle income households is declining while the shares of the poor and the rich are both rising. To compare the countries with respect to polarisation, we calculate the polarisation index by Schmidt (2004). The results are presented in Table 4.4.4.

When analysing polarisation, the same two groups as for inequality become visible: Anglo-Saxon and Southern countries have a high polarisation of disposable income distribution, whereas Nordic and Continental countries have lower polarisation and stronger middle classes. The development of polarisation over time, however, differs within and between the types of welfare states. For Germany (and Finland), for example, polarisation increased from 1998 to 2001 and again to 2003, whereas for Greece it decreased.

	1998	2001	2003
AT	0.215	0.213	0.224
BE	0.235	0.242	0.241
DK	0.220	0.221	.
FI	0.232	0.240	0.242
FR	0.288	0.259	.
GE	0.241	0.247	0.269
GR	0.337	0.335	0.323
IR	0.313	0.275	.
IT	0.338	0.336	.
LU	0.260	0.253	0.256
NL	0.248	0.245	0.247
PT	0.307	0.310	0.309
SP	0.338	0.306	0.306
SW	0.248	0.222	.
UK	0.296	0.300	0.296

Table 4.4.4: Polarisation EU-15
Sources: own calculation using EUROMOD version D1.

4.4.3 Poverty and richness

To analyse poverty, we compute the measures of Foster et al. (1984) with poverty aversion parameters $\alpha = 0$ (headcount index), $\alpha = 1$ and $\alpha = 2$ based on the poverty line taken from the baseline scenario. We compute the poverty lines as 60% of median equivalent income for each country. Measuring richness is a much less considered field in the literature than poverty. We compute the headcount index and the measures of Peichl et al. (2006) which are analogously defined to the FGT indices of poverty. The richness line is computed as 200% of median equivalent income. The results are presented in Tables 4.4.5 (poverty) and 4.4.6 (richness).

Again, there are already distinct differences between the analysed countries in the baseline. The same two groups of countries can be distinguished when looking at the headcount ratios (FGT0, HCR): poverty and richness (like inequality and polarisation) is rather high in Anglo-Saxon and Southern European countries, and it is rather low in Continental and Nordic Europe.

However, when using more sophisticated measures of poverty and richness,

	1998			2001			2003		
	FGT0	FGT1	FGT2	FGT0	FGT1	FGT2	FGT0	FGT1	FGT2
AT	11.498	3.351	1.740	11.810	3.330	1.727	12.149	3.203	1.468
BE	11.109	3.477	1.947	14.547	4.275	2.080	13.642	5.293	3.714
DK	13.270	3.774	1.806	13.074	3.809	1.933	.	.	.
FI	14.678	3.267	1.142	14.597	3.538	1.329	15.410	3.850	1.470
FR	16.237	4.562	2.213	14.068	3.867	1.966	.	.	.
GE	13.244	3.747	1.803	14.073	3.931	1.871	16.244	4.529	2.164
GR	21.980	9.579	6.301	21.555	9.308	6.079	21.300	8.698	5.704
IR	22.026	5.343	2.043	20.729	6.250	2.760	.	.	.
IT	22.838	8.909	5.737	22.452	8.928	5.814	.	.	.
LU	13.593	3.699	2.048	12.246	3.563	2.007	12.370	3.407	1.935
NL	15.968	4.921	3.338	15.686	4.712	2.642	15.784	4.719	2.661
PT	20.001	6.566	3.281	19.842	6.137	3.121	19.734	6.146	3.109
SP	21.671	9.203	5.889	19.759	7.916	4.946	19.643	7.916	4.947
SW	9.392	3.941	3.591	13.200	3.680	2.961	.	.	.
UK	19.533	5.330	2.300	20.577	5.921	2.748	20.207	5.766	2.660

Table 4.4.5: Poverty EU-15
Sources: own calculation using EUROMOD version D1.
Note: FGTα: Foster et al. (1984) poverty measure.

that take both the dimension of changes and the number of people beyond a given poverty/richness line into account, this picture changes slightly, at least for the Anglo-Saxon countries. However, poverty and richness are still the highest in the Mediterranean countries. These results indicate that in those countries many people have incomes way below (above) the poverty (richness) line. This is confirmed by the measure of polarisation as Southern countries are those with the highest polarisation of the income distribution. In contrast, in the Anglo-Saxon countries, many people are just below (above) the poverty (richness) line but not as far away as in the Southern countries.

For the development of poverty and richness no clear pattern across countries can be observed. Poverty is increasing with respect to all measures in Germany only. It is decreasing in Greece for 2001 and 2003. Between 1998 and 2001, poverty is uniformly decreasing in France, Luxembourg, the Netherlands, Portugal and Spain, between 2001 and 2003 in the UK. However, it is increasing in the UK between 1998 and 2001 such that poverty in 2003 is still higher than in 2001.

	1998			2001			2003		
	HCR	R1	R2	HCR	R1	R2	HCR	R1	R2
AT	3.850	0.662	0.196	3.579	0.625	0.184	4.211	0.879	0.307
BE	5.144	1.190	0.474	3.464	0.755	0.286	3.551	0.789	0.306
DK	2.812	0.746	0.328	2.759	0.711	0.306	.	.	.
FI	4.351	0.963	0.396	4.821	1.169	0.512	4.860	1.153	0.499
FR	8.693	2.093	0.786	6.865	1.549	0.542	.	.	.
GE	5.905	0.967	0.288	6.102	1.035	0.293	6.995	1.220	0.361
GR	13.160	2.978	1.028	13.130	2.999	1.043	10.482	2.495	0.948
IR	8.487	2.079	0.849	5.872	1.341	0.539	.	.	.
IT	11.186	2.921	1.219	11.031	2.826	1.167	.	.	.
LU	6.590	1.299	0.443	6.403	1.078	0.343	7.127	1.192	0.382
NL	4.316	0.776	0.253	3.986	0.736	0.233	4.198	0.759	0.239
PT	13.400	3.744	1.503	12.650	3.743	1.656	12.496	3.673	1.622
SP	13.271	3.242	1.191	9.783	2.104	0.757	9.745	2.063	0.751
SW	4.423	1.124	0.514	3.649	0.746	0.278	.	.	.
UK	8.763	1.820	0.624	8.623	1.860	0.652	8.452	1.811	0.637

Table 4.4.6: Richness EU-15
Sources: own calculation using EUROMOD version D1.
Note: R_α: Peichl et al. (2006) richness measure.

Richness is also only increasing according to all measures in Germany in both periods. It is also increasing in Belgium and the UK (1998-2001), as well as in Finland (2001-2003). On the other hand, richness is decreasing in more countries than poverty does: from 1998-2001 in Austria, Belgium, Denmark, Ireland, Italy, Luxembourg, the Netherlands, Spain and Sweden and between 2001 and 2003 in Greece, Portugal and Spain. For the other country-year combinations the different measures do not indicate the same tendency implying a change in the structure of the top (bottom) of the income distribution, i.e. a change in the composition of the rich (poor) subpopulation.

4.5 Redistribution of income

To analyse the redistributive effects of the tax benefit system we compute several measures of tax progression. We compute the measure of effective progression by Musgrave and Thin (1948) (P_{MT}), the index of disproportionality by Suits (1977)

(P_S) and the index of redistribution by Reynolds and Smolensky (1977) (P_{RS}). Table 4.5.1 presents the values for the various indices.

	1998			2001			2003		
	P_{MT}	P_{RS}	P_S	P_{MT}	P_{RS}	P_S	P_{MT}	P_{RS}	P_S
AT	1.098	0.058	0.215	1.098	0.058	0.231	1.111	0.067	0.251
BE	1.087	0.052	0.168	1.088	0.055	0.192	1.089	0.055	0.182
DK	1.173	0.100	0.208	1.182	0.105	0.225	.	.	.
FI	1.105	0.062	0.204	1.102	0.059	0.199	1.101	0.059	0.206
FR	1.064	0.036	0.221	1.091	0.053	0.340	.	.	.
GE	1.103	0.060	0.183	1.098	0.057	0.190	1.113	0.063	0.197
GR	1.062	0.034	0.187	1.073	0.039	0.219	1.077	0.044	0.214
IR	1.134	0.071	0.372	1.127	0.072	0.422	.	.	.
IT	1.085	0.048	0.179	1.087	0.050	0.186	.	.	.
LU	1.103	0.060	0.302	1.100	0.061	0.278	1.095	0.057	0.296
NL	1.101	0.058	0.177	1.088	0.052	0.169	1.082	0.049	0.155
PT	1.093	0.048	0.264	1.094	0.050	0.296	1.096	0.051	0.299
SP	1.087	0.044	0.252	1.084	0.041	0.250	1.086	0.043	0.252
SW	1.109	0.066	0.200	1.083	0.052	0.156	.	.	.
UK	1.152	0.078	0.387	1.138	0.075	0.355	1.143	0.077	0.345

Table 4.5.1: Progressivity of the income tax system (including SIC)
Sources: own calculation using EUROMOD version D1.

In terms of progression and the different concepts of measurement the clustering into the welfare state typology is not working as perfectly as for inequality, polarisation, poverty and richness. The Anglo-Saxon and Nordic countries have the highest progressivity of the tax benefit system as a whole. Redistribution is medium to high in most continental countries (except France), whereas it is rather low in Southern European countries. The results for the Anglo-Saxon countries contradict the implication of the (political sciences) welfare state typology which predicted a low to medium level of redistribution for these countries.

The development over time is, again, not uniform across countries. Austria and Portugal are the only two countries where the progressivity increases in both periods for all measures, the Netherlands is the only one where they decrease.

Figure 4.5.1 plots the Suits index of progression against the level of direct taxes plus social insurance contributions. It shows that the level of redistribution is negatively correlated with the level of taxes, i.e. the higher the progressivity

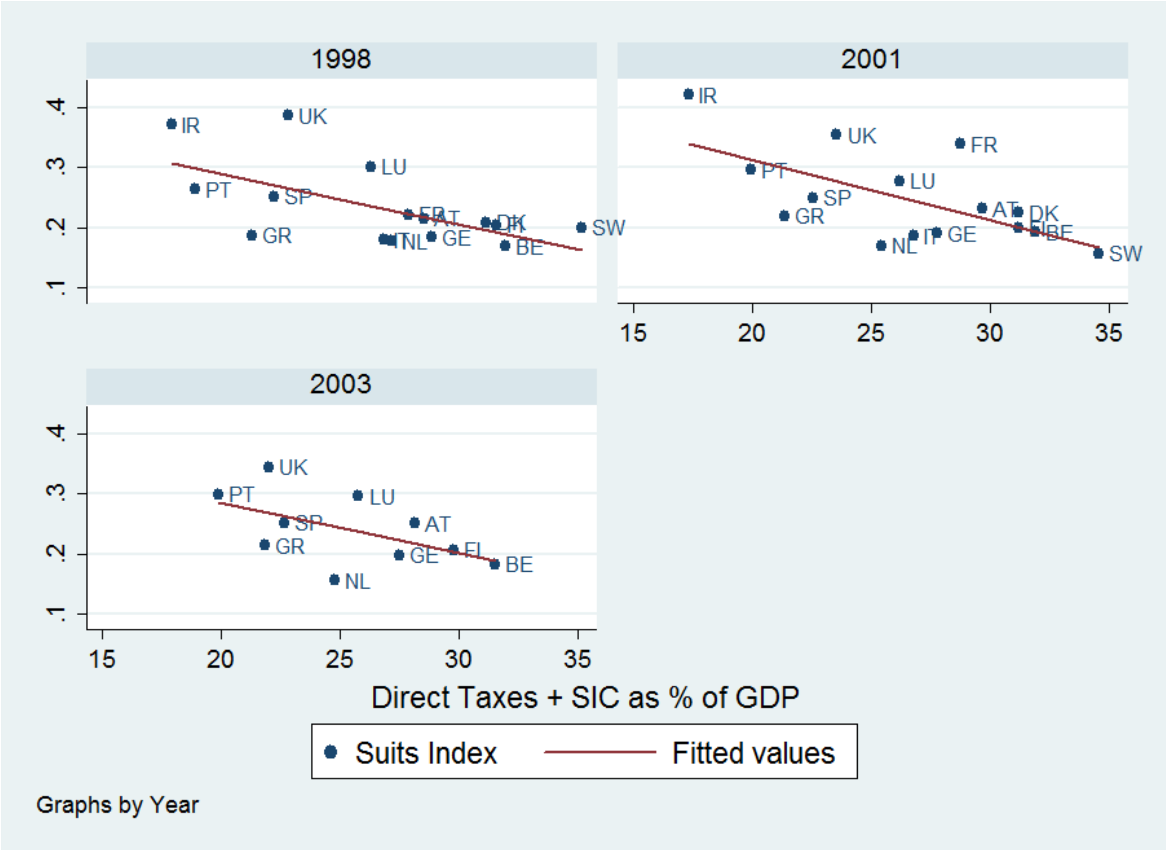

Figure 4.5.1: Correlation between progressivity and direct taxes

of the tax system (including SIC) the lower is the revenue. This result implies a trade-off between the aim to redistribute and the potential to raise revenue for the government. On the one hand, the revenue raising potential is c.p. the higher the broader the tax base. Broader tax bases mostly go along with lower tax rates.[9] This, however, reduces the redistributive effects of the tax system. On the other hand, c.p. high tax rates with a high redistributive potential are mostly levied on narrow tax bases, reducing the revenue collecting possibilities.

[9] This is reflected in the recent tax reform trend of “tax rate cut cum base broadening”.

4.6 How flat is Europe?

4.6.1 How do existing tax benefit systems differ from flatness?

Analysing the redistributive effects of the tax benefit systems in Europe shows that these systems embed some degree of progressivity (see section 4.5). However, the absolute values of these indices are closer to zero (i.e. linearity) than to absolute progression.[10] Tax benefit systems in Europe evolved to quite complex entities embedding various linear and non-linear elements. For instance, income tax systems are generally non-linear with various exemptions, allowances and different tax rates for different levels of income. But, in some countries some income components (like capital income in dual income tax systems) are taxed at a proportional rate. Social insurance contributions, though, are often proportional to income capped at a certain ceiling resulting in a regressive system.[11] Furthermore, many benefits have a proportional withdrawal rate above a certain threshold. The combination of all these measures could result in a system being close to linearity. Therefore, this section asks the question of "*How flat is Europe?*", i.e. to what extent existing tax benefit systems effectively differ from a flat tax system. We use the estimated parameters and the derived deviation from linearity as a summary measure to compare the welfare state designs in different countries.

Figure 4.6.1 plots the net level of taxes paid minus transfers received against the gross income of households in the EU-15 in 2001.[12] At first glance, in some countries the tax benefit systems are rather close to linearity (e.g. Denmark, Germany, the Netherlands and the UK), whereas in other countries (Finland, Italy, Sweden) the deviation seems to be larger. In the following section, this deviation will be analysed even further.

[10] Note that the incidence of flat tax systems in practice is not proportional but (indirect) progressive to income due to the basic allowance.

[11] See e.g. Peichl and Schaefer (2008).

[12] Similar results can be obtained for 1998 and 2003.

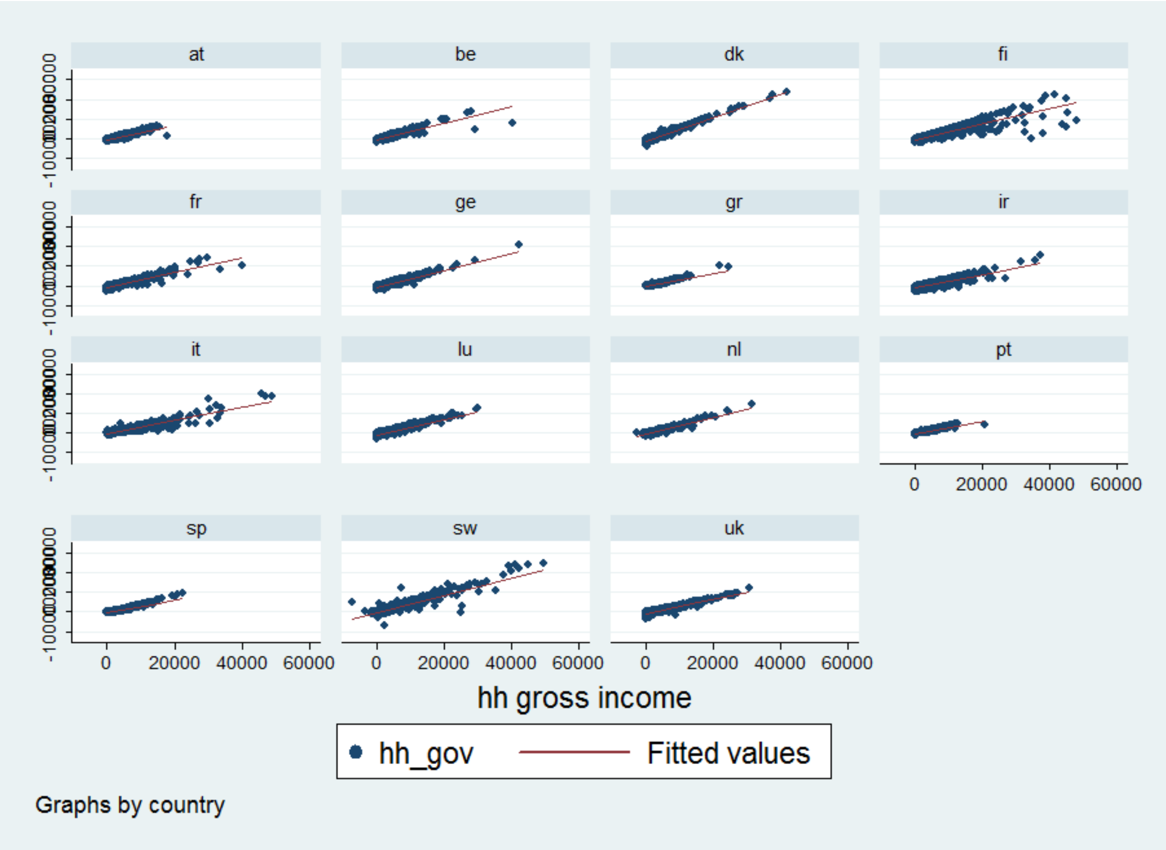

Figure 4.6.1: Are tax benefit systems flat?

4.6.2 Empirical Approach

To assess the deviation of the existing tax benefit system from linearity, we estimate a linear system and evaluate the fraction of the total variance in the data which is explained by this estimated system. To be able to estimate a linear system some definition of concepts are needed: Gross income X equals market income MI plus replacement income RI.

$$X = MI + RI$$

Government action G equals taxes T plus social insurance contributions S minus benefits B, i.e. if G is positive, the individual is a net tax payer and if G is negative the individual is a net benefit receiver.

$$G = T + S - B$$

Disposable income Y equals gross income minus government action G.

$$Y = X - G$$

We estimate the following tax benefit function, i.e. a negative income tax (basic income):

$$G = FTR * X - FTA \tag{4.6.1}$$

Government action is regressed on gross income X and a constant term, which is interpreted as the flat tax allowance (respectively a refundable tax credit) FTA and expected to be positive, i.e. it is deducted. The coefficient of gross income is taken as the flat marginal tax rate FTR and should be positive. Equation 4.6.1 is estimated using OLS and securing revenue neutrality of the government budget. The estimation results are presented in Table 4.6.1. The deviation of existing tax benefit systems from linearity can be seen as a summary measure that allows to compare the design of the welfare state across countries. The amount of the basic allowance can be regarded as a measure of the level of social protection, i.e. the subsistence level, whereas the marginal tax rate can be interpreted as a measure of incentives. Both parameters are interdependent (because of the revenue constraint) and can be used in combination as a measure of redistribution.

The estimated (revenue neutral) tax rate and allowance combinations vary significantly across countries. The absolute parameter values are high in Austria, Belgium, Denmark, Germany, the Netherlands and Sweden (2001), medium in Finland, France, Luxembourg, the UK and Ireland (2001), whereas they are rather low in Greece, Italy, Portugal and Spain, as well as Ireland and Sweden in 1998.[13] However, when looking at the flat tax allowance in relation to median income (column FTA (%)) this picture changes. A high marginal rate does not necessarily imply a high allowance and vice versa. For instance, the relative value is highest in Spain 1998, whereas the absolute value is among the lowest. In general, the values

[13] The NIT results for Sweden 1998 are not statistically significant. Therefore, the low parameter values as well as the small R^2 should be treated with caution.

	1998				2001				2003			
	FTR	FTA	FTA (%)	R2	FTR	FTA	FTA (%)	R2	FTR	FTA	FTA (%)	R2
AT	0.440	379.5	34.5	0.699	0.433	401.4	34.6	0.693	0.459	485.7	39.6	0.772
BE	0.464	360.1	32.9	0.857	0.440	376.7	32.1	0.821	0.433	348.5	28.7	0.821
DK	0.583	546.9	41.4	0.969	0.589	626.2	42.8	0.963	.	.		.
FI	0.389	313.6	30.8	0.787	0.334	270.6	22.8	0.741	0.334	300.0	23.4	0.752
FR	0.369	359.9	35.4	0.652	0.380	358.6	34.9	0.606	.	.		.
GE	0.454	344.0	32.9	0.811	0.431	360.5	31.1	0.799	0.438	369.4	32.3	0.816
GR	0.320	102.6	33.5	0.710	0.319	123.0	34.2	0.713	0.344	170.0	30.4	0.700
IR	0.297	212.9	38.7	0.868	0.386	412.1	38.4	0.923	.	.		.
IT	0.325	165.3	26.9	0.697	0.334	196.4	28.2	0.703	.	.		.
LU	0.378	509.7	36.7	0.754	0.383	558.2	33.6	0.728	0.358	590.4	32.8	0.695
NL	0.458	340.7	34.0	0.875	0.405	339.8	28.3	0.873	0.406	351.9	27.8	0.875
PT	0.322	100.6	30.5	0.670	0.325	128.9	30.4	0.650	0.329	140.0	30.5	0.663
SP	0.327	132.6	46.6	0.717	0.304	141.1	29.1	0.504	0.303	157.9	28.7	0.472
SW	(-0.222)	(-70.1)	(-6.7)	(-0.439)	0.464	416.9	33.8	0.815	.	.		.
UK	0.370	324.9	35.0	0.840	0.377	447.5	33.9	0.898	0.386	409.2	33.7	0.900

Table 4.6.1: Estimation results negative income tax

are around one third of the respective mean income in each country. As expected, the value is higher in Denmark and lower in most Southern countries. Striking results are the rather high value of Ireland and the rather low value of Finland, which, to some extent, contradicts the prediction of the welfare state typology.

To evaluate the deviation of the existing systems from linearity, we estimate the R^2-measure which can be interpreted as the fraction of variation in the data explained by the estimated model. A rather crude interpretation of this measure would be to say that, for example, the value of 0.969 for Denmark in 1998 implies that the Danish system was flat to a degree of 96.9%. Nevertheless, a larger value of R^2 implies an existing system that is closer to the estimated flat tax system. This goodness of fit measure is large in Belgium, Denmark, Germany, Finland, Ireland, the Netherlands, and the UK indicating that these systems are indeed close to linearity.

The estimated values of the basic allowance around one third of median income are below the usual definition of the poverty line, i.e. 60% of median income. Therefore, in a second estimation, the flat tax allowance is constrained to a higher value corresponding to this poverty line definition. This system is estimated using constrained linear regression techniques with OLS and allows to analyse the sensitivity of the results with respect to a different flat tax design. This second estimation corresponds to a more generous basic income scheme (BIC), whereas the first estimation can be seen as a negative income tax system (NIT).[14] The estimation results are presented in Table 4.6.2.

	1998			2001			2003		
	FTR	FTA	R2	FTR	FTA	R2	FTR	FTA	R2
AT	0.646	659.5	0.681	0.640	697.0	0.670	0.624	735.9	0.752
BE	0.661	656.5	0.862	0.654	703.8	0.828	0.669	728.4	0.828
DK	0.705	792.3	0.971	0.704	877.9	0.965	.	.	.
FI	0.618	610.2	0.824	0.619	711.2	0.792	0.620	770.1	0.800
FR	0.562	610.6	0.629	0.588	616.6	0.602	.	.	.
GE	0.646	628.2	0.783	0.635	696.3	0.784	0.623	685.6	0.806
GR	0.462	183.7	0.736	0.460	215.6	0.737	0.557	335.2	0.688
IR	0.414	330.5	0.865	0.540	643.1	0.886	.	.	.
IT	0.545	368.4	0.713	0.548	418.4	0.720	.	.	.
LU	0.551	834.1	0.754	0.589	996.8	0.706	0.574	1080.3	0.673
NL	0.641	600.4	0.880	0.631	720.2	0.874	0.635	760.7	0.876
PT	0.518	197.6	0.604	0.533	254.7	0.534	0.536	275.8	0.550
SP	0.389	170.6	0.707	0.490	290.7	0.480	0.495	330.5	0.450
SW	0.619	632.4	0.468	0.661	740.9	0.706	.	.	.
UK	0.552	557.1	0.837	0.565	792.6	0.885	0.574	729.0	0.886

Table 4.6.2: Estimation results basic income

When looking at the basic income schemes, it is first of all noteworthy that all tax rates (and allowances) are, as expected, higher than for the negative income tax systems. The parameter values are rather high in Austria, Belgium, Denmark, Germany, Finland, the Netherlands and Sweden, medium in France, Italy, Luxembourg, Portugal and the UK, whereas they are rather low in Greece, Ireland and Spain. However, these (revenue neutral) basic income rates are rather high, e.g. above 70% in Denmark. This implies large disincentives effects.[15]

[14] For more on the differences of these two concepts, see e.g. Atkinson (1995).

[15] These results are in line with the literature on basic income schemes which predicts that these concepts can either not be financed or result in large disincentives effects (see e.g. Burtless (1983) or more recently Fuest and Peichl (2007)).

The goodness-of-fit measures are slightly higher for some but lower for other countries in comparison to the NIT. The general message, however, is the same. The systems in Belgium, Denmark, Germany, Finland, Ireland, the Netherlands, and the UK have rather large values for R^2 which reinforces the theses that such systems are close to linearity. However, using this summary measure of linearity does not allow clustering the countries according to the welfare state typology as when using several distributional measures.

4.6.3 Simulation Results

Introducing a revenue neutral tax reform always yields winners and losers. How would such a linear tax benefit system affect the income distribution? Table 4.6.3 reports the changes in Gini coefficients with respect to the baseline values.[16]

	1998		2001		2003	
	NIT	BIC	NIT	BIC	NIT	BIC
AT	5.70	-29.60	7.00	-28.50	3.30	-24.50
BE	8.50	-28.60	13.70	-26.60	14.80	-29.70
DK	4.10	-22.20	2.90	-21.60	0.00	0.00
FI	19.40	-20.50	22.20	-25.10	20.20	-26.40
FR	-1.30	-29.90	4.00	-28.60	0.00	0.00
GE	8.60	-26.70	8.90	-27.10	8.00	-25.00
GR	-2.50	-22.90	-2.50	-22.40	-4.30	-34.50
IR	12.70	-6.20	-5.30	-27.90	0.00	0.00
IT	-0.50	-32.60	-1.40	-32.60	0.00	0.00
LU	7.00	-22.10	8.00	-27.90	8.30	-27.90
NL	1.90	-29.30	2.40	-33.90	2.70	-34.10
PT	-0.30	-28.80	-5.80	-34.80	-5.30	-34.40
SP	-2.20	-11.00	0.00	-26.50	0.00	-27.10
SW	(45.90)	-19.80	5.30	-27.20	0.00	0.00
UK	4.90	-23.60	2.60	-26.60	2.90	-26.80

Table 4.6.3: Changes in Gini coefficient flat tax systems

The basic income scheme decreases inequality in all countries, whereas the negative income tax does not yield unambiguous effects. Inequality increases in

[16] Again, the NIT value for Sweden 1998 is not statistically significant.

most countries, but decreases in the Southern countries, as well as in France (1998) and Ireland (2001). On the one hand, from a political economy point of view, a basic income scheme seems more likely to gain majority support as it would improve the equity of the tax benefit system. However, the high marginal tax rates imply large disincentives effects. Therefore, the political success of such a reform seems unlikely. On the other hand, a less generous negative income tax results in some countries in marginal tax rates which are below the EMTRs (e.g. Belgium, Finland, Germany, Ireland) implying some positive incentives effects. To sum up, Ireland is the only country with decreasing inequality at the NIT proposal, positive incentives effects and a high linearity of the existing tax benefit system. Therefore, such a flat tax reform is most likely to happen there.

4.7 Summary

European countries differ with regard to the existing distribution of income and the amount of redistribution. Nevertheless, four homogenous groups could be identified. The main results are summarised in Table 4.7.1, which ranks the countries, that have been clustered according to the welfare state typology, with respect to various indicators.[17] Although this (political and social sciences) typology is based on the conceptional design of the welfare state, it can be applied to analyse the economic performance of a tax benefit system, as well. In principle, the clustering works very well and confirms the prediction of the welfare state typology as there are indeed correlations between the structure of the tax benefit system and the category that a country is assigned to.

When looking at the elements of government revenue, it can be observed that Social insurance contributions are high in continental Europe and rather low in Anglo-Saxon countries. Direct taxes are highest in the Nordic countries and rather low in Mediterranean welfare states. The two *Anglo-Saxon* countries are in the bottom third for total tax revenue and tax rates. However, there are some imperfections. For example, the ranking in social expenditures of Ireland fits the typology, but the 6th place of the UK does not. The values of the distributional

[17] A higher rank (i.e. a smaller number) represents a higher value of the respective coefficient.

		Tax benefit system						Distribution and redistribution					
		Indir	Dir	SIC	total	EXP	EMTR	Market	DPI	Pols	FGT1	Ra1	Prog.
Anglo-	IR	13	9	14	15	15	11	11	6	6	4	7	3
Saxon	UK	8	5	13	11	6	12	3	4	5	6	5	2
	AT	5	7	4	4	5	4	13	15	15	15	15	6
	BE	11	4	5	3	7	2	4	10	11	8	11	8
Continental	FR	3	10	2	6	2	8	5	8	7	10	6	9
	GE	14	12	1	8	3	3	9	9	9	9	10	7
	LU	9	6	11	9	13	10	8	13	8	13	9	4
	NL	12	11	6	10	9	7	15	10	10	7	13	10
	DK	1	1	15	2	4	1	12	14	14	11	14	1
Nordic	FI	10	3	8	5	10	5	7	7	12	14	8	5
	SW	2	2	3	1	1	6	14	12	13	12	12	10
	GR	4	14	10	12	8	13	5	3	2	1	2	15
	IT	6	8	9	7	10	9	2	2	1	2	3	12
Southern	PT	7	15	12	14	12	14	1	1	3	5	1	14
	SP	15	13	7	13	14	14	9	5	4	3	4	10

Table 4.7.1: Ranking of countries according to various indicators, 2001

Notes: Indir: indirect taxes, Dir: direct taxes, SIC: social insurance contributions, total= Indir+Dir+SIC, EXP: social expenditure, Market (DPI): Gini coefficient market (disposable) income, FGT1 (R1): poverty (richness) measure, Progr.: R-S progressivity measure.

indicators for these two countries are between 4 and 7, i.e. implying a rather low level of equity. The values for progression, however, are among the highest, which is surprising at a first glance and, to some extent, contradicting to the prediction of the welfare state typology. The six *Continental* countries are ranked in the first and second third (except Luxembourg) with respect to revenue and expenditures. In terms of distributions, these countries are ranked in the two bottom thirds, implying a rather high equity level. The three *Nordic* countries have the highest total revenues and expenditures (except Finland). Therefore, Denmark and Sweden are in the bottom third, Finland in the middle third with respect to the equity ranking. The four *Mediterranean* countries have medium to low values of revenue and expenditures which lead to high values of the distributional indicators and signaling the lowest level of equity.

In terms of distributional measures two groups can be differentiated: inequality, polarisation, (relative) poverty and richness are rather high in Anglo-Saxon and Southern European countries, whereas they are medium to low in Continental and Nordic Europe. In terms of redistribution three different groups become visible: progression is rather low in Southern Europe, medium in Continental Europe, whereas it is rather high in the Anglo-Saxon and Nordic countries. When looking at both dimensions a matrix with 9 fields emerges (see Table 4.7.2). Distribution and redistribution are indicators of the outcome, i.e. the performance, of the welfare state. The (political and social sciences) welfare state typology is based on the design, i.e the input. Nonetheless, the European countries can also be clustered according to the aforementioned economic criteria into four groups resembling the modified typology of Esping-Andersen: Mediterranean countries with high inequality and low progression (top right corner), Anglo-Saxon (or liberal) with high inequality and high progression (bottom right), Continental European (or conservative) with low to medium inequality and medium progression (in the middle) and Nordic (or social-democratic) countries with low inequality and high progression (bottom left).

<table>
<tr><th colspan="2"></th><th colspan="3">Inequality/Poverty/Richness</th></tr>
<tr><th colspan="2"></th><th>low</th><th>medium</th><th>high</th></tr>
<tr><td rowspan="3">Redistribution</td><td>low</td><td></td><td>SP</td><td>GR, IT, PT</td></tr>
<tr><td>medium</td><td>AT</td><td>SW, BE, FR, GE, NL</td><td></td></tr>
<tr><td>high</td><td>LU, DK</td><td>FI, IR</td><td>UK</td></tr>
</table>

Groups: SP and GR, IT, PT: (*Mediterranean*); AT and SW, BE, FR, GE, NL: (*Conservative*); LU, DK and FI, IR: (*Social-democratic*); UK: (*Liberal*)

Table 4.7.2: Classification of countries based on the existing tax-benefit systems
Note: high: ranks 1-5, medium: 6-10 and low: 11-15.

To sum up, there are already distinct differences between the countries of the EU-15. Therefore, different outcomes of (similar) flat tax reforms should be expected for different countries. Nevertheless, it is possible to classify these heterogeneous countries into four rather homogeneous groups. The new findings from the economic perspective are in line with the predictions from the social and political sciences literature on types of welfare states. Therefore, similar outcomes of similar flat tax reforms should be expected for countries within the same cluster.

When estimating linear negative income tax systems and analysing the deviation to the existing systems, one may argue that the world is not flat but it is getting flatter. The systems in Belgium, Denmark, Germany, Finland, Ireland, the Netherlands, and the UK have rather large values for R^2 implying that these systems are close to linearity. However, the other side of the coin implies that the other countries have highly non-linear tax benefit systems. Such a fundamental flat tax reform is most likely to happen in Ireland which is the only country that has a high degree of linearity in the existing system and where inequality and marginal tax rates decrease in the reform scenario.

The values of this goodness-of-fit measure are slightly increasing over time, therefore a trend towards more linear systems might be observed. However, further research on this topic with more time series data and other goodness of fit measures is necessary.

Using the deviation from linearity as a summary measure for the welfare state design does, however, not allow clustering the countries according to the welfare state typology. This implies that there are more ways to skin a cat, i.e. several designs within a welfare state cluster yield similar outcomes in terms of distribution and redistribution, whereas linearity of the tax benefit system is just one out of several design options. This shall be investigated further in future research. Furthermore, we have analysed tax benefit systems as a whole entity in this chapter. The analysis of specific structural elements (e.g. taxes, contributions, benefits) and the composition of welfare states is beyond the scope of this analysis and we leave this subject to further research.

Chapter 5

Flat tax reforms in Western Europe

5.1 Introduction

As mentioned before, the flat income tax idea has become increasingly popular recently, yet its implementation has been mainly limited to countries in Eastern Europe. Due to its distributional effects, we argue that a flat tax receives less political support in countries with a well-established middle class (see chapter 3). The aim of this chapter is to analyse the impact of country-specific elements like income distribution and welfare state design on the effects of flat tax reforms. Among others, we study the effect of polarisation, which can be interpreted as an indicator of the strength of the middle class, on the results.

We undertake a systematic approach for choosing flat tax parameters, i.e. flat rate and basic allowance, which seemed to be rather arbitrary in previous studies, for a comparative analysis of different flat tax designs for selected Western European countries. Davies and Hoy (2002) show that in the case of revenue neutral flat tax reforms there are two sets of critical parameter values: a lower bound of flat tax rates below which inequality is always higher compared to a given graduated rate tax and an upper bound above which inequality is always lower. We rely on these theoretical insights to systematically construct hypothetical flat tax reforms and analyse the distributional and incentive effects of their implementation in European countries.

We use EUROMOD, a tax-benefit microsimulation model for the EU-15, to compare the results across countries in a common framework. We analyse which population subgroups gain and which lose from the introduction of flat taxes. We also ask whether different combinations of tax rates and allowances always have an adverse effect on the middle class and if there are indeed positive incentive effects. Furthermore, we concentrate on the short-term static effects assuming that these decide the political feasibility of a tax reform although there are possibly important long-term effects as well.[1]

Our analysis yields the following results. Flat tax rates required to attain revenue neutrality with existing personal allowances (lower boundary) improve labour supply incentives. However, they benefit mainly those with high incomes at the expense of low and middle income households, resulting in more inequality, poverty and polarisation of the income distribution. On the other hand, revenue neutral flat rates necessary to keep the inequality levels unchanged are rather high and lead to ambiguous incentive effects. In general, a revenue neutral flat tax reform cannot overcome the fundamental equity efficiency trade-off, but in some cases an increase in equality and incentives is possible. We show that the different underlying income distributions and compositions of welfare state regimes play a key role for the results in terms of both equity and efficiency. Overall, our findings could contribute to explaining why flat taxes have not been politically successful in Western Europe so far. Our results also suggest that Mediterranean countries with a rather small middle class due to high polarisation are most likely to implement such a reform.

The rest of the chapter is organised as follows: Section 5.2 describes our reform scenarios. Section 5.3 illustrates the distributional effects in terms of inequality, poverty and richness, polarisation, winners and losers as well as the incentive effects in terms of effective marginal and average tax rates. Section 5.4 concludes.

[1] People tend to asymmetrically judge future losses and gains (see e.g. the "prospect theory" by Kahneman and Tversky (1979)). Starting from a reference point (status quo) and given the same variation in absolute values, there is a bigger impact of losses than of gains (loss aversion). Furthermore, people prefer the status quo over uncertain outcomes in the future ("status-quo-bias", see Kahneman, Knetsch and Thaler (1991)). Therefore, short-term losses in comparison to the status quo can have a much stronger impact than (possible) future gains. Hence, the short term effects presented here could be decisive.

5.2 Reform scenarios

In our flat tax reform simulations we aim at replacing all existing personal income tax deductions, allowances and credits with a single personal allowance (which is equivalent to a wastable (i.e. non-refundable) tax credit under a flat tax rate), and the graduated rate schedule with a single flat rate. We only keep refundable tax credits on the basis that these are equivalent to benefits.[2] The same rate is also applied on capital income where it was taxed separately before. Therefore, our reform scenarios have a good potential to simplify the systems (due to fewer specific deductions) and make them more transparent.[3]

In the current chapter, we do not make an attempt to harmonise tax bases across countries. We limit ourselves to income taxes and do not modify existing social insurance contribution schemes[4] or consider benefits (e.g. basic income flat tax). One could also carry out an exercise of simply flattening tax rate schedules, but this would result in higher flat tax rates due to retained exceptions, therefore, limiting gains in terms of incentives.

We simulate the following three flat income tax scenarios for each country:

- a flat rate with a basic allowance in the existing (or equivalent) amount (S1),
- a 10 percentage points higher flat rate compared to the first scenario and an increased tax allowance to preserve revenue neutrality (S2),
- a 20 percentage points higher flat rate compared to the first scenario and an increased tax allowance to preserve revenue neutrality (S3).

All scenarios are revenue neutral with the total income tax revenue within $\pm 0.1\%$ limits of its baseline value. In terms of Davies and Hoy (2002) approach,

[2] Examples include the lone parent tax credit in Austria, the tax credit for families with school children in Greece, the working mother tax credit in Spain, and the working tax credit and the child credit in the UK.

[3] See Table 4.3.2 in Chapter 4 for a summary of the characteristics of current income tax systems. Further on, abolishing specific deductions and allowances (that may have different values for different persons or income levels) and replacing them with one general allowance leads to a (slightly) broader tax base.

[4] The use of social insurance contributions differs considerably across European countries. Therefore, a reform of these would raise further conceptual questions, e.g. if mandatory contributions should be interpreted as taxes or insurance premiums.

which is explained in section 1.2.5, our first scenario should roughly correspond to the lower bound. The 10 and 20 percentage point higher tax rate under the second and the third scenario are chosen to explore the effect on inequality potentially around the upper bound. Because of additional complexities discussed in section 1.2.5 exact critical flat tax rates can be identified only by trial and error.

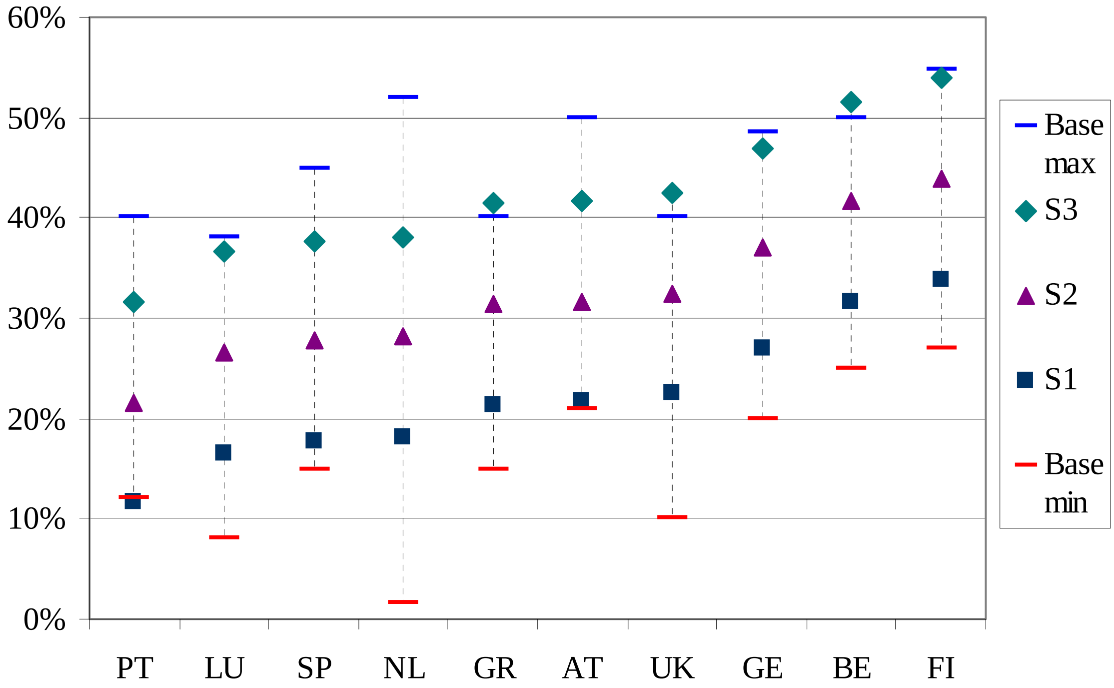

Figure 5.2.1: Existing lowest and highest marginal rates and simulated flat rates

Figure 5.2.1 plots the flat tax rate under each scenario and the lowest and highest (positive) tax rate of the existing tax rate schedules. Because of revenue neutrality the tax allowance is not independent of the tax rate. There is notable variation in the flat tax rate under the first scenario (11.6-33.9%). This variation results from the combination of the underlying pre-tax income distribution and average effective tax burden under the existing system. This also affects the other two scenarios. However, it turns out that for most countries the range of flat tax rates under three scenarios roughly matches the range of existing tax rates. A notable exception is the Netherlands with a very wide range of tax rates.[5]

As expected, flat tax rates under the first scenario are above the lowest existing rates with only Portugal being slightly lower. Again, this is possible due to the elimination of additional tax allowances. Flat tax rates under the third scenario are around the previous highest marginal rates for six countries and below that for the rest.

5.3 Simulation results

In this section we present the results of our analysis. First, we consider distributional effects in terms of inequality, poverty and richness. This is followed by the presentation of the distribution of tax payments and disposable income, and then summarised by the share of winners and losers. Finally, we demonstrate how effective average and marginal tax rates change according to the simulated reform scenarios.[6]

5.3.1 Inequality, poverty and richness

We compute a number of distributional measures to cover several aspects of distribution: inequality, polarisation, poverty and richness. These are based on equivalised household disposable incomes.[7] To analyse income inequality we use the Gini Coefficient and the Generalised Entropy Indices with sensitivity parameters $\alpha = 0$ (Mean Log Deviation), $\alpha = 1$ (Theil index) and $\alpha = 2$. We also calculate the polarisation index of Schmidt (2004) to assess the importance of the middle

[5] The integrated schedule of social insurance contributions and income tax in the Netherlands results in rather low income tax rates for the brackets where full contributions to the "People's Pensions Insurance" have to be paid and rather high rates above the SIC threshold.

[6] When interpreting the results one has to be aware of the fact that revenue neutrality in terms of (overall) tax payments does not necessarily imply a constant mean disposable income. This mainly depends on mean-tested benefits which are calculated on the basis of after-tax net income. In fact the pre- and post-reform mean disposable income varies between +0.4% and -1.4% in the revenue neutral scenarios modelled here.

[7] We use the modified OECD equivalence scale which weights the household head with a factor of 1, household members aged 14 and older with 0.5, and under 14 with 0.3. The household's net income is divided by the sum of the individual weights of each member (=equivalence factor) to compute the equivalence weighted household income.

class. Figure 5.3.1 presents the Gini coefficient for each scenario, other measures are presented in Table 5.5.2 (Appendix 5.5.1).

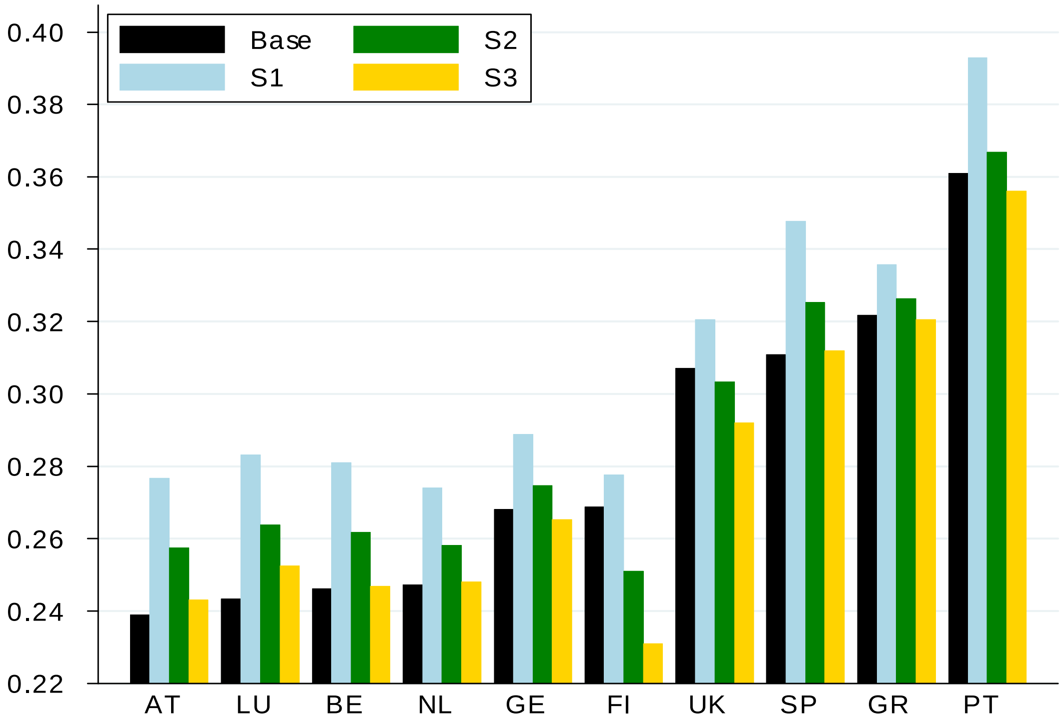

Figure 5.3.1: Income inequality by Gini coefficient

First of all, it is noteworthy that there are already distinct differences between the analysed countries in terms of inequality in the baseline scenario. Two groups become visible: inequality is rather high in Southern European countries (Greece, Portugal and Spain) and the UK, whereas it is rather low in Continental Europe (Austria, Belgium Germany, Luxembourg) and Finland.[8]

Introducing a revenue neutral flat tax increases inequality unambiguously only under the first scenario (S1). In the second scenario (S2) inequality decreases relative to the baseline for Finland and the UK (depending on the inequality measure

[8] This classification of countries corresponds to the modified typology by Esping-Andersen (1990): conservative (Continental Europe), social-democratic (Nordic Europe), liberal (Anglo-Saxon) and Mediterranean (cf. chapter 4.2).

for the latter) and in the third scenario (S3) also for Belgium, Germany, Greece and Portugal.[9] These differences between countries can be explained to some extent by different tax systems and the resulting distribution of tax payments. The latter is rather narrow in Belgium, Finland and UK (where inequality decreases) with a spread of the effective average tax rate in the baseline between the lowest and highest decile of less than 20 percentage points whereas this spread in most other countries is around or well above 30 percentage points.[10]

The scenarios can be ranked according to the level of inequality as follows: $I(S1) > I(S2) > I(S3)$.[11] The increases in inequality, however, are similar in absolute terms for most countries with FI and UK being slightly lower. The fact that inequality levels under the third scenario are below or close to those in the baseline scenario show that they correspond approximately to the upper boundary.[12]

To analyse the effects of flat taxes on poverty we compute the headcount index and the measures of Foster et al. (1984) based on the poverty line taken from the baseline scenario.[13] We compute the poverty lines as 60% of median equivalent income for each country. Measuring richness is a much less considered field in the literature than poverty. We compute the headcount index and the measures of Peichl et al. (2006) which are analogously defined to the FGT indices of poverty. The richness line is computed as 200% of median equivalent income. The results for the headcount ratios are plotted in Figure 5.3.2 (poverty) and 5.3.3 (richness).[14]

[9] These derived results are in line with comparable scenarios from single country studies. Fuest et al. (2007d), for example, find a similar increase in inequality for scenario S1 and one close to S2 for Germany.

[10] This spread, however, is largest for Greece although a similar development can be observed as for low-spread countries. But when taking a closer look at the distribution of tax payments it can be seen that it is right-skewed and the spread between deciles one and nine is below 20 pp. See subsection 5.3.2 for further information.

[11] This ordering is stable when using any inequality index presented in Table 5.5.2 (Appendix 5.5.1).

[12] Inequality under S3 is lower for those countries where flat tax rate under S3 is close or exceeds previous highest rate (LU, GR, UK, GE, BE, FI), except LU and additionally for PT.

[13] We fix the poverty and richness lines at the baseline level to account for (possible) changes in median income. Otherwise, if we would allow for changing poverty (richness) lines an increasing measure of poverty (or a decreasing index of richness) would not necessarily indicate a worse situation for people with low (high) incomes as a result of the changing poverty (richness) line.

[14] The full results for all measures of poverty and richness are presented in Table 5.5.1 (Appendix 5.5.1).

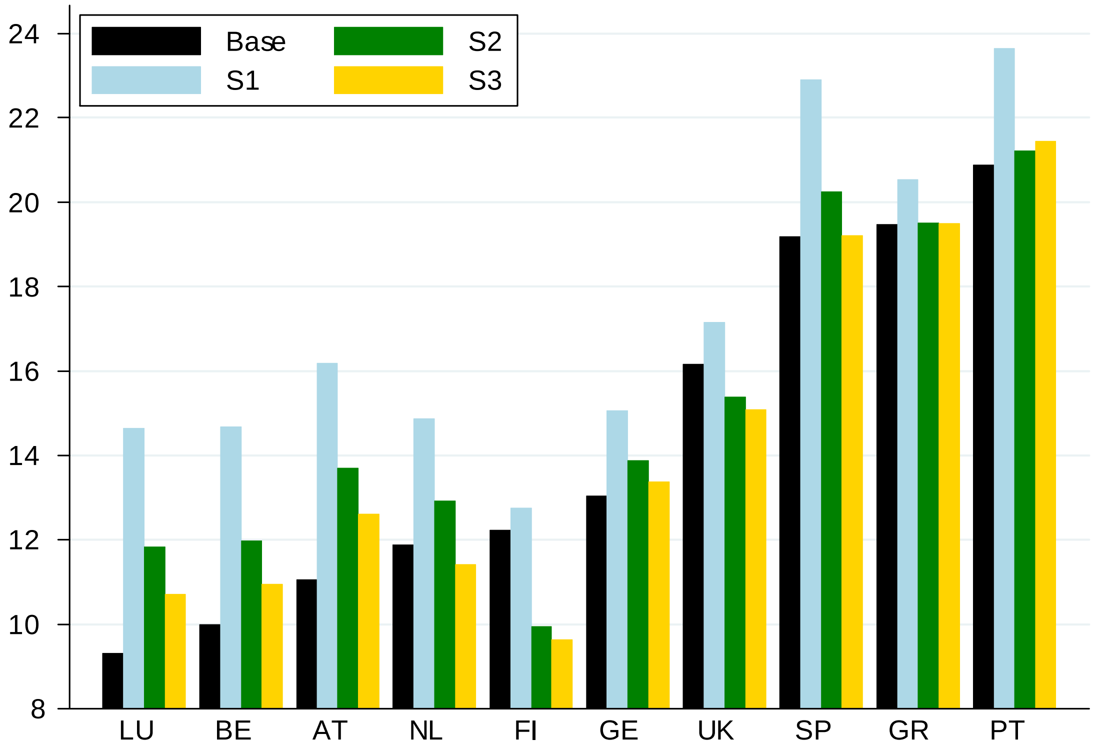

Figure 5.3.2: Poverty rates by headcount ratio (with constant poverty line), %

Again, there are already distinct differences between the analysed countries in the baseline. The same two groups of countries can be distinguished: poverty and richness (like inequality) is rather high in Southern European countries (Greece, Portugal and Spain) and the UK, and it is rather low in Continental Europe (Austria, Belgium Germany, Luxembourg) and Finland.

Poverty increases in terms of all measures in all scenarios compared to the baseline, except for the Netherlands in S3 and Finland and the UK in S2 and S3. When analysing poverty, one has to take into account that the lowest deciles of the income distribution seldom pay income taxes. Therefore, a reduction in income poverty through reduced marginal tax rates is naturally restricted. The pattern of changes in richness measures matches closely the inequality measures, i.e. increasing richness in the first scenario for all countries and measures, decreasing

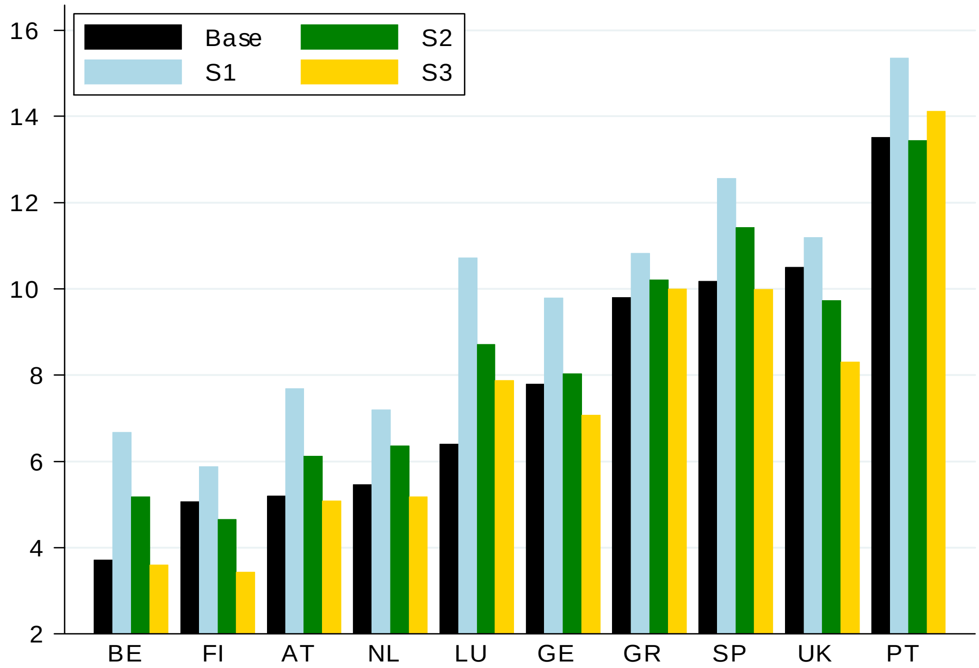

Figure 5.3.3: Richness rates by headcount ratio (with constant richness line), %

richness for Finland and the UK in the second scenario relative to the baseline and additionally for Belgium and Germany in the third scenario. These effects differ slightly when using more sophisticated richness measures (R_α) that also account for changes in the dimension of richness and not only the number of people above a richness line. Richness is then also decreasing for Portugal and Greece in S3.

The polarisation of the income distribution is also high in Southern countries and the UK and low in Continental Europe and Finland. A high income polarisation describes the phenomenon of a declining middle class resulting in an increasing gap between rich and poor. Therefore, the middle class is of less importance in the Southern countries and the UK. And indeed, in these countries, which have high baseline values of inequality, inequality decreases in scenario S3 (and S2 in the UK). The polarisation increases in most countries and scenarios (except for Finland and the UK in S2 and S3) implying a further declining middle class (see Table 5.5.2 in Appendix 5.5.1). This measure is therefore summarising the effects on poverty and richness.

5.3.2 Redistribution

To analyse the impact of flat tax reforms on the redistributive effects of the tax system we compute several measures of tax progression.[15] Figure 5.3.4 presents the values for the Kakwani index. In terms of progression the differences between the analysed countries in the baseline scenario are rather small. Therefore it is not that easy to distinguish homogeneous groups and they are different compared to the previous clustering. Progression is rather low in the Netherlands, Belgium, Luxembourg and Finland, average in Austria, Greece and Spain whereas it is rather high in the UK, Portugal and Germany. Tax progression decreases under scenario S1 with a low tax rate in all countries in comparison to the baseline scenario. The values for scenario S2 and S3 depend on the country. Nevertheless the scenarios can be ranked in terms of all indices of progression in the following way: $I_{PR}(S1) < I_{PR}(S2) < I_{PR}(S3)$.

Overall, the introduction of a revenue neutral tax reform always yields winners as well as losers. Different groups of taxpayers are differently affected by tax schedule flattening and tax base broadening.[16] In the first scenario with the lowest tax rates the gains are solely concentrated in the top 1-2 deciles (only in Belgium also involving 7th and 8th decile). In the second scenario some 9th deciles start losing instead of gaining; in the case of Finland and the UK the top decile is losing as well while the bottom and middle deciles start gaining. In the third scenario only three countries are left with gains for the top decile (Luxembourg, the Netherlands and Spain). In addition to Finland and the UK, Greece, the Netherlands, Portugal and Spain also show gains for the lowest deciles. Germany under the third scenario is an exceptional case as only the middle income deciles

[15] We compute the measure of effective progression by Musgrave and Thin (1948) ($P_{MT} = \frac{1-G_Y}{1-G_X}$), the indices of disproportionality by Kakwani (1977) ($P_K = C_T - G_X$) and Suits (1977) (P_S) as well as the redistributive effect (of taxes) by Reynolds and Smolensky (1977) ($P_{RS} = G_X - C_Y$) (with Y disposable income, X gross income, T taxes, G Gini coefficient and C coefficient of concentration). See Table 5.5.4 in Appendix 5.5.2 for the detailed results

[16] See Table 5.5.3 in Appendix 5.5.2 for the effect in terms of changes in mean disposable income by deciles. The range of changes is somewhat higher for the first (from -9.7% to +12.1%) and the third scenario (-13.1% to 8.0%) compared with the second scenario (-5.5% to 6.2%).

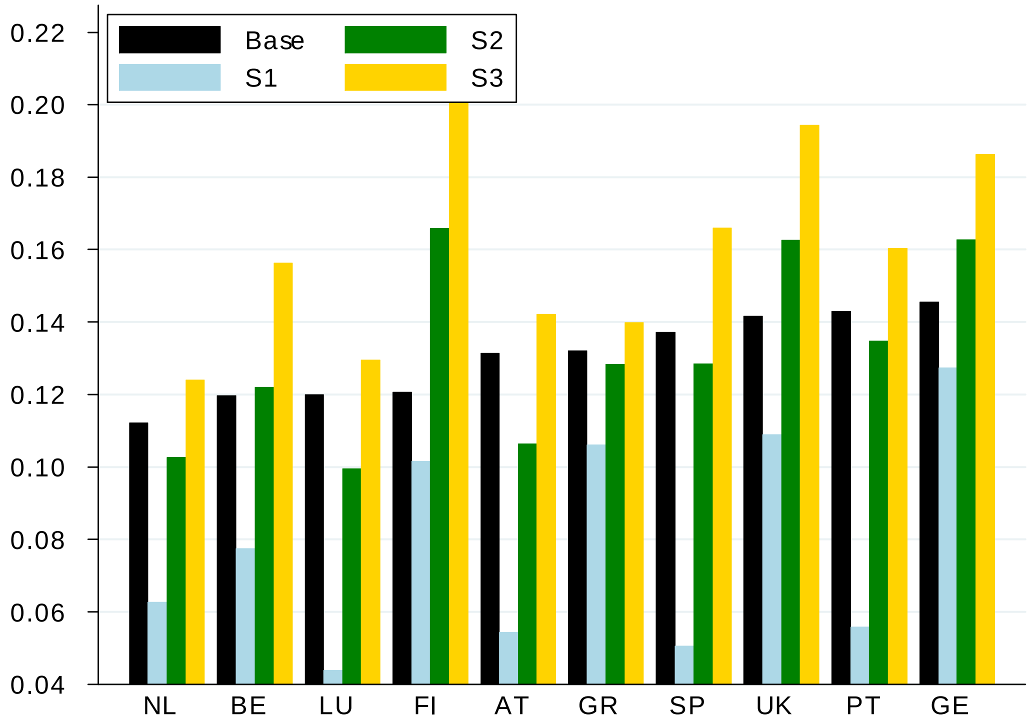

Figure 5.3.4: Tax progression by Kakwani index

gain. Although in a number of cases the gains are quite widespread and involve the middle income groups, the resulting flat tax rates are very high (40-55%). The only plausible cases are Portugal in S3 and the UK in S2 resulting in eight deciles gaining in disposable income with 31.6% and 32.5% flat rate tax respectively. This is similar to Iceland which currently has the highest flat tax (33%).

The changes in mean disposable income are increasing (decreasing) with flat tax parameters (i.e. marginal tax rate and basic allowance) for low (high) income households. In other words, the lower (higher) the flat tax parameters the higher (lower) are the gains (losses) for high (low) income households. In most countries the relative losses in terms of disposable income remain high (or are even highest) for middle income households. These groups, however, usually play an important role in the political process of a mature welfare state. Thus, these effects might explain why a flat tax is not very popular in Western Europe.[17]

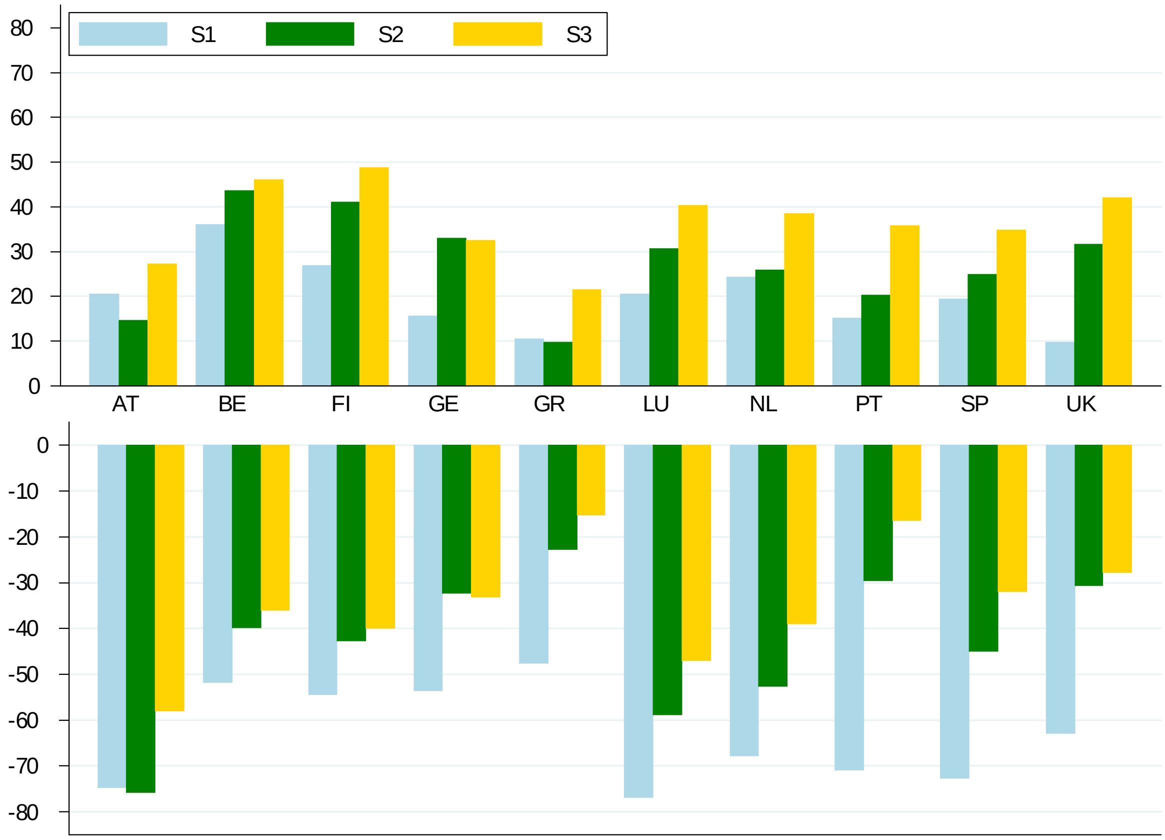

Figure 5.3.5: Share of winners and losers, %

Figure 5.3.5 summarises gainers and losers[18] by presenting the exact shares for each, which differ considerably between countries and scenarios. There are more losers than winners in every country under the first scenario. Belgium, Finland and Germany show about the same share of winners and losers under the second scenario, while Greece, Portugal and the UK have most of the people with unchanged income. In the third scenario, only Austria and Luxembourg have still more losers; Germany, the Netherlands and Portugal have again roughly the same

[17] Fuest et al. (2007d) for Germany and Caminada and Goudswaard (2001) for the Netherlands find similar results for comparable scenarios.

[18] Households whose disposable income does not change more than 10 Euros per month in either direction are regarded as „unchanged". See also Table 5.5.4 in Appendix 5.5.2.

share of those gaining and losing and most people in Greece remain still in the 'no-change' category. The highest fraction of winners appears in Belgium and Finland for all scenarios and it is increasing over scenarios for most countries (except for Austria, Germany and Greece). If disposable income was chosen as the only criterion for an election decision, only the third flat tax scenario would have a majority (in the sense of more winners than losers) in the population for most countries.

5.3.3 Efficiency: effective average and marginal tax rates

In this section, we analyse the effects of flat tax reforms on the effective marginal (EMTR) and average (EATR) income tax rates faced by different groups of taxpayers as a measure for efficiency effects. The underlying idea is that average and marginal income tax rates affect labour supply and savings incentives. Therefore, changes in effective income tax rates may be considered as rough indicators for distortions caused by the tax system. Changes in effective average tax rates are of special interest for the extensive labour supply margin which seems to be more important for particular subgroups at the bottom of the income distribution than the intensive margin which is affected by the effective marginal tax rate (see Heckman (1993) and Immervoll et al. (2007)).

Effective marginal tax rates show at which rate an additional unit of income is taxed. We calculate this for the working age population (those aged 18-64) with positive employment or self-employment income, increasing earnings of each individual in the household in turn by 3% while the change in all taxes and benefits (including social insurance contributions) is observed at the household level. We use the following formula: $EMTR_i = 1 - \frac{\Delta Y_j}{d_i}$, where d_i is the income increment for individual i and Y_j disposable income of household j where this individual belongs to. Effective average tax rate is also calculated for the working age population but further limited to those with employment income but no self-employment or replacement incomes (e.g. pensions, unemployment or maternity benefits). We compute this at the individual level as a proportion of total taxes (including SICs) to market income: $EATR_i = \frac{T_i}{X_i}$, where T_i is total tax payments and X_i the market income of individual i.

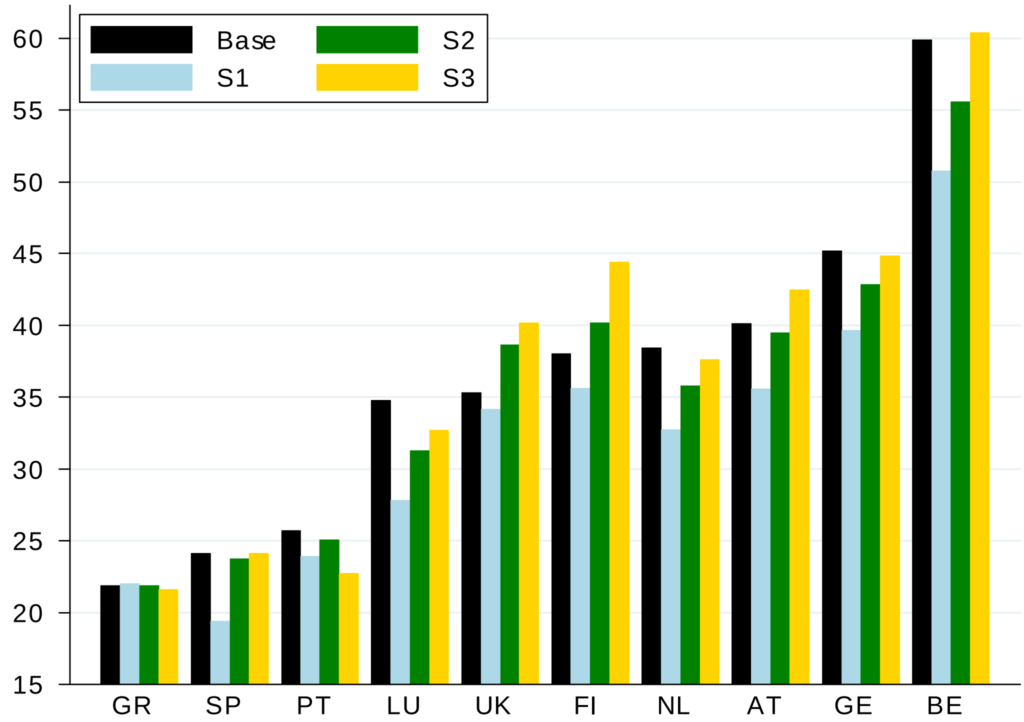

Figure 5.3.6: Effective marginal tax rates (mean), %

Figures 5.3.6 and 5.3.7 present EMTRs and EATRs for the flat tax scenarios.[19] Both measures already differ distinctively in the baseline scenario across countries. This can be attributed to several factors like, for example, the overall size of the government (and therefore the demand for public funds) and the general tax mix (i.e. the importance of the income tax) as well as economic differences between the countries. Mediterranean countries with the lowest EMTRs and EATRs have rather low income levels as well as the lowest relative levels of income taxation and social insurance contributions resulting in high inequality and polarisation of the income distribution. Finland and the UK which have average ETRs attribute much more importance to the income tax whereas social insurance contributions are relatively low. These social insurance contributions, however, play an important role in financing the Continental European welfare states where SIC are almost as

[19]See Tables 5.5.6 and 5.5.7 in the appendix for the detailed results.

high as income taxes.[20]

The effective marginal tax burden is rather low in Mediterranean countries like Greece, Spain and Portugal; average in Luxembourg, UK, Finland and the Netherlands, and rather high in Austria, Germany and Belgium. The scenarios can be ranked in the following (for most countries): $EMTR(S1) < EMTR(S2) < EMTR(S3)$. Therefore, effective marginal rates are increasing with statutory rates although revenue is kept constant. In scenario S1 the EMTRs decrease in all countries in comparison to the baseline, scenarios S2 and S3 depend on the country.

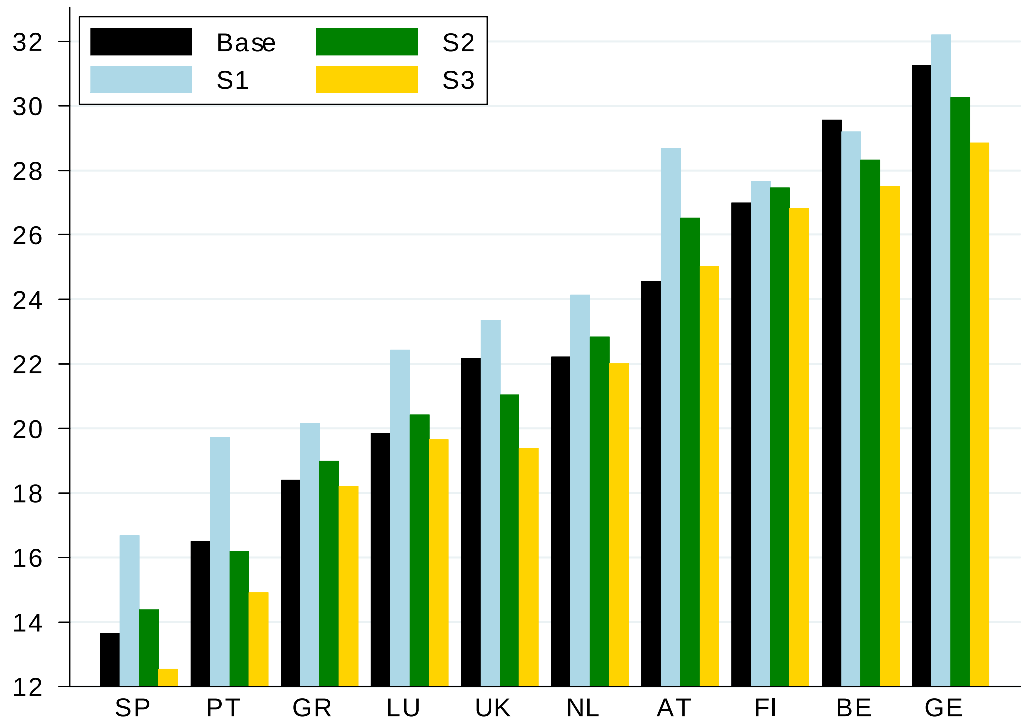

Figure 5.3.7: Effective average tax rates (mean)

The effective average tax burden is rather low in Spain, Portugal, Greece, and Luxembourg, average in UK, the Netherlands, and Austria and rather high in Finland, Belgium and Germany. The scenarios can be ranked in the following: $EATR(S1) > EATR(S2) > EATR(S3)$. Therefore, increasing the allowance

[20] See Table 4.3.1 in for further information.

dominates the increase in (statutory) marginal rate and leads to decreasing EATRs although the revenue is kept constant. In scenario S1 the EATRs increase in all countries (except BE) in comparison to the baseline, scenario S3 is always lower and S2 depends on the country.

To sum up, flat tax rates required to attain revenue neutrality with existing personal allowances (the first scenario) decrease EMTRs in all countries leading to increasing labour supply incentives.[21] On the other hand, (revenue neutral) flat rates necessary to keep the inequality levels close to their baseline values (the third scenario) lead to ambiguous effects. Incentives improve in Mediterranean and most Continental countries but worsen in other countries.

5.3.4 Summary of results

The effects of the different scenarios differ considerably between countries and are summarised in Table 5.3.1. Different groups can be classified according to the welfare state typology. In the Nordic and Anglo-Saxon countries inequality increases (and progression decreases) only in scenario S1. In the Southern European countries inequality increases in scenarios S1 and S2 whereas progression decreases in S1 (and S2 in Spain). In Continental Europe inequality increases (and progression decreases) in all three scenarios (except Germany). In general, the effects of a flat tax reform also differ with changes in the marginal tax rate and the basic tax allowance. Incentives increase in all countries for scenarios S1 and S2 (except FI, UK) as well as for Mediterranean and Continental countries in scenario S3.

Our analysis shows that the selection of the schedule and tax base parameters is crucial for the effects of flat tax reforms in terms of equity and efficiency. Low parameter values that attain revenue neutrality with existing personal allowances decrease EMTRs and therefore increase labour supply incentives. This, however, leads to more inequality, poverty and polarisation as low rates benefit mainly those with high incomes at the expense of low and middle income households. On the

[21] One should note, however, that higher incentives do not necessarily lead to higher labour supply and welfare depending on the directions of the income and substitution effects based on the respective labour supply elasticities. However, recent studies for the Netherlands by Jacobs et al. (2007) and Germany by Fuest et al. (2007d) are comparable with our scenarios S1 and S2. In summary, these studies find and increase in labour supply (and inequality) for scenario S1, whereas in scenario S2 inequality is held constant resulting in negligible efficiency effects.

	Inequality			Progression			Poverty			Richness			EMTRs		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
AT	+	+	+	-	-	(-)	+	+	+	+	+	(+)	-	-	+
BE	+	+	(~)	-	(-)	(-)	+	+	+	+	+	-	-	-	+
FI	+	-	-	-	+	+	(+)	-	-	+	-	-	-	+	+
GE	+	+	(-)	-	(-)	+	+	+	+	+	+	-	-	-	-
GR	+	+	-	-	-	(+)	+	(~)	(~)	+	+	(~)	(~)	(~)	(~)
LU	+	+	+	-	-	(-)	+	+	+	+	+	+	-	-	-
NL	+	+	+	-	-	(~)	+	(+)	-	+	+	(+)	-	-	-
PT	+	+	-	-	-	+	+	+	(+)	+	+	+	-	-	-
SP	+	+	(~)	-	-	(-)	+	+	+	+	+	(-)	-	-	(~)
UK	+	-	-	-	+	+	+	-	-	+	-	-	-	+	+

Table 5.3.1: Summary of simulation results
Note: the symbols have the following meanings: + / - : significant increase (decrease) in all measures considered, (+) / (-): significant increase (decrease) in most measures, (~): ambiguous results or no significant changes.

other hand, higher flat rates keep the inequality levels unchanged. However, this does not necessarily imply strong disincentive effects for all countries. In fact, for some countries the EMTRs decrease in all three scenarios resulting in increasing incentives even in for scenario S3 with a high marginal rate.[22]

5.4 Conclusion

Flat income taxes have become increasingly popular recently, especially in Eastern Europe. However, this popularity has not yet reached Western European countries with well-established middle classes. Using EUROMOD we provide a microsimulation analysis of different flat tax designs for selected Western European countries in a common framework. Overall, our analysis could contribute to explaining why flat taxes have not been politically successful in Western Europe so far. This also suggests which countries would most likely introduce such reforms next.

In general, a revenue neutral flat tax reform cannot overcome the fundamental

[22] Our results are in line with recent findings by others: e.g. similar to our scenario S1 for UK by Adam and Browne (2006), Belgium by Decoster and Orsini (2007) and for Spain by González-Torrabadella and Pijoan-Mas (2006); analyses for the Netherlands by Jacobs et al. (2007) and Germany by Fuest et al. (2007d) are also comparable with our scenarios S1 and S2.

equity efficiency trade-off, i.e. equality and incentives move into different directions. However, in some cases an increase in both equity and incentives is possible (e.g. Greece, Portugal and Spain). These countries have the Southern welfare state regime in common which is characterised by high inequality, poverty, richness and polarisation of the income distribution. These distributional characteristics imply a lack of a well-established middle class. Therefore, the distributional effects are less adverse than in countries with a more equal income distribution. Switching to a flat tax regime in this setting can reduce inequality and increase efficiency in terms of labour supply incentives.

When interpreting these results, one has to be aware of the fact that we limit our analysis to static models. However, flat rate taxes are also supposed to have positive dynamic efficiency and growth effects.[23] As a result of these positive efficiency effects increasing inequality might be acceptable. Nevertheless, the question arises whether a personal income tax reform is the best instrument to increase growth and employment. The user costs of labour and capital play an important role in determining the demand for labour and investment. These user costs, however, are rather determined by social security contributions and corporate taxes than by personal income tax.

Nevertheless, the immediate and short-term distributional effects analysed in this paper are most likely to be decisive for the political feasibility of a flat tax reform. The main problem of implementing a flat rate tax could be to convince a majority of the population that redistribution in favour of the highest income decile is acceptable. These distributional effects at the expense of the middle class help to explain why flat rate taxes have not been successful in the political process in Western Europe. However, our analysis shows that for some Mediterranean countries with a highly polarised income distribution a flat tax can increase both equity and efficiency. Therefore, an implementation of a flat tax regime seems most likely in these and other countries with similar income distributions (i.e. high polarisation) and institutional structures (i.e. Southern welfare state regime).

[23] Cf. Stokey and Rebelo (1995) or Cassou and Lansing (2004).

5.5 Appendix

5.5.1 Inequality, poverty and richness

	PL	FGT0 (HCR)				FGT1				FGT2			
		Base	S1	S2	S3	Base	S1	S2	S3	Base	S1	S2	S3
AT	859.22	11.06	16.19	13.70	12.61	1.93	2.97	2.45	2.25	0.58	0.87	0.73	0.69
BE	809.52	10.00	14.68	11.97	10.94	3.39	4.10	3.74	3.63	1.99	2.25	2.16	2.14
FI	838.33	12.24	12.76	9.95	9.64	2.17	2.17	1.75	1.74	0.63	0.60	0.52	0.52
GE	801.56	13.04	15.06	13.88	13.38	2.74	3.00	2.84	2.81	0.97	1.02	1.00	1.00
GR	437.40	19.48	20.54	19.51	19.50	6.36	6.50	6.37	6.36	3.34	3.37	3.34	3.34
LU	1,274.24	9.31	14.64	11.83	10.72	1.10	2.09	1.46	1.30	0.25	0.46	0.31	0.28
NL	871.00	11.87	14.87	12.93	11.41	2.37	2.82	2.42	2.28	1.20	1.30	1.19	1.16
PT	347.43	20.89	23.65	21.22	21.44	4.75	5.59	4.78	4.71	1.40	1.71	1.40	1.38
SP	548.13	19.18	22.89	20.26	19.21	5.40	6.78	5.75	5.41	2.47	3.03	2.58	2.47
UK	575.07	16.17	17.16	15.38	15.08	3.00	3.13	2.90	2.88	1.05	1.08	1.03	1.03

	RL	R0 (HCR)				R1				R2			
		Base	S1	S2	S3	Base	S1	S2	S3	Base	S1	S2	S3
AT	2,864.06	5.19	7.68	6.12	5.08	1.02	1.83	1.40	1.03	0.35	0.70	0.51	0.36
BE	2,698.39	3.72	6,67	5.17	3.61	0.78	1.37	0.97	0.72	0.32	0.51	0.37	0.28
FI	2,794.42	5.06	5.88	4.65	3.43	1.23	1.52	1.12	0.79	0.53	0.65	0.47	0.33
GE	2,671.85	7.79	9.79	8.03	7.07	1.48	2.16	1.66	1.29	0.46	0.76	0.55	0.39
GR	1,458.00	9.81	10.82	10.21	10.00	2.24	2.77	2.46	2.23	0.82	1.13	0.95	0.80
LU	4,247.46	6.41	10.72	8.71	7.88	1.22	2.37	1.86	1.51	0.38	0.86	0.63	0.47
NL	2,905.09	5.46	7.20	6.36	5.18	0.96	1.63	1.28	1.01	0.29	0.59	0.44	0.34
PT	1,158.09	13.51	15.36	13.44	14.12	4.16	5.31	4.34	4.00	1.83	2.59	1.98	1.69
SP	1,827.09	10.18	12.57	11.42	9.99	2.12	3.26	2.60	2.11	0.70	1.25	0.93	0.71
UK	1,921.48	10.51	11.19	9.73	8.30	2.40	2.86	2.23	1.76	0.87	1.12	0.83	0.61

Table 5.5.1: Poverty and richness lines and rates
Sources: own calculation using EUROMOD version C13.
Note: PL: poverty line, FGTα: Foster et al. (1984) poverty measure.
RL: richness line, Rα: Peichl et al. (2006) richness measure.

	Gini				GE0				GE1				PS			
	Base	S1	S2	S3	Base	S1	S2	S3	Base	S1	S2	S3	Base	S1	S2	S3
AT	0.239	0.277	0.257	0.243	0.095	0.127	0.110	0.099	0.102	0.143	0.122	0.106	0.228	0.259	0.242	0.231
BE	0.246	0.281	0.262	0.247	0.108	0.128	0.112	0.101	0.116	0.142	0.121	0.105	0.231	0.270	0.251	0.237
FI	0.269	0.278	0.251	0.231	0.127	0.134	0.112	0.096	0.175	0.186	0.151	0.122	0.243	0.251	0.224	0.206
GE	0.268	0.289	0.275	0.265	0.119	0.137	0.125	0.117	0.120	0.144	0.128	0.117	0.261	0.277	0.267	0.262
GR	0.322	0.336	0.326	0.321	0.191	0.205	0.195	0.189	0.175	0.198	0.183	0.173	0.305	0.310	0.306	0.304
LU	0.243	0.283	0.264	0.252	0.094	0.127	0.110	0.101	0.099	0.139	0.119	0.107	0.242	0.275	0.258	0.249
NL	0.247	0.274	0.258	0.248	0.103	0.126	0.113	0.105	0.102	0.132	0.116	0.105	0.245	0.265	0.251	0.244
PT	0.361	0.393	0.367	0.356	0.211	0.250	0.218	0.206	0.229	0.282	0.240	0.220	0.321	0.335	0.322	0.323
SP	0.311	0.348	0.325	0.312	0.177	0.216	0.191	0.178	0.167	0.216	0.188	0.169	0.293	0.319	0.302	0.295
UK	0.307	0.321	0.303	0.292	0.153	0.167	0.151	0.140	0.166	0.189	0.166	0.149	0.298	0.302	0.293	0.289

Table 5.5.2: Income inequality

Sources: own calculation using EUROMOD version C13.

Note: GEc indices of the generalised entropy (GE) family, PS: polarisation index of Schmidt (2004).

5.5.2 Distribution of tax payments and disposable income

	AT			BE			FI			GE			GR		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
1	-8.01	-4.44	-2.79	-7.05	-3.68	-2.46	0.70	5.27	5.83	-1.18	-0.54	-0.51	-0.13	0.01	0.01
2	-9.70	-5.51	-2.73	-8.19	-4.09	-1.34	-1.47	4.80	7.98	-3.62	-1.19	-0.05	-1.29	-0.04	0.08
3	-8.22	-4.76	-1.73	-9.01	-5.07	-1.15	-1.51	3.96	7.72	-5.14	-1.40	0.97	-1.90	-0.40	0.22
4	-7.51	-4.44	-1.68	-6.48	-2.98	0.21	-1.72	2.54	6.17	-4.76	-1.46	1.05	-2.66	-0.66	0.47
5	-6.04	-3.53	-1.24	-4.38	-1.19	1.59	-1.90	0.51	3.07	-4.32	-1.84	0.53	-2.65	-0.95	0.22
6	-4.73	-3.04	-0.99	-1.59	-0.30	1.22	-1.90	-0.71	1.01	-3.49	-1.12	1.20	-2.89	-1.43	-0.26
7	-3.42	-2.57	-1.47	0.27	0.79	1.75	-1.35	-1.36	-0.67	-2.64	-1.27	0.31	-2.90	-1.39	-0.21
8	-1.70	-1.85	-1.27	2.26	1.31	0.81	-1.13	-2.26	-2.56	-1.59	-1.14	-0.34	-2.01	-0.96	0.11
9	1.21	-0.45	-1.19	4.24	2.28	1.00	0.07	-2.58	-4.41	0.70	-0.88	-1.88	-1.71	-0.94	0.38
10	11.57	5.16	-0.52	9.26	2.63	-3.49	3.62	-5.01	-13.13	7.38	2.02	-2.68	6.88	2.51	-0.89
	LU			NL			PT			SP			UK		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
1	-8.08	-2.64	-1.13	-3.41	0.14	1.29	-3.66	0.10	0.21	-7.59	-0.82	0.26	-0.58	0.54	0.66
2	-9.15	-4.36	-2.11	-4.34	-1.05	0.70	-5.38	-0.34	0.42	-9.22	-2.89	0.05	-1.32	1.44	2.54
3	-8.16	-3.99	-1.54	-5.09	-1.66	0.11	-6.42	-1.69	-0.30	-8.08	-3.05	0.15	-1.99	1.43	3.23
4	-8.75	-5.23	-2.94	-4.60	-2.16	-0.43	-6.45	-0.35	0.89	-7.51	-3.43	-0.84	-2.24	1.80	4.27
5	-7.92	-5.30	-3.51	-3.86	-2.08	-0.53	-6.08	-0.69	1.30	-5.76	-2.36	0.41	-2.45	1.15	4.21
6	-6.10	-4.61	-2.79	-2.50	-1.59	-0.41	-6.57	-0.88	1.78	-5.30	-2.53	-0.12	-2.40	0.50	3.17
7	-4.58	-4.42	-3.73	-2.53	-2.08	-1.10	-5.82	-1.02	1.77	-2.65	-1.34	0.28	-2.15	-0.07	2.45
8	-2.65	-2.97	-2.51	-0.88	-1.21	-1.03	-4.07	-1.60	1.84	-0.81	-1.20	-0.69	-1.42	-0.85	0.31
9	2.63	0.45	-0.46	1.37	-0.10	-0.73	0.06	-1.08	0.95	1.76	-0.16	-0.67	-0.48	-1.60	-1.61
10	12.05	6.16	1.51	9.75	4.91	0.95	11.24	2.59	-2.99	11.79	5.19	0.05	6.23	-0.26	-5.77

Table 5.5.3: Changes in disposable income by income decile, %
Sources: own calculation using EUROMOD version C13.

	Musgrave-Thin				Kakwani				Reynolds-Smolensky				Suits			
	Base	S1	S2	S3	Base	S1	S2	S3	Base	S1	S2	S3	Base	S1	S2	S3
AT	1.102	1.041	1.085	1.116	0.131	0.054	0.106	0.142	0.046	0.019	0.039	0.052	0.200	0.068	0.150	0.215
BE	1.104	1.071	1.115	1.149	0.120	0.078	0.122	0.156	0.043	0.029	0.047	0.060	0.193	0.122	0.201	0.267
FI	1.088	1.075	1.127	1.164	0.121	0.102	0.166	0.208	0.042	0.035	0.060	0.078	0.163	0.126	0.223	0.294
GE	1.095	1.082	1.111	1.129	0.146	0.127	0.163	0.186	0.048	0.041	0.056	0.065	0.189	0.150	0.212	0.258
GR	1.082	1.065	1.080	1.087	0.132	0.106	0.128	0.140	0.030	0.024	0.029	0.032	0.254	0.176	0.238	0.277
LU	1.072	1.027	1.064	1.083	0.120	0.044	0.100	0.130	0.029	0.011	0.025	0.033	0.217	0.071	0.175	0.241
NL	1.084	1.046	1.078	1.095	0.112	0.063	0.103	0.124	0.036	0.020	0.034	0.041	0.160	0.053	0.127	0.174
PT	1.090	1.034	1.085	1.101	0.143	0.056	0.135	0.160	0.031	0.012	0.029	0.034	0.277	0.084	0.245	0.318
SP	1.090	1.033	1.085	1.110	0.137	0.051	0.128	0.166	0.029	0.011	0.028	0.036	0.287	0.078	0.244	0.346
UK	1.094	1.072	1.109	1.131	0.142	0.109	0.163	0.194	0.039	0.030	0.046	0.055	0.219	0.147	0.248	0.319

Table 5.5.4: Tax progression
Sources: own calculation using EUROMOD version C13.

	S1			S2			S3		
	W	0	L	W	0	L	W	0	L
AT	20.52	4.67	74.81	14.62	9.56	75.81	27.14	14.87	57.99
BE	36.04	12.18	51.78	43.67	16.46	39.87	46.04	17.86	36.10
FI	26.78	18.77	54.44	41.06	16.14	42.79	48.72	11.22	40.06
GE	15.58	30.84	53.58	33.08	34.55	32.38	32.54	34.20	33.26
GR	10.44	41.87	47.69	9.71	67.51	22.78	21.46	63.26	15.28
LU	20.46	2.62	76.92	30.69	10.43	58.88	40.29	12.69	47.03
NL	24.26	7.85	67.89	25.79	21.61	52.60	38.55	22.39	39.06
PT	15.08	13.97	70.95	20.26	50.19	29.55	35.88	47.64	16.48
SP	19.40	7.79	72.81	24.91	30.07	45.02	34.88	33.02	32.10
UK	9.79	27.37	62.85	31.71	37.66	30.63	42.08	30.14	27.78

Table 5.5.5: Share of winners and losers, %
Note: category '0' refers to disposable income changes less than 10 euros per month.
Sources: own calculation using EUROMOD version C13.

5.5.3 Efficiency: effective average and marginal tax rate

		AT	BE	FI	GE	GR	LU	NL	PT	SP	UK
Base	median	26.56	33.39	27.41	33.70	19.45	17.73	26.55	13.92	13.62	24.71
	mean	24.56	29.55	27.00	31.27	18.41	19.86	22.23	16.49	13.65	22.18
S1	median	31.61	32.87	30.01	36.87	21.56	22.44	28.78	19.85	18.80	26.10
	mean	28.69	29.20	27.67	32.21	20.15	22.43	24.13	19.73	16.67	23.36
S2	median	29.55	32.48	29.89	31.92	19.45	20.90	29.13	13.52	15.21	23.82
	mean	26.54	28.33	27.46	30.25	18.99	20.42	22.85	16.20	14.39	21.05
S3	median	26.02	31.37	28.81	26.56	19.45	17.74	26.76	11.00	8.60	19.23
	mean	25.03	27.52	26.83	28.85	18.21	19.66	22.02	14.92	12.53	19.39

Table 5.5.6: Effective average tax rates at the individual level
Sources: own calculation using EUROMOD version C13.
Note: EATR defined as (Income tax + SIC) / (market income). Includes individuals aged 18-64 with employment income but no self-employment and replacement incomes

		AT	BE	FI	GE	GR	LU	NL	PT	SP	UK
Base	median	41.04	51.02	43.40	50.01	19.45	35.46	45.36	23.00	28.83	31.40
	mean	40.16	59.90	38.07	45.20	21.87	34.76	38.45	25.72	24.11	35.30
	< 0	0.00	0.16	0.36	0.25	0.00	0.03	2.76	0.01	0.04	0.00
	[0-0.1)	6.33	0.50	11.97	8.48	24.17	0.58	5.46	8.86	21.26	4.42
	[0.1-0.2)	11.51	1.93	5.77	1.34	32.39	21.30	0.46	28.84	4.62	1.55
	[0.2-0.3)	0.88	0.90	7.55	7.93	10.31	18.18	10.80	29.47	44.37	9.47
	[0.3-0.4)	12.51	4.47	13.99	11.70	11.04	25.55	10.38	17.61	25.75	61.61
	[0.4-0.5)	59.94	25.54	41.56	20.24	21.26	29.59	56.96	11.49	3.59	12.13
	[0.5-0.6)	6.05	57.85	16.10	40.88	0.82	1.40	8.45	0.38	0.03	1.07
	[0.6-0.7)	0.10	0.63	0.58	6.02	0.00	0.03	0.78	0.02	0.06	4.23
	[0.7-0.8)	0.06	0.43	0.64	1.87	0.00	0.14	0.55	0.16	0.02	3.01
	[0.8-0.9)	0.06	0.50	0.16	0.14	0.00	0.00	0.57	1.42	0.02	1.03
	[0.9-1)	0.04	0.75	0.09	0.02	0.00	0.24	0.29	1.46	0.01	0.39
	> 1	2.52	6.34	1.23	1.12	0.02	2.95	2.56	0.27	0.23	1.09
S1	median	35.37	40.54	39.62	45.98	21.40	26.85	33.26	21.32	22.88	31.90
	mean	35.59	50.76	35.60	39.66	22.02	27.84	32.76	23.92	19.43	34.17
	< 0	0.00	0.09	0.02	0.25	0.00	0.00	2.71	0.01	0.04	0.00
	[0-0.1)	3.98	0.98	14.64	12.02	19.94	0.52	4.77	3.54	7.92	4.36
	[0.1-0.2)	0.39	2.38	0.68	0.69	16.40	16.72	15.43	15.97	37.82	0.13
	[0.2-0.3)	10.71	0.11	0.91	21.71	25.30	76.18	23.34	57.33	53.90	18.77
	[0.3-0.4)	78.28	28.80	76.78	6.11	37.69	3.31	16.70	19.44	0.01	64.96
	[0.4-0.5)	3.31	57.60	3.19	47.02	0.65	0.00	7.72	0.13	0.01	1.04
	[0.5-0.6)	0.05	0.49	0.48	6.76	0.00	0.11	24.28	0.24	0.03	0.30
	[0.6-0.7)	0.00	0.60	0.86	1.29	0.00	0.05	0.81	0.00	0.00	4.25
	[0.7-0.8)	0.07	0.53	0.84	2.80	0.00	0.05	0.69	0.07	0.05	3.53
	[0.8-0.9)	0.09	0.26	0.37	0.14	0.00	0.08	0.44	1.27	0.01	1.05
	[0.9-1)	0.22	1.39	0.06	0.01	0.00	0.56	0.50	0.87	0.02	0.51
	> 1	2.91	6.78	1.16	1.19	0.02	2.42	2.61	1.12	0.20	1.10
S2	median	43.62	49.23	49.16	49.87	19.45	35.94	32.27	21.60	27.65	41.90
	mean	39.52	55.57	40.19	42.85	21.89	31.29	35.78	25.08	23.76	38.65
	< 0	0.00	0.09	0.02	0.10	0.00	0.00	2.71	0.01	0.04	0.00
	[0-0.1)	6.24	1.82	20.58	14.39	25.90	0.66	5.23	4.72	24.35	10.95
	[0.1-0.2)	10.22	6.79	0.92	0.97	31.22	26.48	0.26	37.69	0.30	3.85
	[0.2-0.3)	0.77	0.10	0.74	13.47	1.03	9.93	27.07	10.62	28.67	0.98
	[0.3-0.4)	10.40	0.25	1.01	17.58	18.63	56.85	31.91	32.82	46.34	17.96
	[0.4-0.5)	69.77	74.16	71.52	5.15	22.72	2.92	2.35	10.57	0.00	57.70
	[0.5-0.6)	0.00	8.40	2.44	29.49	0.47	0.05	25.39	0.07	0.03	0.78
	[0.6-0.7)	0.06	0.29	0.52	15.66	0.00	0.00	0.84	0.16	0.05	0.49
	[0.7-0.8)	0.06	0.46	0.59	1.08	0.00	0.09	0.80	0.16	0.00	3.16
	[0.8-0.9)	0.08	0.61	0.56	0.90	0.00	0.09	0.48	1.40	0.00	2.57
	[0.9-1)	0.03	0.57	0.12	0.08	0.00	0.24	0.36	1.45	0.04	0.48
	> 1	2.37	6.46	0.99	1.13	0.02	2.69	2.60	0.33	0.18	1.07
S3	median	51.66	57.93	58.70	49.59	19.45	38.52	39.00	11.00	37.65	49.20
	mean	42.49	60.42	44.41	44.85	21.62	32.70	37.64	22.74	24.11	40.18
	< 0	0.00	0.09	0.03	0.06	0.00	0.00	2.73	0.01	0.04	0.00
	[0-0.1)	6.42	1.87	25.08	15.44	28.59	0.72	5.46	8.04	43.05	20.26
	[0.1-0.2)	20.17	11.39	1.12	2.19	38.88	40.92	0.22	58.13	0.49	6.70
	[0.2-0.3)	1.60	0.31	0.72	20.40	1.67	1.45	12.52	0.39	0.43	1.10
	[0.3-0.4)	0.29	0.28	1.10	1.34	0.37	9.48	36.99	23.66	23.87	1.19
	[0.4-0.5)	11.30	0.35	1.23	16.88	16.29	42.23	22.32	0.55	31.85	21.11
	[0.5-0.6)	57.69	71.99	66.93	2.36	14.18	2.10	3.79	0.04	0.00	43.76
	[0.6-0.7)	0.03	5.98	1.91	28.68	0.00	0.00	11.98	5.92	0.06	0.99
	[0.7-0.8)	0.04	0.54	0.38	10.82	0.00	0.09	0.72	0.20	0.02	0.09
	[0.8-0.9)	0.00	0.82	0.35	0.22	0.00	0.02	0.41	1.36	0.00	2.61
	[0.9-1)	0.09	0.51	0.29	0.49	0.00	0.22	0.34	1.44	0.01	1.11
	> 1	2.37	5.87	0.84	1.12	0.02	2.78	2.52	0.26	0.18	1.07

Table 5.5.7: Distribution of effective marginal tax rates by intervals (%)
Sources: own calculation using EUROMOD version C13. Note: EMTR defined as [1 – (change in hh disposable income) / (increase in individual earnings)] and includes individuals aged 18-64 with positive earnings.

Chapter 6

Concluding remarks

European welfare states are under pressure because of population ageing and globalisation. The former increases the need for public funds, whereas the latter leads to more elastic tax bases (i.e. the sources of public funds) and tends to increase unemployment especially of low-skilled workers, which in turn increases the need for public funds again. In the ongoing political debate, the complex tax benefit systems of grown-up welfare states are frequently seen as inappropriate to meet the economic challenges ahead. Therefore, fundamental reforms of the tax systems including the simple flat tax idea are often proposed. As a matter of fact, the flat tax idea has been remarkably successful recently. However, its implementation has not yet spilled over from Eastern to Western Europe.

The aim of this book was to answer several fundamental flat tax reform questions and to identify hereby the driving forces behind the economic effects of such a reform. The introduction elaborated on the fact that in practice flat taxes are not a clearly cut defined concept but several different tax systems exist that are labelled as "flat". Chapter 2 introduced the methodology for the analysis by reviewing and extending the literature on simulation models and their capability to ex-ante estimate equity and efficiency effects of fiscal reforms. Chapter 3 analysed the role of the flat tax design for the effects of three different hypothetical flat tax reforms in Germany. Chapter 4 compared the institutional background and the underlying income distribution in Western European countries. In chapter 5, the role of those country specific aspects and their relevance for the outcome of flat tax reforms were investigated by conducting a cross-country comparison of different flat tax scenarios. Our main findings and the resulting policy implications can be summarised in the following three results:

1. *"How flat is the world?"*
   The tax benefit systems in some European countries including Germany are close to linearity, whereas in other countries the systems are highly non-linear (see chapter 4). Therefore, the world (or at least Europe) is not flat, but a tendency towards flatter systems can be observed.

   Result 1: Europe is not flat, but it is getting flatter.

2. *"What effects can be expected from a flat tax reform?"*
   There is no universal answer to this question other than: "*It depends*". The outcome of a flat tax reform crucially depends on two dimensions: the flat tax design and the country-specific environment.

   (a) *"What is the role of the flat tax design?"*
   This question has been analysed with respect to tax base simplification, tax schedule parameters, revenue neutrality and the combination with a cash flow corporate income tax (see chapter 3). First, the effects of revenue neutral tax base simplification on after tax income inequality and tax distortions mainly depend on the type of tax schedule adjustment. Second, we find that a flat rate tax with a low tax rate and basic allowance yields positive static efficiency effects but increases inequality, poverty and polarisation. The increase in inequality can be avoided by combining a higher tax rate with a higher basic allowance. But, in this case, the efficiency gains vanish. Third, an ex-ante not revenue neutral flat tax reform can overcome the fundamental equity-efficiency trade-off. This, however, is true only in the long-run when taking the general equilibrium effects into account, whereas the immediate distributional effects still increase inequality. Fourth, combining a personal income flat tax with a cash flow flat tax on business income increases inequality due to the large gains at the top of the distribution.

(b) *"Do the results differ across European countries?"*
The results differ considerably across (groups of) countries. At the same time, they depend on the flat tax design (see chapters 4 and 5). On the one hand, labour supply incentives increase for low marginal rates (and allowances) in all countries, whereas for high values they increase only in Mediterranean and Continental countries. On the other hand, inequality increases for low tax rates in all countries, whereas for high parameter values it decreases in all but the Continental countries. These results indicate that there is some scope for flat taxes to overcome the fundamental equity efficiency trade-off. Therefore, the flat tax idea is most likely to have success in countries with a high existing polarisation of the income distribution, i.e. a large gap between rich and poor, whereas it will be hard to invade countries with a well established middle class.

To sum up, there is not a unique flat tax effect, i.e. the design and the type of welfare state determine the outcome of a flat tax reform. Improved incentives and decreased inequality are jointly possible, but only with specific details and in specific environments.

Result 2: Flat taxes polarise, but polarisation facilitates flat taxes.

3. *"Could or should the world be flat?"*
Introducing a flat tax gives scope for the improvement of the efficiency, equity and simplicity of the tax benefit system. However, these effects crucially depend on the details of the reform. Furthermore, "*at least some of the gains could be made simply by modifying the existing system.*"[1] Flatness of the rate schedule itself can reduce some distortions, e.g. tax arbitrage, but is unlikely to yield significant efficiency gains. Lowering tax rates will increase labour supply incentives. The size of the effects depend on the respective elasticities. In general, the labour supply elasticities are higher at the bottom of the distribution than at the top. Therefore, a progressive rate schedule would be optimal.[2] Tax base broadening and simplification have positive

[1] Gale (1999), p. 157.
[2] See e.g. Aaberge and Colombino (2006).

effects but this does not necessarily have to be combined with a flat rate schedule. The same is true for a cash flow flat tax, which can also have positive effects.

To sum up, evidence suggest that the world could be flat, i.e. the introduction of a flat tax is conceivable, but no compelling reasons that the world should be flat can be found.

Result 3: A flat world is feasible, but not necessarily desirable.

Note that there are limitations to our analysis. We model revenue neutral flat income tax reforms. If a flat tax reform allows for high losses in revenue, everybody's after-tax income could increase. However, a loss in revenue implies always a cut in government spending or the use of other financing sources. As a consequence, it is impossible to make everybody better-off, at least in the short-run. Furthermore, the personal income tax is only part of the tax mix as there are other taxes and contributions, as well. In particular, we leave social security contributions unchanged, which represent an additional tax on labour. Moreover, we do not consider effects on investment and capital accumulation, nor on human capital accumulation or on compliance costs. However, the income tax might not be the best instrument to address these issues. Even if it would be, there is no need for a flat tax reform. Other measures (within the income tax system) can be used to reduce the tax burden on capital, as well as tax evasion or avoidance.

At last, what can be learnt from our analysis is that the flatness of the tax schedule itself is not a key feature of the economic success of a tax reform. Other elements (simplification, increased compliance, corporate taxation) play a more important role. However, a flat tax reform can indeed overcome the fundamental equity efficiency trade-off. This is only true in two specific cases: first, for Mediterranean countries with highly polarised income distributions, and second, for Germany in the long-run if accounting for general equilibrium effects. Therefore, due to its adverse short-term distributional effects, the chances that the flat tax idea will invade the grown-up democracies of Western Europe are rather low. However, a further movement towards lower (marginal) tax rates with broader and simpler tax bases shall be observed. This, however, could eventually lead to tax benefit systems moving closer to linearity, albeit without an actual flat tax schedule.

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