Fiscal policy and economic growth in the presence of intergenerational transfers

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Contents

Part I

Introduction

The development of endogenous growth theory has provided many new insights into the sources of economic growth. The essence of the new theory is that growth is a consequence of rational economic decisions. [...] Consumers invest in education to develop human capital and increase lifetime earning. Governments increase growth by providing public inputs, [...] and enhancing educational opportunities. Through the aggregation of these individual decisions the rate of growth becomes a variable of choice, and hence a variable that can be affected by the tax policies of governments.

Gareth D. Myles, (2009). Economic Growth and the Role of Taxation - Aggregate Data. OECD Economics Department Working Papers No. 714.

There surely are strong reasons, in principle, to believe that policies formulated for the provision of infrastructure and even human capital that are sensitive to regional or local conditions are likely to be more effective in encouraging economic development than centrally determined policies that ignore these geographical differences.

Wallace E. Oates, (1993). Fiscal Decentralization and Economic Development. National Tax Journal, volume 46, number 2.

This thesis is entitled "Fiscal policy and economic growth in the presence of intergenerational transfers". It is composed of four self-contained chapters[1] and focusses on the growth and welfare effects of taxation and public spending. The baseline is to further investigate the two conjectures introduced above, namely *how* various tax and spending policies affect economic growth when different forms of intergenerational and intergovernmental transfers are present.

In the first and second chapter the implications of capital income taxation for the growth process are discussed. The analysis emphasizes the role of public and private intergenerational transfers in form of public pensions and bequests as well

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[1]The first chapter is co-authored by my colleague Chrisitane Schuppert and has been published in FinanzArchiv, see Kunze and Schuppert (2010) for further details. The second chapter is an extended version of a paper that has been published in the Journal of Macroeconomics, see Kunze (2010) for further details.

as intergenerational redistribution induced by public policies. As will be explained in further detail below, the presence or absence of such transfers may substantially alter the results of the previous literature.

A more general and broader interpretation of the statement of Myles to include not only private educational spending but also intergenerational transfers in form of physical capital leads to the third chapter. The focus of the analysis is on social security funding and its implications for economic growth. Whereas a pay-as-you-go pension scheme, as considered in chapter one, naturally includes intergenerational transfers from the current working generation to retirees, a fully funded social security system does not. Still, the presence of such transfers within the economy turns out to play a key role in determining the impact of funded social security on economic growth and therefore allows to establish interesting new policy implications.

In order to further inspect Oates' conjuncture that fiscal decentralization may be beneficial to the growth process, the perspective in chapter four is again broadened to encompass intergovernmental transfers between different levels of government in addition to intergenerational transfers. While the traditional theoretical literature on fiscal decentralization focusses mainly on efficiency issues, empirical evidence for a positive relationship between fiscal decentralization and economic growth turns out to be mixed. Some studies can confirm the positive impact of higher degrees of decentralization on economic growth, whereas others face difficulties in establishing a positive relationship and, in fact, obtain either no dependency or a negative one. The aim of the present chapter is therefore to further evaluate the theoretical linkage and, at the same time, to give an explanation for the discrepancy between the empirical literature.

The common denominator of all four chapters is that they incorporate an endogenous growth process in an overlapping generations model to evaluate long-term policy implications when different generations are affected in different ways by fiscal policy. In this respect, the overlapping generations framework is perfectly suited to analyze the impact of public policies related to intergenerational redistribution on economic long-run growth as the economy's development, in terms of growth, is directly related to individuals' optimizing behavior. Specifically, in case the model includes capital accumulation, the growth path of the economy is to a large extend determined by an agents' saving decision. Similarly, if the model features human capital accumulation as engine of growth, the optimal amount of resources devoted

to public and private educational funding is all important. In any case, the decisive mechanism of the overlapping generations model is the individual's decision about consumption smoothing over the life-cycle, namely the allocation of a given income towards consumption when young and savings used for old-age consumption (and also resources to be transferred to the own children). In order to obtain intuitive and explicit results, and to keep the different models analytically tractable, production functions are assumed to be of the Cobb-Douglas type throughout this thesis whereas utility functions are either CES or Cobb-Douglas. The aim of the present thesis is therefore to point out how various tax policies impact on economic growth and how such relationships may change depending on the presence of different types of intergenerational transfers, and not to give a complete characterization in its most general form. In this regard, each chapter of the present work highlights a different channel through which the effects of taxation and public spending on economic growth can be explored.

More specifically, the first chapter sets up a two period overlapping generations model where endogenous growth is ensured by the existence of externalities between firms in form of learning-by-doing. These externalities support the view that knowledge from a single firm instantly spreads across the whole economy and thus enhances the aggregate stock of capital. Moreover, the model features unemployment and a social security system comprising pensions and unemployment benefits, thereby capturing important institutional features of European economies. Given this framework, the aim of the first chapter is to investigate the growth and welfare effects of an increase of capital income taxes with additional revenue being devoted to cut wage-related social security contributions to reduce unemployment. Consequently, the analysis examines an alternative way of financing social security which, in view of the looming crisis of these systems, is highly relevant and on top of the agenda in most industrial countries. It is shown that such a reform not only promotes employment but may additionally stimulate economic growth. Calibrating the model to match data for the EU15 reveals that European countries can indeed gain in form of higher employment growth *and* welfare if the initial capital income tax is not too high.

The focus of the second chapter is still on capital income taxation but, in contrast to the first chapter, intergenerational transfers take the form of private bequests instead of public pensions. This introduces a novel channel through which capital

income taxation may effect economic growth, namely private income redistribution within the family as a response to public redistribution induced by the various policy reforms. While in the first chapter it is shown that higher capital taxes can have a growth-enhancing effect when combined with a revenue-compensating cut in wage taxes, the present chapter demonstrates that this result critically hinges on the non-existence of a bequest motive. The analysis reveals that a wage-tax cut is no longer growth-enhancing when bequests are operative as individuals then encounter any public redistribution resulting from shifts in the tax levels by adjusting their own savings and bequests which unambiguously reduces growth. Moreover, growth in this chapter is generated by productive government expenditures that grow at an equal rate as the capital stock which allows to explicitly focus on the interaction of the government's revenue and expenditure side. More specifically, the issue of spending composition when governments may decide on allocating a given tax revenue towards alternative spending categories as well as an increase in the capital income tax which is combined with an expansion of productivity-enhancing public services and their implications for the growth process will be discussed. For the latter case it turns out that a positive growth effect is still possible and becomes even more likely compared to the case of inoperative bequests as it obtains under less restrictive conditions. Finally, all theoretical findings are illustrated by numerical simulations based on US data.

The third chapter introduces another aspect of fiscal policy in the presence of intergenerational transfers, namely human capital transmission as a means of redistributing resources across different generations. While such intergenerational transfers have been modeled as either exclusively public (pensions) or private (bequests) in the first and second chapter, the interplay of two types of transfers in form of private investments into human capital and bequests within the family will be the focus of the present chapter. The analysis aims at investigating the relationship between economic growth and a fully funded social security system in an overlapping generations model with family altruism where private investment in human capital of children is the engine of growth. In contrast to the first chapter, which studies an alternative way of financing pay-as-you-go pension schemes, the focus is therefore on the growth effects of an alternative social security system whose introduction has been on top of the agenda in recent reform debates. It is shown that a funded pension scheme may harm growth if there are operative bequests within the family, and

parents thus face a trade-off between educating their children and leaving bequests. By contrast, when bequests are inoperative, the Ricardian equivalence holds and an increase in forced savings is exactly offset by a reduction in private savings leaving capital accumulation and educational spending unchanged. Moreover, an unfunded pension scheme may bring about faster long-run growth than a fully funded one when bequests are inoperative while the opposite is true when bequests are operative. These results contribute to the recent debate on reforming existing social security systems.

Finally, the fourth chapter examines the effects that fiscal decentralization may have on economic growth and welfare levels. Using a similar model setup as in chapter three, namely when growth is driven by human capital accumulation which in turn builds on public and private intergenerational transfers in form of educational investments, growth and welfare maximizing levels of fiscal decentralization are derived. The model setup features different levels of governments, namely local and central governments. In contrast to the previous chapters, the central government does not decide about a tax rate but instead on the amount of education subsidies provided to local governments, which is interpreted as an indicator of the degree of fiscal decentralization. The analysis reveals that there exists indeed a growth maximizing degree of fiscal decentralization which is increasing in the output elasticity of human capital with respect to private educational spending. Consequently, the more education rests on private resources the less should local educational spending be subsidized by the central government. Furthermore, it is shown that some degree of fiscal decentralization is always superior (in terms of long-run growth and welfare) to a system where either local or central governments exclusively finance educational investments.

In summary, comparing the results obtained in the four chapters with those in the related literature some general conclusions emerge: first, the impact of capital income taxation on growth is not as clear cut as has been proposed by most previous studies which claim a negative relationship, as capital income taxation reduces the return to private investment and thus exerts a negative impact on the process of capital accumulation. Rather, the presence of intergenerational transfers plays a key role when assessing the impact of fiscal policy on economic growth. Whenever individuals may counteract public redistribution induced by policy changes, this may also overturn the implications of such changes for growth and welfare. Sec-

ond, the analysis puts some caution on the conventional view that a fully funded pension scheme is beneficial for (or at least neutral to) economic growth. Again, the presence of intergenerational transfers turns out to be the critical factor in determining the growth effects: when individuals face a trade-off between allocating parts of their income towards educating their children or increasing their children's disposable income by leaving bequests, proportional mandatory contributions may distort parents' educational choices and therefore harm growth. Consequently, besides the well known result that shifting from a pay-as-you-go pension system to a funded one can, in general, not be established in Pareto improving way, our analysis provides an additional argument against a too strong reliance on fully funded social security. Third, the theoretical findings with respect to the relationship between fiscal decentralization and economic growth can only partly confirm Oate's conjecture that fiscal decentralization is conducive to higher growth as a positive growth effect only obtains if the initial degree of fiscal decentralization is sufficiently small. Furthermore, the existence of a growth maximizing degree of fiscal decentralization may not only explain the opposed empirical findings, but also points to the fact that the theoretical linkage is not as clear cut as proposed by some previous studies. These results may provide new insights into the field of economic theory as well as influencing the relevant policy debates.

Part II

Chapters

Chapter 1

Capital taxation and social security financing

1.1 Introduction

The combination of high unemployment rates and slow economic growth in most European countries has lead to a re-examination of social security systems and triggered efforts for possible alternatives of financing these systems. Empirical evidence by Daveri and Tabellini (2000) and, more recently, by Planas et al. (2007) suggests that a significant part of European unemployment can be traced back to a steady rise in the costs of labour. As can be seen in Figure 1.1, for example, the long-term movements of the two variables unemployment and effective labour tax rate are globally upward sloped over the last 30 years, despite the fact that there is a slight decrease in the slope since the mid eighties. Consequently, there exists a direct link between wage-related social security contributions and unemployment. Although unemployment rates have been declining in recent years, the continuous rise in contribution rates resulting from population aging implies that the problem is not only still relevant but will even become more important in the future as old age dependency ratios are projected to increase from around 30 % at the moment up to 60 % in 2050 in most European countries.

So far, several reform proposals to lower the wage tax have been discussed in the literature. Yet, most existing studies focus on either environmental tax reforms (e.g., Wendner (2001); Ono (2005, 2007)) or the introduction of a consumption tax (e.g., Hu (1996); Lopez-Garcia (1996) and Lin and Tian (2003)) as alternative financing
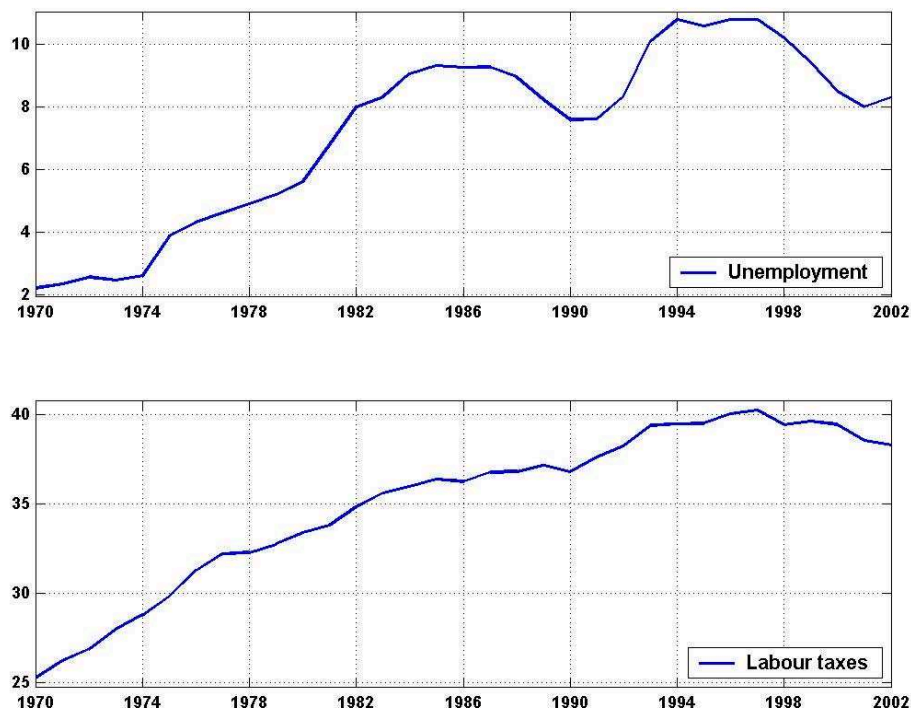
Figure 1.1: EU 12 Unemployment and Labour taxes (in %) over 1970-2002
Source: Planas et al. (2007), Figure 1.

instruments. In contrast, capital income taxation is generally not considered an alternative. This is due to the fact that the literature dealing with optimal capital income taxation, originated by Chamley (1986), generally finds it optimal not to tax income from capital. Moreover, it seems to be apparent that a rise in capital income taxes that reduces the rate of return to savings hinders any growth process driven by capital accumulation. Yet, Uhlig and Yanagawa (1996) and Caballé (1998) derive potential positive growth effects related to a rise in capital income taxation. This is due to a shift of the tax burden from the young generation to the old, giving rise to positive saving and growth effects if the interest elasticity of intertemporal substitution in consumption is sufficiently small. Against this background capital income taxation seems to provide a suitable alternative to wage-related social security contributions.[1] However, both models feature full employment and discuss taxes levied to finance a fixed public budget. Hence, it is not clear a priori whether

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[1]Quite differently and in contrast with the empirical literature, Birk and Michaelis (2006) develop a model in which the growth rate is independent of payroll taxes and conclude that a reduction of the tax rate on capital financed by higher payroll taxes unambiguously promotes growth.

the derived growth effects survive in the presence unemployment and tax-financed social security systems.

The present chapter examines possible positive growth effects of an increase of the capital income tax used to cut wage-related social security contributions and thereby increase employment. The issue is explored within an overlapping generations model allowing for endogenous growth in the spirit of Romer (1986). To capture important institutional features of European economies, a tax-financed social security system comprising unemployment benefits and pensions is introduced. Moreover, labour markets are imperfect and characterized by wage bargaining between unions and firms generating equilibrium unemployment.

The results of the present model reveal that an increase of capital income taxation that lowers the wage tax not only reduces unemployment but can additionally promote growth. Yet, whether growth is actually stimulated depends on the magnitude of the different, partly opposing effects on capital accumulation. Firstly, there is a direct effect via the public budget inducing a decline of the wage tax. This increases the net income of employed households and thereby promotes savings as well as growth. Secondly, a higher tax on capital income raises the present value of pensions, resulting in a disincentive to accumulate capital and, thus, in lower growth. Thirdly, a rise in the capital income tax provokes the opposing income and substitution effects, and, therefore, has an ambiguous impact on growth. Fourthly, a decline in the wage tax reduces unemployment which in turn has an ambiguous effect on growth as, on the one hand, the share of wage earners in the population increases and thus also savings whereas, on the other hand, lower levels of unemployment reduce efficiency and therefore current and future wages which in turn lowers aggregate savings and growth.

Consequently, depending on the magnitude of the different effects, a policy reform that increases capital income taxation to lower the labour income tax has the scope to not only reduce unemployment but moreover to facilitate growth. To assess the relevance of possible growth-enhancing effects, the model is calibrated to match data from the EU15. The results imply the existence of a growth-maximizing capital income tax rate that is clearly positive. Moreover, the calibrated model indicates that increasing the capital income tax fosters growth if the initial level of capital taxation is not excessively high.

Finally, the welfare effects of the tax reform are discussed. This is important as

a reform that is not capable of generating a net welfare gain will most probably lack political support. Extending the previous calibration exercise and focusing on the range of tax rates where growth-enhancing effects occur, however, shows that the reform will indeed generate a net welfare gain already in the first period: while the old population and unemployed individuals clearly lose, the welfare gains of the young and employed are high enough to compensate for these arising losses.

The remainder is organized as follows. Section 1.2 presents the model. Section 1.3 derives the growth effects of the revenue-neutral tax reform and discusses the numerical results. Section 1.4 then turns to the welfare implication of the reform and studies whether the reform can generate net welfare for the entire population. Section 1.5 summarizes the results and concludes.

1.2   The model

Consider a closed economy with overlapping generations in the tradition of Diamond (1965). It is assumed that the population size grows at the constant rate $n = N_t/N_{t-1} - 1$. Labour markets are imperfect in the sense that unemployment results from wage bargaining between unions and firms. Moreover, a social security system ensures against the risk of unemployment and the risk of old age via unemployment benefits and pensions. The basic model setup follows Bräuninger (2005) who studies interrelations between unemployment, pensions and economic growth. This work is extended by introducing capital taxation to explicitly analyze the impact of changes in the taxation of capital income on the growth process.

1.2.1   Households

At each moment in time, the population consists of a large number N_t of young individuals which either work or are unemployed and a large number N_{t-1} of old individuals which are retired from work. Each young individual inelastically supplies one unit of labour. The fraction of working individuals is given by $(1 - u_t)N_t$, where u_t denotes the unemployment rate. When young, individuals work and receive income I_t, which comprises net wage income if employed or unemployment benefits if unemployed. This income is partly used for consumption in the current period c_t and partly saved for consumption during the retirement period d_{t+1}. Consequently,

the individual's first period budget constraint is given by

$$I_t = c_t + s_t. \tag{1.1}$$

When retired, an individual earns interest income on savings, $R_{t+1}s_t$ where $R_{t+1} = (1 + (1-t^r)r_{t+1})$ denotes the interest factor and t^r the tax on interest income which constitutes an additional revenue instrument to finance social security. Moreover, the individual receives a pension pw_{t+1}[2]. The second period budget can, thus, be described as

$$d_{t+1} = (1 + (1-t^r)r_{t+1})s_t + pw_{t+1}. \tag{1.2}$$

Individuals have identical preferences, depending on consumption during the two periods of life, c_t and d_{t+1}. These preferences are assumed to be described by a CES utility function of the following form

$$U(c_t, d_{t+1}) = \frac{c_t^{1-\frac{1}{\sigma}} - 1}{1 - \frac{1}{\sigma}} + \delta \cdot \frac{d_{t+1}^{1-\frac{1}{\sigma}} - 1}{1 - \frac{1}{\sigma}}. \tag{1.3}$$

The parameter δ captures the individual's discount rate and σ the intertemporal elasticity of substitution. Maximizing the above utility function subject to the budget constraints yields the individual savings function

$$s_t(R_{t+1}, \sigma) = \vartheta(R_{t+1}, \sigma)I_t - \theta(R_{t+1}, \sigma)pw_{t+1} \tag{1.4}$$

where

$$\vartheta(R_{t+1}, \sigma) = \left(1 + \delta^\sigma R_{t+1}^{1-\sigma}\right)^{-1} \text{ with } \frac{\partial \vartheta}{\partial R_{t+1}} = \frac{(\sigma-1)}{\delta^\sigma R_{t+1}^\sigma \cdot \vartheta(R_{t+1}, \sigma)^2} \gtreqless 0 \tag{1.5}$$

and

$$\theta(R_{t+1}, \sigma) = \left(\delta^\sigma R_{t+1}^\sigma + R_{t+1}\right)^{-1} \text{ with } \frac{\partial \theta}{\partial R_{t+1}} = -\frac{1 + \sigma\delta^\sigma R_{t+1}^{\sigma-1}}{\theta(R_{t+1}, \sigma)^2} < 0 \tag{1.6}$$

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[2]Clearly, it is assumed that the pension level in the retirement period depends on the wage level of the retirement period. Despite the fact that in most countries pension benefits are related to the wage in the (previous) working period, this assumption can be justified as homogeneous individuals are considered and the model, thus, does not allow for different pensions resulting from wage differentials due to skill differentials. Moreover, in most countries each year's pension increase is closely linked to the wage increase.

Besides the straightforward dependence of individual savings on income I_t and the pension ratio p, the interest factor R_{t+1} affects individual savings via two channels. Firstly, a decline in the interest factor, e.g. resulting from an increase in the capital income tax, causes the income and substitution effects. Which of the two effects dominates depends on the intertemporal elasticity of substitution. For $\sigma > 1$, the substitution effect dominates and savings decline. For $\sigma < 1$, the income effect prevails and individual savings increase. The effect of a declining interest factor on savings is, therefore, ambiguous. Secondly, a lower interest factor raises the present value of pensions. Since pensions and savings are perfect substitutes, this pension effect discourages private capital accumulation and leads to crowding out of individual savings.

1.2.2   Government

Next, consider the role of the public sector in providing a social security system that comprises both unemployment insurance and pensions. To do so, the government can resort to two fiscal instruments, a wage tax t^w and a tax on capital income t^r, which finance unemployment benefits as well as the pay-as-you-go pension system.[3] It is assumed that the contribution rates can be decided by the government, while the replacement rate and the pension ratio are exogenously given. More precisely, granted unemployment as well as retirement payments are fixed in proportion to the gross wage with the replacement rate $b < 1$ and the pension ratio $p < 1$. Consequently, a balanced public budget requires

$$t^w w_t(1 - u_t)N_t + t^r r_t K_t = p w_t N_{t-1} + b w_t u_t N_t, \tag{1.7}$$

where $p w_t N_{-1}$ constitute aggregate expenditures on pensions for the old generation and $b w_t u_t N_t$ comprise unemployment benefits paid to the fraction of unemployed individuals $u_t N_t$. K_t denotes the current capital stock which is fully determined by savings of the previous period. To focus on the role of revenue-neutral changes of capital income taxation on growth, the budget constraint is rearranged to express

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[3]Note that the pension scheme is modeled in a Bismarckian tradition in this paper; apart from the capital income tax as a means of financing public expenditures, individuals' pensions are proportional to their contributions. In most countries, however, pension schemes also comprise Beveridgean elements. In this case individuals receive uniform pension benefits, irrespective of their contributions. Yet, the modeling here can be justified as individuals are assumed to be homogenous and the analysis does not focus on the redistributive effects of pension systems.

the wage tax t^w as a function of the tax on capital income t^r,

$$t^w = \frac{p + bu_t(1+n)}{(1-u_t)(1+n)} - t^r r_t \frac{K_t}{w_t(1-u_t)N_t}.$$ (1.8)

Equation (1.8) reveals that an increase in the tax on capital income leads to a reduction of the wage tax. Moreover, a higher rate of unemployment requires more payments on unemployment benefits and, thus, directly raises the wage tax.

1.2.3   Production

On the production side of the model, perfect competition between a large number of identical firms is assumed. Given the factor inputs capital K_t and labour L_t, the production technology can be described by a Cobb-Douglas production function of the form $Y_t = A K_t^\alpha (E_t L_t)^{1-\alpha}$ with $0 < \alpha < 1$. The parameter A is a general index of efficiency, while E_t describes a labour efficiency index depending on the knowledge of workers.

This labour efficiency index allows to model an endogenous growth process in line with Romer (1986) and Lucas (1988): Assuming that knowledge is accumulated in proportion to aggregate capital, the aggregate index of labour efficiency equals $E_t = K_t/L_t$. This implies that there exists a positive externality of the aggregate stock of capital on the production process. Moreover, as will be explained in the following subsection, unemployment occurs in every period with u_t denoting the proportion of unemployed individuals. It follows that the aggregate labor input can be written as $L_t = (1 - u_t)N_t$. The production technology thus simplifies to the AK-type production function allowing for endogenous growth[4],

$$Y_t = A K_t.$$ (1.9)

In line with Frankel (1962) labour efficiency in the present setting is given by aggregate knowledge per employed worker. This captures the idea of learning by doing as an increase in the physical capital stock simultaneously enhances the aggregate

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[4]A shortcoming of this modeling is, however, that efficiency is increasing with unemployment which seems to be at odd with what can be observed. Still, this assumption ensures analytical tractability in deriving the growth and welfare effects of the revenue neutral tax reform as the interest rate and output turn out to be independent of unemployment (Corneo and Marquardt, 2000).

stock of knowledge.

Firms maximize profits $\Pi_t = Y_t - w_t L_t - r_t K_t$, implying that the wage rate and the interest rate have to equal the marginal revenue of the respective factor input,

$$w_t = \frac{\partial Y_t}{\partial L_t} = \frac{(1-\alpha)AK_t}{(1-u_t)N_t}, \tag{1.10}$$

$$r_t = \frac{\partial Y_t}{\partial K_t} = \alpha A. \tag{1.11}$$

Notice that output and the wage rate are proportional to capital and will grow at the same rate in the steady state. In contrast, the interest rate is constant. An increasing unemployment rate does neither affect output nor the interest rate, but increases the wage rate.

1.2.4 Labour Market

Despite the fact that profits will vanish in a competitive market equilibrium, unions can try to capture quasi rents by pushing up their wage demands: For a fixed amount of capital employed by the firm, higher wage demands induce firms to increase the marginal product of labour by lowering the level of employment. This raises the wage rate employed workers receive and is, thus, in the interest of the union.

Following Layard et al. (1991), the wage bargaining process occurs at the firm level with every firm being represented by a union l. Since all firms and unions are identical, it suffices to consider the bargaining problem of a representative union.[5] This representative union is interested in maximizing the aggregate utility of all union members N_t, which amounts to maximizing the sum of expected income of the young individuals[6]

$$\Gamma_t = N_t \left((1-u_t)(1-t^w)w_t + u_t a_t \right), \tag{1.12}$$

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[5]The firm index will be suppressed in the following.

[6]Note that this is equivalent to maximizing the utility of a risk neutral representative union member, since it is implicitly assumed that layoffs are by random assignment and that there is perfect foresight about the unemployment rate as well as the unemployment benefit, see Layard et al. (1991). Furthermore, the trade union is formed by all individuals of the working generation, implying that only the young of each period are union members. Thereby, the analysis follows the common view of the literature that trade unions represent the interest of labour and consequently seek to maximize the utility effects of the wage related components of lifetime income and neglect effects via capital incomes. As unions are assumed to be small their effect on aggregate savings and hence the interest rate and future wages will, in fact, be negligible. However, further elaboration on this issue may be an interesting topic of future research projects.

where $(1 - t^w)w_t$ denotes the net income when staying employed which might occur with probability $1 - u_t$. The variable a_t describes the alternative income that will be received in case the worker looses the job at this specific firm with probability u_t. This alternative income can be described by the weighted average $a_t = \phi u_t b w_t + (1 - \phi u_t)(1 - t^w)w_t$, indicating that in the presence of periodical fluctuations on the labour market, each employed worker faces a positive probability $1 - \phi u_t$ of finding a job in another, identical firm. With probability ϕu_t, the worker remains unemployed for the current period and receives unemployment benefits. Moreover, the alternative income is also what workers will receive in case the bargaining process fails, and thus constitutes the threat point of the union, $\overline{\Gamma}_t = a_t N_t$. In contrast, firms intend to maximize profits and face losses in form of the cost of capital $\overline{\Pi}_t = -r_t K_t$ if no solution is reached in the bargaining process. Given this setup, the bargaining process can be described by the Nash-product,

$$\Omega_t = \left(\Gamma_t - \overline{\Gamma}_t\right)^\gamma \left(\Pi_t - \overline{\Pi}_t\right)^{1-\gamma} = ((1 - t^w)w_t L_t - a_t L_t)^\gamma \left(Y_t - w_t L_t\right)^{1-\gamma} \qquad (1.13)$$

where γ denotes the bargaining power of the union. Solving the Nash-product reveals that the net wage amounts to a fixed mark up over alternative income,

$$(1 - t^w)w_t = \mu a_t = \mu \left[\phi u_t b w_t + (1 - \phi u_t)(1 - t^w)w_t\right] \qquad (1.14)$$

with $\mu \equiv 1 + \frac{\alpha\gamma}{(1-\alpha)}$. Rearranging equation (1.14) shows that the bargaining process directly determines the rate of unemployment[7]

$$u_t = \frac{(\mu - 1)(1 - t^w)}{\mu\phi(1 - t^w - b)}. \qquad (1.15)$$

The unemployment rate resulting from the wage bargaining process depends on the wage tax, while the wage tax arising from the governments budget restriction depends on the rate of unemployment (equation (1.8)). In line with Bräuninger (2005), solving the two equations verifies the existence of either two unemployment

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[7]However, to obtain a positive and finite solution of the unemployment rate, mild parameter restrictions on b have to imposed. More specifically, unemployment benefits need to be lower than the net wage, i.e. $b < 1 - t^w$. In a related paper, Bräuninger (2005) shows that there exists a maximum for the level of the replacement rate and the pension ratio above which the unemployment rate converges to 1 and the economy thus collapses. This, of course, also holds for the present analysis.
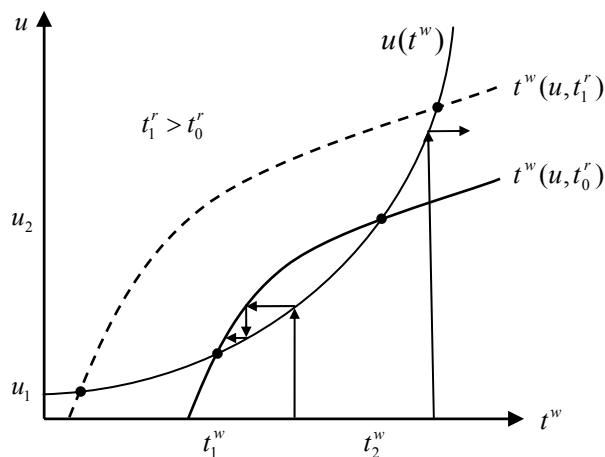
Figure 1.2: Unemployment equilibria and the role of capital income taxation

equilibria of which only one is stable, or no equilibrium at all.[8]

These unemployment equilibria are displayed in Figure 1.2 as intersections of the unemployment rate due to wage bargaining, $u_t(t^w)$, and the wage tax derived using the public budget constraint, $t^w(u_t, t^r)$. One can immediately reveal that for a fixed capital income tax t_0^r, the stable unemployment equilibrium can be found at the wage tax t_1^w. Yet, increasing the capital income tax rate shifts the $t^w(u_t, t^r)$ graph upwards, implying that a new stable equilibrium realizes itself at a lower wage tax and a lower level of unemployment. This gives rise to the following proposition:

Proposition 1.1. *There exists an indirect, positive effect of the capital income tax on unemployment: Increasing t^r decreases t^w and thereby reduces unemployment.*

Proposition 1 indicates that raising the capital income tax is associated with a lower wage tax and, thus, constitutes a potential policy option to increase the level of employment. The intuition behind this result is the following: A lower wage tax increases the individual's net wage and thus the union's utility. Consequently, the union can mitigate its wage demands and still attain the same utility level as before the tax reform. Lower wage demands then reduce the level of unemployment. Yet, at the same time an increase in the taxation of capital income might reduce private savings incentives and thereby deteriorate growth. To assess the overall effect of such a policy, the following sections studies the effects of changes in the capital income tax on the growth factor of the economy.

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[8]To see this, insert equation (1.8) into (1.15) to derive a quadratic expression determining the unemployment rate which can be solved for two unemployment equilibria.

1.3 Growth Effects

To determine the growth factor of the domestic capital stock, one needs to derive aggregate savings by summing up individual savings over all residents N_t. Recall that at every moment in time a proportion $(1 - u_t)$ of the population is employed earning $(1 - t^w)w_t$, while a fraction u_t remains unemployed and receives unemployment benefits bw_t. Thus, aggregate savings can be stated as

$$S_t = \vartheta(R_{t+1}, \sigma)[(1 - t^w)(1 - u_t) + bu_t]w_t N_t - \theta(R_{t+1}, \sigma)pw_{t+1}N_t. \qquad (1.16)$$

In a closed economy setup, aggregate savings of the young are used to finance next period's capital stock $K_{t+1} = S_t$. Therefore, aggregate savings can be used to determine the growth factor of capital $g_t = K_{t+1}/K_t$. Expressing the wage rate by the marginal productivity of labour yields an implicit expression for the growth factor of capital,

$$g_t = \vartheta(R_{t+1}, \sigma)\frac{((1 - t^w)(1 - u_t) + bu_t)(1 - \alpha)A}{(1 - u_t)} - \theta(R_{t+1}, \sigma)\frac{p(1 - \alpha)Ag_t}{(1 - u_t)(1 + n)}(1.17)$$

Rearranging to determine the growth factor explicitly yields

$$g_t = \frac{\vartheta(R_{t+1}, \sigma)\left((1 - t^w)(1 - u_t) + bu_t\right)}{\left[\frac{(1 - u_t)}{(1 - \alpha)A} + \theta(R_{t+1}, \sigma)\frac{p}{(1 + n)}\right]} \qquad (1.18)$$

Now consider the growth effect of increasing the capital income tax,

$$\frac{\partial g_t}{\partial t^r} = \frac{(1 - t^w)(1 - u_t) + bu_t}{\chi} \cdot \frac{\partial \vartheta}{\partial t^r} - \frac{g_t p}{(1 + n)\chi} \cdot \frac{\partial \theta}{\partial t^r} - \frac{\vartheta(R_{t+1}, \sigma)(1 - u_t)}{\chi} \cdot \frac{\partial t^w}{\partial t^r}$$
$$+ \frac{\vartheta(R_{t+1}, \sigma)[\frac{b}{(1 - \alpha)A} - \theta(R_{t+1}, \sigma)\frac{p}{1 + n}(1 - t^w - b)]}{\chi^2} \frac{\partial u_t}{\partial t^r} \qquad (1.19)$$

with $\chi = \frac{(1 - u_t)}{(1 - \alpha)A} + \theta(R_{t+1}, \sigma)\frac{p}{(1 + n)} > 0$. An increase of the capital income tax influences aggregate savings through four channels: Firstly, increasing the capital income tax evokes the opposing substitution and income effects. Therefore, the overall effect on savings and, hence, on growth is ambiguous, $\frac{\partial \vartheta}{\partial t^r} \gtreqless 0$, and depends on the intertemporal elasticity of substitution. Secondly, a higher capital tax increases the present value of pensions $\frac{\partial \theta}{\partial t^r} > 0$. As a consequence, aggregate savings decline as the individuals save less for retirement indicating that the *pension effect* is detrimental

to growth. Thirdly, raising the capital tax allows for reduction of labour income taxes $\left(\frac{\partial t^w}{\partial t^r}\right) < 0$. This increases the net wage of the employed part of the population, thereby leading to more income out of which to save. Thus, this *budget effect* is equivalent to a pure positive income effect and fosters the growth process. Finally, as has been established in proposition 1.1, increasing the capital income tax exerts an indirect negative effect on unemployment $\left(\frac{\partial u_t}{\partial t^r}\right) < 0$. Lower unemployment in turn has an ambiguous effect on growth, stemming from two opposing forces: On the one hand aggregate income and thus also savings increase as the share of wage earners in the population increases which is good for growth. On the other hand higher levels of employment decrease efficiency which is assumed to be proportional to capital per employed worker. Consequently, current and future wages decrease, thereby lowering aggregate savings and growth[9]. The net effect turns out to be positive if unemployment benefits are not too generous, i.e. if $b < \left(1 + \frac{1+n}{(1-\alpha)Ap}\frac{1}{\theta(R_{t+1},\sigma)}\right)^{-1}(1-t^w)$. Still, the overall effect of raising the capital income tax depends both on the magnitude of the various effects and on the direction of the savings effect. This gives rise to the following proposition:

Proposition 1.2. *Increasing the capital income tax while maintaining a balanced budget may enhance the growth factor.*

The analysis reveals that lowering unemployment by raising the capital income tax rate might be a valuable policy option with the byproduct of potentially even promoting growth. However, it remains to be shown how realistic it is that the policy change actually increases growth. To this end, the model economy is calibrated to fit the situation of the EU15 and to analyze the growth effects of increasing the capital income tax rate in different scenarios.

Before computing the growth effects of an increase of the capital income tax, the parameters of the model have to be fixed. Note that one period in the model is assumed to last half a generation, i.e. 30 years. Population grows at the rate $n \approx 0.16$, corresponding to an annual average growth rate of roughly 0.5% over the last 30 years in the EU15[10]. On the side of the households, the parameter δ is set to $\delta = 1$, implying that individuals do not discount future consumption. Yet, in

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[9]This negative effect is a direct implication of the assumed externality in production, namely that higher unemployment increases efficiency, and would not arise under the alternative assumption in which efficiency is assumed to be proportional to the per capita capital stock, see Bräuninger (2005).

[10]See OECD (2008).

order to evaluate the effect of a change in the discount rate, the case of $\delta = 0.55$ is additionally considered, thereby matching an annual discount rate of 2%. With respect to the value of the intertemporal elasticity of substitution in consumption, there exists no consensus in the econometric literature. Consequently, most studies like Uhlig and Yanagawa (1996) or Dalgaard and Jensen (2007) assume log-utilities, i.e. $\sigma = 1$.[11] Since the intertemporal elasticity of substitution in consumption is crucial in determining the reaction of individual savings, alternative scenarios with $\sigma = 5/6$ and $\sigma = 10/7$ are also included in the analysis.[12]

To focus on the role of revenue-neutral changes of capital income taxation on growth and in line with the formal model analysis, the wage tax is determined endogenously to balance the budget. The exogenously given policy variables pension level p and replacement rate b are set to $p = 0.63$ and $b = 0.32$. Both values correspond to recent averages in the EU15 (OECD, 2007a,b). The production function is calibrated following the standard literature (Layard et al., 1991), entailing that the capital income share α is approximated by $\alpha = 0.3$. In order to match the average unemployment rate in the EU15 of 7.7% in 2006, the parameter ϕ is set to 2.25 and bargaining power of the union γ equals 0.175, resulting in a mark-up over the alternative income of $\mu = 1.075$.[13] Following the literature and matching the data of the EU15, the production efficiency index is set to $A = 14$.[14] This generates annual growth and after tax interest rates of 1.5% and 4.5% for a capital income tax rate of 35%.[15] The parameters of the model are summarized in table 1.1.

In a next step, the effects of an increase of the capital income tax on growth are computed. Since there are no transitional dynamics, such a shock can completely be described by the derivative of the growth factor with respect to the capital income tax, $\partial g_t / \partial t^r$. Varying t^r, σ and δ, the entries in table 1.2 depict the annualized growth effects of a marginal increase in the capital tax rate, $\partial g_t / \partial t^r$. Since t^w is

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[11]Dalgaard and Jensen (2007) justify this observing that the empirical savings elasticity is more or less constant. This implies that substitution and income effects offset each other, which will only be the case if $\sigma = 1$.

[12]These choices correspond to the values used by Rivas (2003) who carries out a similar calibration exercise.

[13]Since estimates of μ lie in the range of $[1.05, 1.15]$, the parameter choice is in line with the empirical literature, see e.g. Layard et al. (1991).

[14]Note that a slightly higher value than the one used by Uhlig and Yanagawa (1996) is chosen here in order to generate more plausible values for the growth and interest rate.

[15]This choice is in line with Rivas (2003). Moreover, the value roughly matches the average effective tax rate on capital income for the EU15 countries in the period of 1975-2000 (Carey and Rabesona, 2002).

Parameters

population growth rate	n≈ 0.16
individual discount rate	δ=1 [0.55]
elasticity of substitution	σ=1 [0.83, 1.43]
pension level	p=0.63
replacement rate	b=0.32
capital income share	α=0.3
capital income tax rate	t^r=0.35
index of labour market fluctuations	ϕ=2.25
union bargaining power	γ=0.175
production efficiency index	A=14

Table 1.1: Fixed parameters

endogenously determined, each choice of the capital income tax t^r implies a corresponding wage tax rate, displayed in the second row. The range of capital income tax rates is chosen to roughly match labour income tax rates in the EU15, ranging from 23% to 56%.

The calibration exercise reveals that there are cases with plausible parameter constellations where an increase in the capital income tax fosters growth, e.g. for capital income tax rates between 0.25 and 0.5, growth rises if the intertemporal elasticity of substitution does not exceed $\sigma = 1$. Clearly, in case of $\sigma > 1$, positive growth effects are less probable as the substitution effect, that negatively affects savings, becomes more and more pronounced. Moreover, as the capital income tax increases, it is less likely that the proposed policy reform promotes growth. Rather, the growth effect of marginally raising the capital tax is decreasing in t^r. Consequently, there seems to exist a growth-maximizing capital income tax rate which, however, depends on the preferred parameter values. For $\sigma = 1$, for example, this growth-maximizing capital income tax rate is well above 50%.

What are the policy conclusions to be drawn from this calibration exercise? Of course, the model can not exactly mirror the situation in the EU15. Still it points to an important insight that has so far been neglected in policy discussions: The effects of raising the capital income tax rate are not as straightforward as often suggested. Especially when allowing for social security systems and unemployment, additional effects arise that might offset the (possibly negative) direct savings effects. As has been shown, this might not only influence growth positively, but moreover raise the level of employment if revenues are used to lower wage-related contribution rates.

		$\sigma = 0.83$		$\sigma = 1$		$\sigma = 1.43$	
t^r	t^w	$\delta = 1$	$\delta = 0.55$	$\delta = 1$	$\delta = 0.55$	$\delta = 1$	$\delta = 0.55$
0.25	0.53	0.037	0.036	0.034	0.032	0.028	0.022
0.3	0.49	0.025	0.024	0.021	0.019	0.015	0.009
0.35	0.46	0.019	0.018	0.016	0.013	0.009	0.002
0.4	0.44	0.015	0.014	0.011	0.009	0.004	-0.004
0.45	0.41	0.012	0.010	0.007	0.005	-0.001	-0.009
0.5	0.39	0.009	0.007	0.004	0.001	-0.006	-0.014
0.55	0.36	0.005	0.004	0.000	-0.003	-0.011	-0.020
0.6	0.34	0.002	0.000	-0.004	-0.007	-0.016	-0.025

Table 1.2: Growth effects of marginally raising the capital income tax

1.4   Welfare Effects

So far, the analysis has focused on the growth effects of increasing capital taxation. However, it remains unclear in which way the reform affects the welfare of the different generations and if potential losers can be compensated by the winners of the tax change. Yet, this is of special importance in determining the political support for such a reform. To address this issue, the following section sheds light on the question whether a reform capable of generating positive growth effect additionally leads to a net welfare gain for the economy. To this end, the welfare effects of a tax reform today are firstly evaluated for the currently young and all successive generations, given that growth is indeed positively affected. In a second step, the welfare effects for the currently old population are derived and the potential for compensation is determined in a calibration exercise.

Consider first the welfare effects of the currently young and all subsequent generations. As the tax change is assumed to be announced prior to private decision making, these individuals can fully adjust to the new tax rates. To determine the welfare effects of these adjustments, one needs to derive the individual's indirect utility function $V(R_{t+1}, I_t, w_{t+1})$. Recall that income I_t refers to the net wage in case of employment and to unemployment benefits in case of job loss. Noting that

wages grow at the rate $g_t/(1+n)$ simplifies the indirect utility function to

$$
V(R_{t+1}, I_t, g_t) = \frac{[1 + \delta^\sigma R_{t+1}^{\sigma-1}]^{\frac{1}{\sigma}}}{1 - 1/\sigma} \left(I_t + \frac{pw_t g_t}{(1+n)R_{t+1}} \right)^{1 - \frac{1}{\sigma}} - \frac{(1+\delta)}{1 - 1/\sigma}, \qquad (1.20)
$$

which describes the individual's maximum utility given the price for future consumption R_{t+1} and the present value of life-time income, $I_t + \frac{pw_t g_t}{(1+n)R_{t+1}}$. The welfare effects for the young and all successive generation can now be derived as

$$
\frac{\partial V}{\partial t^r} = \tilde{\chi} \left(\frac{\partial I_t}{\partial t^w} \frac{\partial t^w}{\partial t^r} + \frac{pw_t}{(1+n)R_{t+1}} \frac{\partial g_t}{\partial t^r} + \left(\frac{\partial I_t}{\partial w_t} + \frac{pg_t}{(1+n)R_{t+1}} \right) \frac{\partial w_t}{\partial u_t} \frac{\partial u_t}{\partial t^r} \right) \qquad (1.21)
$$

$$
+ \tilde{\chi} \underbrace{\left(\frac{\delta^\sigma R_{t+1}^\sigma I_t - \frac{pw_t g_t}{(1+n)}}{R_{t+1}^2 \left(1 + \delta^\sigma R_{t+1}^{\sigma-1} \right)} \right)}_{\gtreqless 0} \frac{\partial R_{t+1}}{\partial t^r}
$$

with $\tilde{\chi} = \left(\frac{1 + \delta^\sigma R_{t+1}^{\sigma-1}}{I_t + \frac{pw_t g_t}{(1+n)R_{t+1}}} \right)^{\frac{1}{\sigma}} > 0$. Clearly, changes in the capital income tax rate affect welfare via four different channels. Firstly, increasing the capital income tax directly reduces the private return to savings, $\frac{\partial R_{t+1}}{\partial t^r} < 0$ and, thereby, affects the present value of an individual's life-time income in an ambiguous way: On the one hand, it induces an income effect that decreases future consumption possibilities, but on the other hand it increases the present value of future pensions. Secondly, raising the capital tax allows for a reduction of the wage tax, $\frac{\partial t^w}{\partial t^r} < 0$, which increases the net income of employed individuals and, thus, their present and future consumption. Consequently, the positive effects of the tax reform are higher for employed individuals than they are for the unemployed and can at least partially offset the possibly negative effects resulting from changes in the private return to savings. Thirdly, the growth effects of the tax reform directly influence future wages and, therefore, the pension income of individuals. As has been discussed before, these growth effects are in general ambiguous, $\frac{\partial g_t}{\partial t^r} \gtreqless 0$. Yet, if positive growth effects are present, these will contribute to the welfare of the currently young and all successive generations and, thereby, render a net welfare gain even more probable. Finally, from proposition 1.1 it is clear that an increase in the capital income tax reduces unemployment, $\frac{\partial u_t}{\partial t^r} < 0$, which in turn negatively impacts on wages and social security benefits and thus the income of the employed and unemployed individuals as labour efficiency declines. Consequently, this channel unambiguously reduces consumption possibilities of the

young individuals.[16]

The welfare effects for the currently old population are more clear-cut as these individuals can no longer adjust to changes in tax rates. Rather, decisions on the amount of savings of this generation, s_{t-1}, have been made prior to the tax reform and, together with pension, determine their level of old-age consumption, $d_t = R_t s_{t-1} + p w_t$. While the level of pension in the period of reform remains unchanged, an increased capital income tax, on the one hand, reduces the returns of these savings and, on the other hand, the wage level which in turn reduces the absolute amount of received pension benefits as unemployment declines. Consequently, individual welfare will unambiguously be lower:

$$\frac{\partial U(c_{t-1}, d_t)}{\partial R_t} \frac{\partial R_t}{\partial t^r} = \delta d_t^{-\frac{1}{\sigma}} \cdot \left(s_{t-1} \frac{\partial R_t}{\partial t^r} + p \frac{\partial w_t}{\partial t^r} \right) \tag{1.22}$$

with c_{t-1} and d_t denoting current and old-age consumption of the generation born in period $t-1$. As equation (1.22) reveals, the old generation experiences a welfare loss. This gives rise to the following proposition:

Proposition 1.3. *Increasing the capital income tax while maintaining a balanced budget may enhance individual welfare for the current and all subsequent generations, while the presently old generation experiences a welfare loss.*

As the welfare effects for the young generation are ambiguous while the old generation loses, it remains unclear whether the reform can generate a net welfare gain. Thus, political support might be lacking even in case of positive growth effects. To clarify whether this is indeed the case, the proceeding calibration computes the marginal welfare effects of the tax reform, given that growth is positively effected, $\partial g_t / \partial t^r > 0$. More precisely, the calibration builds on the previous calibration exercise and determines the welfare effects for the range of capital income tax rates for which a positive growth effect has been derived. For clarity of presentation, the results displayed refer to the case $\sigma = 1$.[17] The parameter choices as depicted in

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[16]Without loss of generality, the infinite sum of all future generations is not taken explicitly into account. This is due to the fact that if the reform is capable of generating a welfare gain for the currently young individuals *and* a positive growth effect, utility levels of all subsequent generations will in fact be higher. More specifically, a positive growth effect is a sufficient condition to enhance utility for all subsequent generations provided that there is a gain for the currently young. Furthermore, the latter aspect is, in practise, crucial for political support of such a reform.

[17]The findings are, however, equally well supported by the calibration results for $\sigma = 5/6$ and $\sigma = 10/7$.

		young		old		net effect	
t^r	t^w	$\delta = 1$	$\delta = 0.55$	$\delta = 1$	$\delta = 0.55$	$\delta = 1$	$\delta = 0.55$
0.25	0.51	1.42	1.33	-0.43	-0.24	1.21	1.31
0.3	0.49	1.07	1.02	-0.44	-0.25	0.80	0.94
0.35	0.46	0.89	0.87	-0.46	-0.25	0.57	0.75
0.4	0.44	0.74	0.75	-0.47	-0.26	0.39	0.61
0.45	0.42	0.61	0.65	-0.48	-0.27	0.22	0.49
0.5	0.40	0.48	0.56	-0.50	-0.27	0.06	0.38

Table 1.3: Welfare effects of marginally raising the capital income tax for currently and formerly employed individuals ($\sigma = 1$ and $\partial g_t / \partial t^r > 0$)

table 1.1 remain unchanged. Moreover, the capital stock in the period of tax reform has been normalized to one. The entries in tables 1.3 and 1.4 depict the welfare effects of a marginal increase in the capital income tax rate for the young and old generation respectively, distinguishing between individuals with and without an employment history. The net welfare effect is derived comparing the marginal welfare effect of the currently young generation with the loss of the old generation, taking into account that the population grows at rate n and unemployment declines as a response to lower labour income taxation. This net effect determines the scope for compensation between winners and losers in the period of reform. As the calibration reveals, a positive overall net welfare effect may arise as long as capital income taxation promotes growth: Although the old generation and the unemployed individuals experience a decline in consumption[18], as can be inferred from table 1.4, the gains for the young and employed are likely to be high enough to compensate them, e.g. by means of an intergenerational transfer in the period of reform. This can be seen

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[18]Note that due to the assumed externality in production, namely $E_t = K_t/L_t$, consumption levels of the young and unemployed individuals are not only reduced by a lower rate of return to their savings but also because higher employment tends to exert a negative external effect by limiting K_t/L_t and therefore non-rival knowledge which in turn leads to lower wages as efficiency declines. This negative externality would, however, not be present for the alternative assumption, namely that efficiency is proportional to capital per worker (Bräuninger, 2005). Thus, a positive net welfare effect for the economy can be expected to become even more likely in this scenario. The disadvantage of such modeling, however, would be the loss of analytical tractability with respect to the derivation of the growth effects as, in this case, unemployment would negatively affect growth and the interest rate.

t^r	t^w	young		old		net effect	
		$\delta = 1$	$\delta = 0.55$	$\delta = 1$	$\delta = 0.55$	$\delta = 1$	$\delta = 0.55$
0.25	0.51	-0.66	-0.53	-0.26	-0.13	-1.02	-0.74
0.3	0.49	-0.33	-0.27	-0.23	-0.10	-0.60	-0.42
0.35	0.46	-0.22	-0.18	-0.19	-0.08	-0.45	-0.29
0.4	0.44	-0.18	-0.14	-0.16	-0.06	-0.37	-0.22
0.45	0.42	-0.17	-0.13	-0.12	-0.03	-0.32	-0.18
0.5	0.40	-0.18	-0.12	-0.08	-0.00	-0.29	-0.14

Table 1.4: Welfare effects of marginally raising the capital income tax for currently and formerly unemployed individuals

by comparing the net welfare effects from the two tables and taking into account the relative shares of employed and unemployed individuals in total population.

1.5 Conclusion

The present chapter analyzes the growth effects of a revenue neutral tax reform that increases the tax rate on capital income to reduce wage-related social security contributions. It is found that such a policy not only reduces unemployment but can additionally promote economic growth. The overall effect on growth, however, depends on different, partly opposing effects on capital accumulation. Firstly, the lower wage tax directly raises the net income of households, thereby fostering savings and, consequently, growth. Secondly, the present value of pensions increases, inducing a disincentive to accumulate capital and, thus, leading to lower growth. Thirdly, there are the opposing income and substitution effects, having an ambiguous impact on growth. Fourthly, increasing the capital income tax exerts an indirect negative effect on unemployment which in turn has an ambiguous effect on growth. Depending on the magnitude of the various effects, a policy reform that increases the capital income tax in a revenue-neutral way has the scope to not only reduce unemployment but moreover facilitate the growth process.

Calibrating the model to match data from the EU15 suggests that the aforemen-

tioned tax reform can indeed be growth-enhancing if the initial capital income tax is not too high. This is due to the fact that there seems to exist a growth-maximizing level of the capital income tax below which any increase of the tax on capital income contributes to the growth process. Moreover, it is shown that political support for the aforementioned reform is probable as long as growth-promoting effects are present: since the gains of the young and employed individuals outweigh the losses for the old and unemployed, the reform generates a net welfare gain for the entire population.

The present results are derived within the context of a model that is general in some respects, but of course it depends on other, less general assumptions. For example, the analysis assumes a closed economy. This naturally raises the question if the present findings still hold in case the economy is opened to capital mobility since, in fact, capital is internationally mobile. In this respect, it could easily be shown that all the qualitative results are not affected by allowing for (imperfect) capital mobility; only the magnitudes of the comparative statics are changed. Moreover, for a detailed discussion of capital income taxation in open economies, see Palomba (2008), who finds an ambiguous relation between capital income taxation and the growth rate, similar to the present results. Consequently, the findings of this paper are likely to hold if international capital mobility is allowed for.

The following chapter continues to study the growth effects of capital income taxation in the presence of intergenerational transfers, but instead of relying on public transfers in form of public pensions, the focus of the analysis is on private transfers in form of bequests. Moreover, the issue of spending composition when governments may decide on allocating a given tax revenue towards alternative spending categories and its implications for the growth process will be discussed. While the present analysis reveals that an increase in the capital income tax rate in order to finance social security benefits and to reduce the pressure on wage taxes may enhance growth, this result does no longer hold in the presence of private transfers: As long as bequests are positive, individuals encounter any public redistribution resulting from shifts in the tax levels by adjusting their own savings and bequests which unambiguously reduces growth. Under which circumstances, however, a positive growth effect due to an increase in the capital income tax is still possible will be one of the issues addressed in the proceeding chapter.

Chapter 2

Capital taxation, economic growth and bequests

2.1 Introduction

2.1.1 Motivation

Over the last decades there has been a long-lasting debate in the empirical and theoretical economic literature on whether, and if so how, fiscal policy affects economic growth. Numerous papers have analyzed the effects of taxation, transfers, spending, and other actions related to fiscal policy on economic performance. There are at least two things that can be concluded from these studies: First, fiscal policy does affect economic growth. Second, the extent and the direction of the concrete policy at hand generally depend on the specification of the model. Concerning taxation of income, especially from capital, it is, however, commonly believed that there is an adverse effect on growth. Models analyzing the equilibrium relationship between capital income taxes and growth typically find that an increase of the capital income tax reduces the return to private investment, which in turn implies a decrease of capital accumulation and thus growth (Lucas, 1990; Rebelo, 1991). Besides these positive studies, there also exists a huge body of literature dealing with normative effects of capital income taxation, originally triggered by Judd (1985) and Chamley (1986), who find that capital taxation decreases welfare and a zero capital tax is thus efficient in the long-run steady state.

In some theoretical work, however, provocative evidence is put forward that cap-
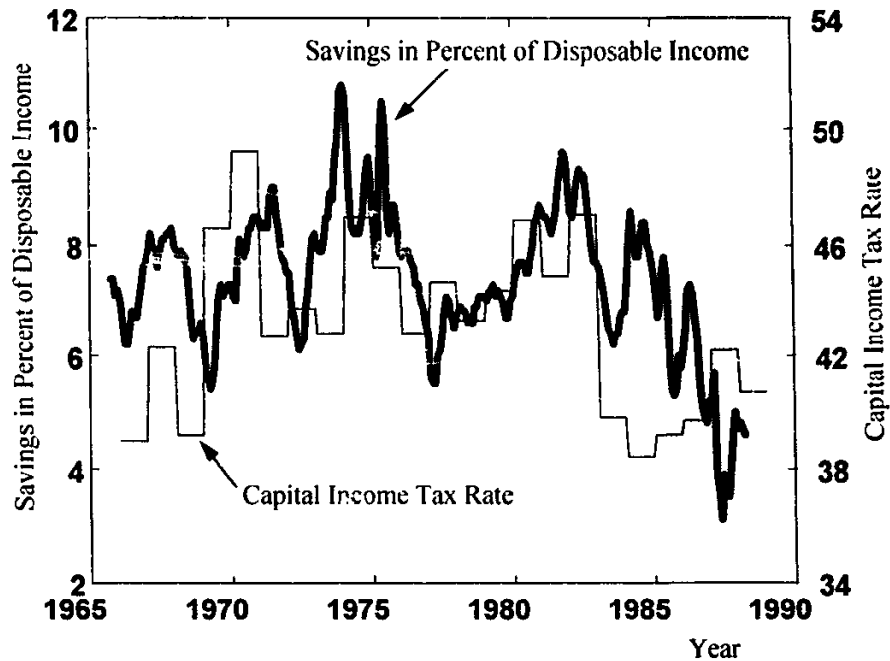
Figure 2.1: Personal Savings versus Capital Income Tax Rates in the US
Source: Uhlig and Yanagawa (1996), Figure 1.

ital income taxation may increase growth (Uhlig and Yanagawa, 1996; Rivas, 2003). Time series of capital income tax rates and personal savings in the US, for instance, seem to be positively correlated in the long run, suggesting that the conventional wisdom of low capital taxes fostering growth is less clear cut than had been proposed by most preceding theoretical studies. This point is visualized in Figure 2.1 which shows a plot of the US personal savings rate versus the US capital income tax rate over time.

Yet, an important deficiency of these studies is the absence of intergenerational transfers in form of bequests. The importance of such transfers for capital accumulation has been documented by several papers; see for instance Kotlikoff and Summers (1981, 1986), who find that 45 % to 80 % of the capital stock held by households in the United States are due to intergenerational transfers, and, more recently, DeLong (2003, Fig. 2-1)who estimates the share of bequest in total wealth to be 43 %.

These studies confirm a significant influence of bequests on capital accumulation and growth. What they cannot reveal, however, is the actual individual motive for leaving bequests.[1] Most of the existing literature models that motive by assuming

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[1]For a comprehensive survey of different altruistic bequest motives see Michel et al. (2006).

that individuals take into account the infinite stream of descendants' utilities as in Barro (1974). Within such a setting, various authors have shown that capital income taxation typically translates into lower growth[2]. The main criticism of Barro's approach is that a whole dynasty behaves as one decision unit having perfect foresight about the indefinite future.

Alternatively, individuals may be assumed to have a joy-of-giving bequest motive (Andreoni, 1989). In this case, the time horizon is finite, but the magnitude of transfers is independent of the descendant's well-being, and thus capital taxation may have a positive effect on growth under similar conditions as in Uhlig and Yanagawa (1996). In the present work, however, the so called family altruism model is adopted, which allows to work with a finite planning horizon and, at the same time, leaves the bequest motive sensitive to the offspring's economic situation (Lambrecht et al., 2005, 2006; Bréchet and Lambrecht, 2009). Within such a setting, parents are concerned about the disposable income of their immediate descendants and not about the use of this income.[3] Consequently, the disposable income of the children (not their utility) becomes an argument of the individual's utility function. Empirical evidence for the family altruism model is provided by Laitner and Justner (1996), who find that the amount of households' bequests is largest for those with the lowest assessment of children's possible earnings.[4] Altogether, such a specification is clearly more general than the joy-of-giving approach and seems to be more realistic than Barro's model.

In the next section, the family altruism motive is incorporated into an endogenous growth model in order to study two important fiscal policies. Firstly, the effect of capital income taxation on long-run growth is reexamined if intergenerational transfers within the family are operative. Secondly, the focus of the analysis is on how the composition of government spending affects the growth rate. The model

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[2]This kind of model is formally equivalent to one assuming a representative and infinite-lived agent; see, again, Lucas (1990) and Rebelo (1991).

[3]This formulation originally goes back to Becker and Tomes (1979), who assume that parents care about the quality or the economic success of their children as measured by the children's lifetime income. Such an approach has also been used in growth models with human capital; see, e.g., Glomm and Ravikumar (1992), in which preferences depend on the quality of schools, which in turn are directly related to the disposable income of the children. See also Grüner (1995).

[4]See also Mankiw (2000), who argues that neither the Barro model nor the pure life-cycle model is suited to analyze fiscal policy. This is due to three important observations: First, in reality consumption smoothing over time is not as perfect as both models predict. Second, there are a lot of households near zero wealth for which saving is not a normal activity. Third, the life-cycle model cannot account for the importance of bequests in capital accumulation.

describes a unified framework comprising the results found by Uhlig and Yanagawa (1996) and Rivas (2003) as special cases whenever intergenerational transfers are inoperative and the government uses additional tax revenue from capital taxation to either reduce the tax burden on labour income or enhance productive government spending.

Endogenous growth in this model is generated by a positive externality of a fraction of total government spending that affects private investment and bequest decisions. This type of spending is referred to as public services (or productive spending, as above) and captures expenditures on the stock of a country's infrastructure, including, e.g., highways, hospitals, and communication systems.[5] The government decides about the fraction of total outlays allocated to either productive spending or usual government consumption that do not affect productivity. Furthermore, public services are assumed to be provided without user fees, and, for reasons of simplicity, the issue of congestion is ruled out.

It turns out that the results critically depend on how the government uses the additional tax revenue resulting from an increase of the capital income tax. Growth unambiguously declines in the presence of intergenerational transfers if expenditures are fixed and revenue from capital income taxation is used to cut labour taxes, but may increase if public services are enhanced instead. Finally, the impact of changing the composition of total spending in favor of government consumption on growth is clearly negative. These results are generally driven by three channels: First, they depend on how savings react to changes in long-run interest rates. Second, they depend on the mechanism of income redistribution, which is either a shift of the tax burden across generations or a shift in factor productivity. Third, the possibility of redistributing income within the family as a reaction to a change in the tax structure matters. Numerical results reveal realistic parameter constellations in which growth increases if income is redistributed through an increase in total factor productivity.

Though the qualitative results for each fiscal policy described above are consistent with the findings of previous studies, see e.g., Barro (1990) and Caballé (1998), the contribution of the present chapter is to stress the sensitivity of policy implications to the presence of bequests within the family as compared to the dynastic altruism assumed in Barro (1974). In the present model, the response of individuals' bequest

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[5]For a recent review of the role of public spending in endogenous growth theory see Minea (2008).

decisions to fiscal policy has a key role in determining the relationship between capital income taxation and growth as will be further explained below.

The idea that public spending may have a positive effect on growth has received much attention in both the empirical and the theoretical literature. Following the pioneering work of Aschauer (1989), many empirical studies confirm the result that public investment positively affects the return to private capital and thus private investment (e.g., Easterly and Rebelo 1993; Gramlich 1994; Morrison and Schwartz 1996)[6]. On theoretical grounds, much of the literature follows the seminal work of Barro (1990), who establishes productive government services to be one important source of sustained endogenous growth. In these models, the relation of income taxation and growth is usually nonlinear, depending on the initial level of taxation. Yet, in those studies the analysis is conducted within a representative, infinite-lived agent model and is thus not able to capture the impact of taxation on life-cycle savings and intergenerational transfers within the family.

Finally, the present work also addresses the welfare implications of the model which is of special importance in determining the political support for any of the above mentioned policy reforms. By analyzing the welfare effects for the currently young and old generation, it is found that when bequests are inoperative, positive growth effects are accompanied by a welfare gain for the economy if the level of capital income taxation is not too high. By contrast, in case of operative bequests, the welfare effects are generally ambiguous depending on the relative strength of the effects of fiscal policy on growth and interest rates. However, a shift of government expenditures in favor of government consumption clearly reduces not only growth but also welfare irrespectively of bequests being operative or not.

2.1.2   Related Literature

From a technical point of view, there are a lot of studies that examine the relation of capital taxation and growth in the presence of bequests and then distinguish the two cases of operative transfers and bequest constraints (see, e.g., Ihori 1997; Caballé 1998). In general, these studies find negative (or no) growth effect if bequests are operative, depending on how the additional revenue from increased taxation is

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[6]Note, however, that some studies either face difficulties in isolating a positive effect in cross section data or even report a negative relation of government spending and growth in that high spending may decrease income, e.g. Agell et al. (1997) and Evans and Karragas (1994).

used. In a pioneering paper, Caballé (1998) shows that the presence of intergenerational transfers may reverse the relation between capital income taxation and growth: If bequests are inoperative, an increase in the capital income tax may have a growth-enhancing effect, provided that the elasticity of intertemporal substitution is sufficiently low. Yet, in case of operative bequests, the economy behaves dynastically and a zero tax rate would be optimal from a growth- (and welfare-) maximizing point of view. However, the modeling of the bequest motive in this chapter is in contrast to most of this literature and it is a priori not clear if the results also hold in the framework of the family altruism model.[7] So far, there have only been a few papers dealing with intergenerational transfers *within* the family: Lambrecht et al. (2005) analyze the effect of public pensions on growth when altruistic parents can affect their children's income through investment in education and by leaving bequests. It turns out that an increase in the pension level is bad for growth, in that it distorts the decision between bequest and education in the case of inoperative bequests. Lambrecht et al. (2006) study different fiscal policies within a neoclassical framework. They find that a pay-as-you-go pension scheme has no effect on the intertemporal equilibrium, whereas public debt is not neutral, because private intergenerational transfers cannot neutralize public intergenerational transfers induced by public debt. Finally, Bréchet and Lambrecht (2009) examine the interplay between population growth and the use of natural resources, which can either be used in production or bequeathed to the children. They find that the strength of the bequest motive is crucial in determining the role of resource preservation as a reaction to demographic shocks.

The most closely related studies are Uhlig and Yanagawa (1996) and Rivas (2003); also, Aschauer (1989) and Morrison and Schwartz (1996) provide empirical evidence for some of the results concerning the role of productive government spending. Moreover, the specification of the family altruism model can be justified by the empirical findings of Laitner and Justner (1996) and Mankiw (2000).

Uhlig and Yanagawa (1996) set up an overlapping-generations model in which endogenous growth is generated by a positive externality—viz., technological spillovers in production, across firms. Moreover, government expenditures are assumed to be a fixed fraction of output, being financed by proportional taxes on wage and capital

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[7]Note that when bequests are operative in this framework, the economy will not behave dynastically as in the standard Barro model. Rather, each family forms a distinct decision unit, having a finite time horizon (Lambrecht et al., 2006).

income. As labour income accrues mostly to the young generation and capital income to the old generation, a shift of the tax burden from wage to capital taxation may then increase growth if the interest elasticity of savings is sufficiently small.[8]

Rivas (2003), by contrast, presents an overlapping-generations model in which sustained growth is ensured by public investment in a country's infrastructure, i.e., productive government spending. In fact, this is a different source of externality in production that is capable of generating endogenous growth. This model explicitly takes into account the composition of total government outlays: Tax revenue can be allocated either to government consumption, to public services, or to transfers.[9] Rivas shows that within such a setting increased capital taxation may enhance growth if, again, the interest elasticity of savings fulfils some restrictions. Yet, the result does not require a shift of the tax burden, but stems from the effect of taxation on factor productivity, which constitutes an alternative channel for redistributing income among generations.

Consequently, these studies indicate that the actual mechanism of direct or indirect income redistribution across generations matters in determining the outcome of capital taxation on growth. By allowing for intergenerational transfers within the family, the present research adds an alternative private redistribution channel to the analysis and then reexamines the effect of capital taxation on growth. Interestingly, it turns out that the latter channel offsets the income redistribution induced by the shift of the tax burden but cannot (totally) compensate intergenerational redistribution induced by changes in total factor productivity. By contrast, in the latter scenario, positive growth effects are obtained under weaker assumptions than in the case when intergenerational transfers are absent.

The remainder of this chapter is organized as follows. Section 2.2 presents the basic model. The intertemporal equilibrium for this economy is defined, and it is shown that such an equilibrium is characterized either by operative or by inoperative

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[8]In a recent contribution, however, Ho and Wang (2007) show that the relation between capital income taxation and growth is non-monotonic if capital accumulation is subject to the adverse selection problem in the credit market. More specifically, if risk types of borrowers are unknown to lenders, capital taxation worsens the adverse selection problem, thereby inducing an additional negative effect on growth that diminishes the positive effect stemming from a shift of the tax burden across generations.

[9]Note, however, that if government expenditures are fixed, a shift of the tax burden from the young to the old as in Uhlig and Yanagawa (1996) is then capable of generating their positive-growth result. In this case the two models are formally equivalent and the only difference is the source of sustained growth.

bequests. For both cases the growth effects of capital taxation are determined in Sections 2.3 and 2.4. Further, in Section 2.5, the impact of an increase in government consumption on growth is analyzed, the model is calibrated using US data, and the numerical results are presented in Section 2.6. Section 2.7 analyzes how the different policy reforms affect the welfare of the living generations, the currently young and the presently old. Finally, Section 2.8 concludes.

2.2   The model

The basic framework is an overlapping-generation model in the tradition of Diamond (1965), in which parents have an altruistic concern for their children. In contrast to most of the existing literature, this concern is modeled by providing children with a disposable income later on in life, i.e., the disposable income of the child becomes an argument of the individual utility function (Lambrecht et al., 2006). Moreover, markets are competitive, and the size of population is assumed to be constant. The government collects taxes and allocates the revenue to either productive government spending or nonproductive government consumption. This setup is capable of generating an endogenous growth process in line with Barro (1990).

2.2.1   Firms

On the production side of the model, perfect competition between a large number of identical firms is assumed. A representative firm in period t produces a homogenous output good according to a Cobb–Douglas production function with capital K_t and homogeneous labour L_t as inputs:

$$Y_t = AK_t^\alpha (G_t^s L_t)^{1-\alpha}, \tag{2.1}$$

where $1 > \alpha > 0$ is the share parameter of capital, $A > 0$ is a general index of efficiency, and G_t^s denotes the flow of aggregate government services.

Each firm maximizes profits under perfect competition, implying that, in equilibrium, production factors are paid their marginal products:

$$w_t = (1-\alpha)AK_t^\alpha L_t^{-\alpha}(G_t^s)^{1-\alpha} \tag{2.2}$$

and

$$r_t = \alpha A K_t^{\alpha-1}(G_t^s L_t)^{1-\alpha}. \tag{2.3}$$

Clearly, an increase of the amount of government services G_t^s exerts a positive externality on each firm's output, since producers take G_t^s as given when maximizing profits. This in turn enhances the productivity of labour and capital. The specific form of the technology exhibits increasing returns to scale in labour, capital, and government expenditures taken together. However, as will be shown below, there are constant returns at the aggregate level, which enables one to analyze the long-run growth effects of policy changes without transitional dynamics.

Due to the specification of the production technology, the model features scale effects. Yet, as population size is assumed to be constant, these effects, and also those of congestion (see, e.g. Barro and Sala-i-Martin 1992; Glomm and Ravikumar 1998), are excluded from the analysis. More specifically, the assumption that the aggregate flow of government services (instead of the per capita flow) enters the production technology implies that public services are nonrival and nonexcludable.

2.2.2 Government

The government balances its budget in each period t. Revenue is generated by proportional taxes on wage income, $0 \leq t^w \leq 1$, and interest income, $0 \leq t^r < 1$,[10] in order to finance the amount of total government spending G_t in period t. Total spending can be decomposed into a fraction $0 \leq \phi < 1$ of government consumption, denoted G_t^c, and a fraction $1 - \phi$ of productive government services, denoted G_t^s:

$$G_t = G_t^c + G_t^s. \tag{2.4}$$

Such a specification allows one to study the effect of a change in the composition of total government expenditures on long-run growth. It is further assumed that total expenditures are a fixed share of national output, i.e., $G_t = \kappa Y_t$, where κ is the government-spending–output ratio. A balanced budget, thus, requires

$$t^w w_t L_t + t^r r_t K_t = \kappa Y_t. \tag{2.5}$$

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[10]In order to generate sustained long-run growth, the interest rate must be positive. This restricts the capital income tax rate to be smaller than one.

2.2.3   Consumers

At each period in time, there exist a number of young (N_t) and a number of old individuals (N_{t-1}). The population is assumed to be stationary. When young, each individual inelastically supplies one unit of labour and receives the net wage $(1 - t^w)w_t$. She also receives a nonnegative bequest, b_t. Income is spent on consumption c_t and savings s_t:

$$I_t \equiv (1 - t^w)w_t + b_t = c_t + s_t. \tag{2.6}$$

When old, each individual allocates the return to savings $(R_{t+1}s_t)$ to second-period consumption (d_{t+1}) and to a nonnegative bequest to the offspring (b_{t+1}). The second period's budget constraint is thus

$$d_{t+1} = R_{t+1}s_t - b_{t+1}, \tag{2.7}$$

where $R_{t+1} = (1 - t^r)r_{t+1}$ is the total private return to savings or the gross interest factor after capital tax between dates t and $t + 1$.[11] The economy is called *bequest-constrained* if $b_{t+1} = 0$, and bequests are *operative* if $b_{t+1} > 0$.

Individual preferences are of the CES type and depend on first- and second-period consumption and on the disposable income of the children:

$$I_{t+1} = (1 - t^w)w_{t+1} + b_{t+1}. \tag{2.8}$$

Consequently, the life-cycle utility function of an individual born in t is

$$U(c_t, d_{t+1}, I_{t+1}) = \frac{c_t^{1-1/\sigma} - 1}{1 - 1/\sigma} + \delta \left[\frac{d_{t+1}^{1-1/\sigma} - 1}{1 - 1/\sigma} + \lambda \frac{(I_{t+1})^{1-1/\sigma} - 1}{1 - 1/\sigma} \right]. \tag{2.9}$$

This specification allows one to explicitly study the effects of a varying degree of altruism captured by the parameter $\lambda \geq 0$. Here $\delta > 0$ is a discount factor, and $\sigma > 0$ the intertemporal substitution elasticity.

Each individual maximizes the utility (2.9), subject to the constraints (2.6), (2.7), (2.8) and to the nonnegativity of bequests $(b_{t+1} \geq 0)$, by choosing c_t, s_t, d_{t+1}, and b_{t+1}. The first-order conditions of this maximization problem are

$$d_{t+1} = (R_{t+1}\delta)^\sigma c_t \tag{2.10}$$

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[11]For reasons of simplicity, it is assumed that capital depreciates completely.

and

$$d_{t+1} \leq \left(\frac{1}{\lambda}\right)^{\sigma} I_{t+1} \quad (= \text{if } b_{t+1} > 0). \tag{2.11}$$

The first equation is the standard condition over the life cycle, determining optimal savings. The second one gives the optimal amount of bequests. Bequests are positive if the marginal utility from old-age consumption equals the marginal utility from leaving the bequest.

Solving equation (2.10) subject to the budget constraints (2.6) and (2.7), the optimal savings function is found:

$$s_t = \psi(R_{t+1})I_t + (1 - \psi(R_{t+1}))\frac{b_{t+1}}{R_{t+1}}, \tag{2.12}$$

where $\psi(R_{t+1}) = (R_{t+1}\delta)^{\sigma}/[R_{t+1} + (R_{t+1}\delta)^{\sigma}]$ is the saving rule. From equations (2.11), (2.8), and (2.7) one obtains the optimal amount of bequest:

$$b_{t+1} = \frac{\lambda^{\sigma}}{1 + \lambda^{\sigma}} R_{t+1}s_t - \frac{1}{1 + \lambda^{\sigma}}(1 - t^w)w_{t+1}. \tag{2.13}$$

Individual savings depend positively on the disposable income and the amount of bequest transferred to the descendant. In turn, optimal bequests are positively related to individual savings, but decrease with increase of next period's net wage.[12]

2.2.4   Intertemporal Equilibrium

In a competitive equilibrium, firms' profits will be zero, and profit maximization implies that each firm equates, for a given amount of productive government spending G_t^s, the rental and the wage rate to the marginal products of capital and labour, respectively (equations (2.3) and (2.2)). Consequently, each firm chooses the same capital–labour ratio. With these facts, it is easy to obtain the share of national output spent by the government, i.e., κ, as a weighted average of the tax rates: Insert the equilibrium factor prices into the government's budget constraint, equation

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[12]Note that equations (2.12) and (2.13) can easily be solved explicitly for s_t and b_{t+1}, which are then functions of individual income I_t, the interest factor R_{t+1}, and next period's net wage $(1 - t^w)w_{t+1}$. Yet, for reasons of convenience and in order to clarify the effect of private intergenerational transfers on savings and growth, the following analysis rests on the equations mentioned above. This, of course, does not affect any of the results.

(2.5), and rearrange terms to reach

$$\kappa = (1 - \alpha)t^w + \alpha t^r. \tag{2.14}$$

The aggregate production technology is then given by the standard AK type with constant returns to capital:

$$Y_t = \tilde{A}K_t, \tag{2.15}$$

where $\tilde{A} = [A((1 - \phi)\kappa L_t)^{1-\alpha}]^{1/\alpha}$. Aggregate input prices can thus be rewritten as

$$w_t = (1 - \alpha)\tilde{A}K_t L_t^{-1} \tag{2.16}$$

and

$$r_t = \alpha\tilde{A}. \tag{2.17}$$

Output and wage rate are proportional to capital and will grow at the same rate as aggregate capital on a balanced growth path. The interest rate and thus also the interest factor R_{t+1} are constant and time-invariant[13]. For a given composition of government expenditures, both marginal productivities increase with the government-spending–output ratio κ, which in turn depends positively on both tax rates. For fixed tax rates instead, input prices also increase if the government changes the composition of expenditures in favour of productive spending (a decrease in the parameter ϕ).

Given these facts, an intertemporal equilibrium of the economy can now be defined as follows. Given a fiscal policy (parameters t^w, t^r, and ϕ) and an initial value of the capital stock $k_0 = K_0/N_{-1} = s_{-1}$, a perfect-foresight intertemporal equilibrium is characterized by a sequence of quantities and prices:

$$\{c_t,\ d_t,\ k_t,\ s_t,\ b_t;\ w_t,\ r_t\}_{t\geq0}.$$

Individuals maximize utility, factor markets are competitive, and all markets clear.

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[13]The time index will therefore be omitted in the following; it is $R = R_{t+1}$ for all t.

The market-clearing conditions for the labour, capital and good markets are

$$L_t = N_t, \tag{2.18}$$

$$K_t = N_{t-1}s_{t-1}, \tag{2.19}$$

$$Y_t = N_t(c_t + s_t) + N_{t-1}d_t + G_t. \tag{2.20}$$

For all t, the values of G_t^s and G_t^c are determined by equations (2.4) and (2.5). The condition (2.18) states that the labour market is characterized by full employment; the demand for labour determines the market-clearing wage rate. The condition (2.19) states that in each period, the stock of capital results from individuals' savings in the preceding period. The demand for capital determines the market-clearing rental rate. According to Walras' law in period t, the equilibria in the labour and capital market imply that of the good market. Furthermore, by substituting the young's budget constraint, equation (2.6), into (2.20) and making use of (2.15) and the relation $G_t = \kappa Y_t$ one obtains:

$$(1 - \kappa)\tilde{A}K_t = N_t I_t + N_{t-1}d_t \tag{2.21}$$

In a next step, it is shown that the intertemporal equilibrium is characterized by either operative or inoperative bequests, depending on the parents' degree of altruism towards their child. Moreover, the growth rates of the economy in both cases are determined, and the conditions for a balanced growth path are specified. The analysis reveals that there exists an explicit threshold for the altruism parameter λ that indicates which of the two regimes, operative or inoperative bequests, is at work.

The first step is to determine aggregate savings: Summing individual savings, equation (2.12), over all N_t young individuals and taking the definition of I_t, equation (2.6), into account gives

$$S_t = \psi(R)[(1 - t^w)w_t N_t + b_t N_t] + (1 - \psi(R))\frac{b_{t+1}N_t}{R}. \tag{2.22}$$

Aggregate savings are positively related to aggregate income (the sum of wage income and the amount of bequest received from parents) and to aggregate bequests devoted to children. The impact of an increase in the interest factor is ambiguous, depending on the parameters of the model. In a closed economy, aggregate savings

of the young are used to finance next period's capital stock $K_{t+1} = S_t$ (the capital market clearing condition). Therefore, the expression (2.22) can be used to determine the growth factor of capital, $g_t = K_{t+1}/K_t$. Moreover, by the definition of a balanced growth path, bequests grow at the same rate as capital, i.e., $g_t = b_{t+1}/b_t$. Finally, expressing the wage rate by the marginal productivity of labour, equation (2.16), yields an implicit expression for the growth factor of capital,

$$g_t = \psi(R)[(1 - t^w)(1 - \alpha)\tilde{A} + x_t] + (1 - \psi(R))\frac{x_t g_t}{R}, \tag{2.23}$$

where $x_t = b_t N_t / K_t$ defines the bequest–capital ratio in period t. This ratio equals zero if and only if the economy is bequest-constrained, i.e., $b_t = 0$. Solve (2.23) for g_t to get an explicit expression for the growth factor:

$$g_t = \tilde{\psi}(R, x_t)[(1 - t^w)(1 - \alpha)\tilde{A} + x_t]. \tag{2.24}$$

with $\tilde{\psi}(R, x_t) = (R\delta)^\sigma / [R + (R\delta)^\sigma - x_t]$. In the case of inoperative bequests, it is $x_t = 0$. The growth factor is then constant over time, and $\tilde{\psi}(R, 0) = \psi(R)$. In case of operative bequests, however, growth is additionally affected by the bequest–capital ratio x_t. The analysis proceeds by showing that this ratio is constant on a balanced growth path, implying that g_t (in the case of operative bequests) in equation (2.24) is also constant over time and there are no transitional dynamics.

From the definition of x_t, it follows that $b_t = x_t K_t / N_t$. Dividing equation (2.13), the optimal amount of bequests devoted by parents to their child, by b_t and recalling that the wage rate grows at the same rate as aggregate capital, i.e., $w_{t+1} = g_t \cdot w_t$, yields

$$\frac{b_{t+1}}{b_t} = \frac{\lambda^\sigma}{1 + \lambda^\sigma} R \frac{s_t N_t}{b_t N_t} - \frac{1}{1 + \lambda^\sigma}(1 - t^w) w_t \frac{g_t}{b_t N_t}.$$

Now, expressing the wage rate in terms of the marginal productivity of labour, equation (2.16), one gets

$$\frac{b_{t+1}}{b_t} = \frac{\lambda^\sigma}{1 + \lambda^\sigma} R \frac{1}{x_t} g_t - \frac{1}{1 + \lambda^\sigma}(1 - t^w)(1 - \alpha)\tilde{A}\frac{1}{x_t} g_t. \tag{2.25}$$

Further analysis of equation (2.25) gives rise to the following proposition:

Proposition 2.1. *On a balanced growth path, the bequest–capital ratio is constant and satisfies*

$$x \equiv x_t = \frac{1}{1 + \lambda^\sigma} \left[\lambda^\sigma R - (1 - t^w)(1 - \alpha)\tilde{A} \right]. \tag{2.26}$$

Bequests are operative, i.e., $x > 0$, as long as

$$\lambda > \hat{\lambda} = \left(\frac{(1 - t^w)(1 - \alpha)\tilde{A}}{R} \right)^{1/\sigma}. \tag{2.27}$$

Proof: *Setting $b_{t+1}/b_t = g_t$ in (2.25) and solving for x_t gives (2.26). In turn, solving (2.26) for λ gives the critical value in equation (2.27).*

The threshold level $\hat{\lambda}$ is related negatively to the wage tax and positively to the capital income tax. Bequests are thus more likely when wage taxes are high, since individuals then foresee that the descendant's economic situation will worsen as net wages will be lower. The inverse relation applies to the capital income tax, because a higher tax rate reduces the old's return to their savings and consequently also the amount of bequest that parents devote to their child. Consequently, excessive capital income taxation may crowd out private intergenerational transfers.

On the basis of these findings, the following sections will reexamine the effect of capital income taxation with (in)operative bequests on growth for two specific fiscal policies: Firstly, a situation in which the additional revenue from an increase of the capital income tax is used to cut the wage tax and government spending is fixed will be considered. This is exactly the fiscal policy examined by Uhlig and Yanagawa (1996), in which the shift of the tax burden generates a pure positive income effect and thus possible positive growth effects due to increased savings. Secondly, an increase of the capital income tax is used to enhance the government-spending–output ratio, thereby boosting output and the marginal productivity of labour as well as capital. Rivas (2003) shows that such a setting constitutes a different source of positive growth effects.

In the following, without loss of generality, population size and thus also labour supply will be normalized to one for reasons of simplicity, i.e. $N_t = L_t = 1$.

2.3 Growth Effects

2.3.1 Revenue-neutral tax reform

Throughout this section it is assumed that the composition and the level of government expenditures, i.e., the parameters ϕ and κ, are fixed. An increase of the capital income tax rate t^r is used to reduce the wage tax t^w, implying that the wage tax is now endogenously determined. Recall the expression for the government-spending–output ratio, equation (2.14), and solve for t^w to obtain

$$t^w = \frac{\kappa}{1-\alpha} - \frac{\alpha}{1-\alpha}t^r. \tag{2.28}$$

Under these assumptions, the model is very similar to the one in Uhlig and Yanagawa (1996) if bequests are inoperative. Yet, the engines of growth are different in the two models: In Uhlig and Yanagawa sustained growth results from a positive technological spillover, whereas in this model public services ensure the existence of a balanced growth path. Moreover, the presence of intergenerational transfers in the form of bequests within the family adds additional effects to the growth process. The formal analysis proceeds as follows:

The growth factor in the case of operative bequests, equation (2.24), depends on the wage tax t^w and the bequest–capital ratio x, where x in turn depends on t^w, equation (2.26). Plugging equation (2.28) into both expressions and rearranging terms yields

$$x = R - \frac{\theta}{1+\lambda^\sigma} \tag{2.29}$$

and

$$g = \tilde{\psi}(R,x)[\theta - R + x] \tag{2.30}$$

with $\theta = (1-\kappa)\tilde{A}$. Now, first look at the case when intergenerational transfers are absent, i.e., $x = 0$. The growth factor is then influenced through two channels that are captured by the two multiplicative factors determining the growth factor in equation (2.30): Firstly, increasing the capital income tax evokes the well-known opposing substitution and income effects. Therefore, the overall effect on savings and hence on growth is ambiguous and depends on the interest elasticity of savings,

which in turn depends on the intertemporal elasticity of substitution[14]. Secondly, raising the capital tax allows for reduction of labour income taxes. This increases the net wage of the working part of the population, thereby leading to more income out of which to save. Thus, the second effect is equivalent to a pure positive income effect and fosters the growth process. The overall effect turns out to be positive if the interest elasticity of savings, denoted $\epsilon(R)$, is sufficiently small—more specifically, if

$$\epsilon(R) < \frac{I_K}{I_L}, \tag{2.31}$$

where I_K/I_L is the ratio of after-tax capital income to after-tax labour income. This condition is exactly the same as stated by Uhlig and Yanagawa (1996) in their second proposition. The pure positive income effect then outweighs possible negative substitution effects (occurring in the case of $\sigma > 1$).

However, if intergenerational transfers are operative, i.e., $x > 0$, the bequest–capital ratio additionally influences growth via two channels: On the one hand, the presence of intergenerational transfers affects the saving rule.[15] In contrast to the case of $x = 0$, savings are higher, since young individuals not only save for future consumption but also to leave a positive amount of bequest. Yet, an increase of the capital income tax enhances the disposable income of the immediate descendant, as future net wages will increase. Anticipating this positive future income effect, the current young generation reduces its savings in order to transfer a smaller amount of bequest to its children in period $t + 1$.

On the other hand, family members respond to the public income redistribution due to the change in the tax structure by redistributing the total family income (in period t).[16] More specifically, currently old individuals reduce their amount of

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[14]The interest factor elasticity of savings is defined as

$$\epsilon(R) = \frac{\partial \psi(R)}{\partial R} \frac{R}{\psi(R)} = \frac{\sigma - 1}{1 + \delta^\sigma R^{\sigma - 1}}.$$

[15]Recall that, in contrast to the case of inoperative bequests, this rule is now given by

$$\tilde{\psi}(R, x) = \frac{(R\delta)^\sigma}{R + (R\delta)^\sigma - x}.$$

[16]Note that the tax reform under consideration does not affect total family income in period t, which is the sum of returns to savings from the old plus the net wage of the young, i.e., $\Omega_t = (1 - t^w)w_t + Rs_{t-1}$. It is straightforward to show that $\partial \Omega_t / \partial t^r = 0$.

bequest by exactly the amount that barely offsets the negative income effect due to a declining return to savings and the positive income effect of the young individuals resulting from an increasing net wage.

Analytically, this can be shown by inserting equation (2.29) into (2.30). One then obtains a simple expression for the growth factor with operative bequests that solely depends on the interest factor R:

$$g = \frac{(R\delta)^\sigma}{(R\delta)^\sigma + \frac{\theta}{1+\lambda^\sigma}} \left[\frac{\lambda^\sigma}{1+\lambda^\sigma} \theta \right]. \tag{2.32}$$

From this equation, it is easy to see that the positive income effect is exactly canceled out by an appropriate decrease of the bequest–capital ratio, since θ is independent of the capital income tax rate. Moreover, optimal individual savings always decline due to an increase of the capital income tax, as argued above.

The following proposition summarizes the above findings:

Proposition 2.2. *A revenue-neutral increase of the capital income tax that decreases the wage tax*

1. *may increase growth in the case of inoperative bequests if the interest elasticity of savings is sufficiently small, i.e.,*

$$\epsilon(R) < \frac{I_K}{I_L};$$

2. *unambiguously decreases growth if bequests are operative.*

Proof: *In the case of inoperative bequests, it is $x = 0$. Taking the derivative of equation (2.30) with respect to t^r gives*

$$\frac{\partial \psi(R)}{\partial R}(\theta - R) - \psi(R) < 0.$$

Rewriting this inequality yields the result.

The saving rule in the case of operative bequests is

$$\tilde{\psi}(R, x) = \frac{(R\delta)^\sigma}{R + (R\delta)^\sigma - x}.$$

Insert the bequest–capital ratio x, equation (2.29), to reach

$$\tilde{\psi}(R) = \frac{(R\delta)^\sigma}{(R\delta)^\sigma + \frac{\theta}{1+\lambda^\sigma}} > 0.$$

Taking the derivative with respect to the capital income tax rate t^r gives

$$\frac{d\tilde{\psi}(R)}{dt^r} = -\frac{\theta}{1+\lambda^\sigma}\tilde{\psi}(R) < 0.$$

It follows that an increase of t^r always reduces growth.

The analysis reveals that the overall effect is always negative when bequests are operative. Consequently, the introduction of intergenerational transfers within the family constitutes an additional objection to the results found by Uhlig and Yanagawa (1996). In their study, they already admit that there are no positive growth effects if the overlapping-generations structure is extended to multiple periods of life. The same holds if parents are concerned about the disposable income of their child. Furthermore, Caballé (1998) derives a result that comes close to Proposition 2.2. but that assumes altruistic preferences as in Barro (1974). The comparison allows one to stress the critical relevance of intergenerational transfers for determining the effect that capital income taxation has on growth. The time horizon of individual decision making is not so relevant.

2.3.2 Increasing public services

Now, consider a situation in which the composition of government expenditures, ϕ, and the labour tax rate, t^w, are fixed. An increase of the capital income tax rate is used to enhance productive government spending, implying that the government-spending–output ratio κ is now endogenous and equation (2.14) holds.

Under these assumptions the model is very similar to the one in Rivas (2003) in the case of inoperative bequests. However, if bequests are operative, there is an additional channel that influences growth as in the preceding section. In contrast to the model in Uhlig and Yanagawa (1996), where the government finances a fixed level of government consumption, the government is now provided with an active role in the economy by allocating tax revenues to different categories of spending. Moreover, growth is now primarily driven by changes in productivity rather than by shifts of the tax burden.

In order to assess the effect of capital income taxation on long-run growth, it turns out to be important to determine the effect on the long-run interest rate. Following Rivas (2003), the impact of an increase in the capital income tax on the interest factor R is analyzed in a first step, and afterwards the growth effect is determined. Taking the definition of the productivity index $\tilde{A}$ into account, the interest factor becomes

$$R = (1 - t^r)\alpha A^{1/\alpha}[(1 - \phi)\kappa]^{(1-\alpha)/\alpha}. \tag{2.33}$$

It is easy to see that R is decreasing in ϕ and increasing in t^w. However, there exists a nonlinearity with respect to t^r, since an increase of the capital income tax decreases the capital tax factor on the one hand but enhances the government-spending–output ratio κ (i.e., $\partial\kappa/\partial t^r = \alpha > 0$) on the other hand. The overall effect can be written as

$$\frac{\partial R}{\partial t^r} = R(\vartheta(t^r) - \varphi(t^r)) \tag{2.34}$$

with

$$\vartheta = \frac{\partial\tilde{A}/\partial t^r}{\tilde{A}} = \left(t^w + \frac{\alpha}{1-\alpha}t^r\right)^{-1}$$

and

$$\varphi = (1 - t^r)^{-1}.$$

Here ϑ is the rate of change in total factor productivity due to changes in capital taxation, and φ the rate of change in the capital tax factor, which can be interpreted as the degree of distortion due to capital income taxation. Depending on the relative strength of the two effects, an increase of the capital income tax may either increase or decrease the net-of-tax interest factor, which in turn depends on the existing level of taxation. These results are summarized in the next proposition:

Proposition 2.3. *The interest factor R is a concave function of the capital income tax t^r, reaching a maximum at $\bar{t}^r = (1-\alpha)(1-t^w)$. The direction of the change in the total private return to savings (for given labour tax and expenditure composition) due to an increase of the capital income tax depends on the ratio of government revenue from capital taxation to the net-of-tax capital income of the private sector (equal to R) for a given tax rate. It is given by*

$$\frac{\partial R}{\partial t^r} \gtrless 0 \quad \Leftrightarrow \quad \hat{A}_{t^r} \gtrless \frac{M_K}{R},$$

where

$$\hat{A}_{t^r} = \vartheta t^r = \frac{\partial \tilde{A}}{\partial t^r} \frac{t^r}{\tilde{A}} = \left(\frac{t^w}{t^r} + \frac{\alpha}{1-\alpha} \right)^{-1}$$

is the elasticity of productivity with respect to the capital tax rate, and $M_K = t^r \alpha \tilde{A}$
is the government's per unit of capital revenue from capital income taxation.
Proof: *Consider the function*

$$B(t^r) = \vartheta(t^r) - \varphi(t^r).$$

It is then straightforward to check that $B(\bar{t}^r) = 0$, where $0 < \bar{t}^r = (1-\alpha)(1-t^w) < 1$.
Moreover, rewriting the inequality $t^r B(t^r) \gtrless 0$ yields the equivalence stated above.
In order to establish concavity, note that $\varphi(0) = 1 < 1/t^w = \vartheta(0)$ with $\varphi'(t^r) > 0$
and $\vartheta'(t^r) < 0$ for $t^r \in [0, 1)$. Consequently, ϑ and φ intersect only once in the
relevant range, namely at $\bar{t}^r$.

Note that these results are essentially the same as in Rivas (2003). What differs, however, is the restrictions imposed on the tax rate parameters. In this model the only restriction is $t^r < 1$ in order to have a positive net-of-tax interest factor. Rivas, by contrast, imposes an upper (lower) bound on the capital (labour) income tax rate to ensure sustained growth. Those differences result from the simplifying assumption of complete capital depreciation on the one hand and the fact that lifetime income may be positive even if labour income is completely taxed away due to intergenerational transfers on the other hand.

Given these prerequisites, one can now analyze the overall effect of an increase in the capital income tax rate on growth in the case of (in)operative bequests. Recall therefore equation (2.24), the growth factor. Similarly to the preceding section, growth is affected through three channels with respect to capital income taxation: Firstly, an increase in the capital income tax enhances productivity and thus wages and income. Secondly, changes in capital taxation affect the real rate of return, which in turn affects growth. The direction of this latter effect depends on the interest elasticity of savings. Finally, the presence of intergenerational transfers distorts the individual saving rule on the one hand and induces an adjustment of private intergenerational transfers on the other hand. In order to simplify the theoretical analysis, insert the bequest–capital ratio x, equation (2.26), into the growth factor,

equation (2.24), and collect terms to reach

$$g = \frac{(R\delta)^\sigma}{(R\delta)^\sigma + \frac{1}{\lambda^\sigma}I(R,\tilde{A})} \cdot I(R,\tilde{A}) \tag{2.35}$$

with

$$I(R,\tilde{A}) = \frac{\lambda^\sigma}{1+\lambda^\sigma}[R + \bar{t}^r\tilde{A}].$$

Depending on the existing level of capital taxation, the model features positive growth effects even if bequests are operative:

Proposition 2.4. *Suppose that the the rate of capital income taxation is sufficiently low, i.e., $t^r < \bar{t}^r$, and that the composition of government spending is fixed. Increasing the capital income tax then enhances growth even if bequests are operative.*
Proof: *In the following, the elasticity of a variable k with respect to the argument j will be denoted $\hat{k}_j$.*

The elasticity of the growth factor with respect to t^r is then

$$\hat{g}_{t^r} = \hat{g}_R\left(\hat{\tilde{A}}_{t^r} - \frac{M_K}{R}\right)g + \hat{g}_I\hat{I}_{t^r}.$$

Calculating and inserting the respective elasticities, this equation can be rewritten as

$$\hat{g}_{t^r} = g\left[\frac{\sigma}{\lambda^\sigma(R\delta)^\sigma}\left(\hat{\tilde{A}}_{t^r} - \frac{M_K}{R}\right) + \frac{(1-\alpha-\kappa)t^r\tilde{A}}{\frac{1+\lambda^\sigma}{\lambda^\sigma}\kappa I}\right]. \tag{2.36}$$

Taking the definition of κ into account, it is straightforward to show that the second term in the brackets is positive if and only if the initial capital income tax rate is not too high, i.e., if $t^r < \bar{t}^r/\alpha$. In this case, the positive income effect of higher net wages always offsets the (possibly) negative effect on individual income due to a reduced amount of bequest. Consequently, for $t^r < \bar{t}^r$ one has $\hat{\tilde{A}}_{t^r} > M_K/R$, and the above expression is clearly positive.

Three remarks are in order. First, note that the inequality stated in the above proposition is a sufficient condition but not necessary. From equation (2.36) it is easy to see that positive growth results are still possible even if the existing capital income tax level exceeds the threshold value $\bar{t}^r$. In fact, there exists a growth-maximizing level of the tax rate as long as $\bar{t}^r < t^r < \bar{t}^r/\alpha$. Second, if intergenerational transfers are absent, i.e., $x = 0$, the model is equivalent to the one in Rivas (2003). The

growth factor, equation (2.24), can then be written as

$$g = \tilde{\psi}(R,0) \cdot \frac{1+\lambda^\sigma}{\lambda^\sigma} I(0,\tilde{A}) = \frac{(R\delta)^\sigma}{(R\delta)^\sigma + R} \bar{t}^r \tilde{A}, \qquad (2.37)$$

implying that

$$\hat{g}_{t^r} = \epsilon(R) \left(\hat{\tilde{A}}_{t^r} - \frac{M_K}{R} \right) + \hat{\tilde{A}}_{t^r}. \qquad (2.38)$$

A positive growth effect in this case requires not only a sufficiently small prevalent capital income tax rate as above, i.e., $t^r < \bar{t}^r$, but also an interest elasticity of savings, $\epsilon(R)$, that exceeds zero. More specifically, the substitution effect must dominate the income effect, which is fulfilled if $\sigma \geq 1$. Consequently, a positive growth result can be obtained under weaker assumptions when individuals have the possibility to redistribute income within the family. Third, the above results can be interpreted as confirming Barro (1990) who finds a humped-shaped relationship between taxation and growth. In fact, it is easy to show that in case of a uniform income tax with $t^r = t^w$, the above threshold level equals $\bar{t}^r = 1 - \alpha$, restating Barro's optimal tax rule. The merit of the present analysis, however, is to highlight the significant role of intergenerational transfers in determining the effect that capital income taxation has on growth.

So what is the intuition behind these results? An increase of the capital income tax increases the flow of public services if the composition of spending is unaltered. This in turn enhances total factor productivity, thereby increasing the real wages and thus the individual income of the young. Consequently, individuals are left with more income out of which to save. This is the direct effect of capital taxation, which increases aggregate savings and growth. Furthermore, income is affected by the amount of bequest that individuals receive from their parents. This amount may either increase or decrease, depending on the relative strength of the effects from increased capital taxation on the wage and on the interest rate: If the positive income effect of the young offsets the (ambiguous) effect stemming from changes in the rate of return to the old's savings, the amount of bequest declines as parents deal with the negative effect of public income redistribution on their own income by adjusting private intergenerational transfers.[17]

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[17]Analytically, it is straightforward to show that a sufficient condition for bequests to decline, i.e., $\partial(1-t^w)w_t/\partial t^r > \partial R s_{t-1}/\partial t^r$, is $\alpha \geq 0.5$. In this case, the effect of capital taxation on individual income is ambiguous, depending on the trade-off between higher net wages and reduced bequests.

There are two more indirect effects at work: On the one hand, movements of the capital tax rate affect the after-tax rate of return to savings and thus the intertemporal price of consumption. The direction of this effect depends on the direction of change in the interest rate and on how individuals adapt their consumption–saving decision to this change. On the other hand, the presence of intergenerational transfers affects the individual saving decision even further, since individuals adapt the amount of bequest devoted to their child, and thus their savings, to changes in the capital income tax rate. If future net wages increase, the current young individuals save less to give a smaller amount of bequest to their descendants. Yet, the effect of increased capital taxation on the individual saving decision is clear: savings decline if and only if future income increases and the interest rate decreases.

To sum up, the overall effect on growth is generally ambiguous. However, the analysis does not exclude positive growth effects even if bequests are operative.

So far, the analysis has shed light on the question how capital income taxation affects growth under two specific fiscal policies when intergenerational transfers are operative. The following section, by contrast, examines the impact of the outlay of government expenditures on growth.

2.3.3 Changing the expenditure composition

In this section it is assumed that the tax rates, t^w and t^r, and thus also the total share of government expenditures, κ, are fixed. The focus is now on changes in the parameter ϕ—more specifically, a situation in which the government decides to reduce the amount of spending on public services in favour of an increase in government consumption, i.e., an increase in ϕ. In the related model where intergenerational transfers are absent, Rivas (2003) shows that such a policy unambiguously decreases growth if the interest elasticity of savings exceeds zero. The intuition behind this result is that a decline in government services reduces productivity and consequently the return on savings and real wages. If the interest elasticity is sufficiently large, both channels will reduce savings and thus growth. However, the situation is not that clear if intergenerational transfers are operative. The overall effect on growth then additionally depends on how private income redistribution within the family reacts to such a policy reform.

In analogy to the preceding section, the amount of bequest that parents devote to their child decreases if the negative income effect on the young caused by declining

real wages is larger than the negative income effect on the old that stems from a decreased rate of return to savings.[18] Consequently, bequests and thus also individual and aggregate income may well increase through this channel. The overall effect on income is then characterized by a trade-off between lower real wages and a larger amount of bequests. Yet, analytical results indicate that the negative effect always offsets the (possibly) positive effect. Furthermore, individual savings decline as interest rates decrease and also as individuals have less income out of which to save due to the negative income effect. These results are summarized in the following proposition:

Proposition 2.5. *A larger share of total government outlays allocated to government consumption unambiguously decreases growth.*
Proof: *Recall the growth factor, equation (2.35). The elasticity of growth with respect to the parameter ϕ can then be written as*

$$\hat{g}_\phi = \hat{g}_R \hat{R}_\phi + \hat{g}_I \hat{I}_\phi$$

with

$$\hat{g}_R = \frac{\lambda^\sigma (R\delta)^\sigma}{\sigma} g > 0, \quad \hat{g}_I = \frac{g}{I} > 0, \quad \hat{I}_\phi = \frac{(1-\kappa)\tilde{A}}{\frac{1+\lambda^\sigma}{\lambda^\sigma} I} \hat{\tilde{A}}_\phi < 0,$$

$$\hat{R}_\phi = \hat{\tilde{A}}_\phi < 0, \quad and \quad \hat{\tilde{A}}_\phi = -\frac{(1-\alpha)\phi}{\alpha(1-\phi)} < 0.$$

Consequently, the overall effect is clearly negative.

The intuition behind this result is simple: Private income redistribution is not capable of offsetting the negative income effects through declining real wages and lower rates of return to savings. This is due to the fact that every generation is hit in the same negative way by such a policy reform. In contrast to the results found by Rivas (2003), there are no restrictions on the intertemporal substitution elasticity; this means that private income redistribution contributes an additional negative effect to the analysis, thereby ruling out possible positive effects.

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[18]Analytically, it can be shown that bequests decline if the initial capital income tax rate is sufficiently small, i.e., $\partial(1-t^w)w_t/\partial t^r > \partial R s_{t-1}/\partial t^r \Leftrightarrow t^r < 1 - \bar{t}^r/\alpha$. Yet, total family income always declines due to the policy reform under consideration.

2.4   Simulations

Since in general some of the above results have ambiguous effects on growth, this section conducts a numerical calibration exercise using US data in order to illustrate how the different tax policies from the preceding sections may affect growth.

Before computing these growth effects, the parameters of the model have to be fixed. Note that one period in the model is assumed to last half a generation, i.e., 30 years. Following Uhlig and Yanagawa (1996), the capital income share α is fixed at 0.4. Furthermore, the parameter $\tilde{A} = Y/K$ is set to 12, corresponding to a capital–output ratio of 10.59 on a quarterly basis. A is then chosen to match $Y/K = 12$.

The choices of the capital and labour income tax rates are taken from Rivas (2003) and set to 35% and 40% respectively. The first value is drawn from IRS data, while the second one is chosen to match the average share of US total outlays of GDP over the period 1960–1995, amounting to 38%. The corresponding average share of government consumption expenditures of GDP is 17.4% for the same time period.[19] Accordingly, the spending composition parameter is set so that $\phi = 0.6$.[20] On the side of the households, the altruism parameter λ is adjusted to generate a steady-state bequest–capital ratio of 43% for a given value of the intertemporal substitution elasticity (DeLong, 2003, Fig. 2-1). Further, the individual discount rate δ is chosen to match annual growth and after-tax interest rates of 2% and 4.8% (for given σ). With respect to the value of the intertemporal elasticity of substitution in consumption, there exists no consensus in the econometric literature. Consequently, most studies, like Uhlig and Yanagawa (1996) or Dalgaard and Jensen (2007), assume log utilities, i.e., $\sigma = 1$.[21] Since the intertemporal elasticity of substitution in consumption is critical in determining the reaction of individual savings, alternative scenarios with $\sigma = 5/6$ and $\sigma = 10/7$ are also included in the analysis.[22] The parameters of the model are summarized in table 2.1.

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[19]See OECD Historical Statistics 1995.

[20]Note that expenditures on government transfers are not considered here. Consequently, the value for the composition parameter is higher than the one implied by the data, i.e., $\phi = 0.53$, for the same time horizon as mentioned above.

[21]Dalgaard and Jensen (2007) justify this, observing that the empirical savings elasticity is more or less constant. This implies that substitution and income effects offset each other, which will only be the case if $\sigma = 1$.

[22]These choices again correspond to the values used by Rivas (2003), who carries out a similar calibration exercise.

Parameter	Value	Source
α	0.4	Uhlig and Yanagawa (1996)
δ		Chosen to generate an annual growth rate of 2%
λ		To match $x = 0.43$ for given σ—DeLong (2003)
$\tilde{A}$	12	Matches $K/Y = 10.59$—Uhlig and Yanagawa (1996)
A		Chosen to satisfy $\tilde{A}$
t^r	0.35	IRS data—Hendricks (1999)
t^w	0.4	Matches $\kappa = 0.38$—Uhlig and Yanagawa (1996)
ϕ	0.6	Matches total outlays of 22% of GDP

Table 2.1: Utilized parameter values

				$\sigma = 0.83$		$\sigma = 1$		$\sigma = 1.43$	
t^r	t^w	x	R	g	$\partial g/\partial t^r$	g	$\partial g/\partial t^r$	g	$\partial g/\partial t^r$
0.35	0.4	0.43	1.048	1.020	-1.09	1.02	-1.31	1.02	-1.87
0.4	0.37	0.19	1.046	1.0189	-1.14	1.0187	-1.37	1.0182	-1.94
0.45	0.33	0	1.044	1.0184	1.97	1.0180	1.71	1.0168	1.04
0.5	0.3	0	1.042	1.0203	2.02	1.0196	1.71	1.0178	0.94
0.55	0.27	0	1.039	1.222	2.07	1.0212	1.71	1.0187	0.82

Table 2.2: Increasing the capital income tax and reducing wage taxes—the effects on the bequest–capital ratio x, the interest factor R, the growth factor g, and its derivative $\partial g/\partial t^r$.

Tables 2.2 and 2.3 summarize the results when an increase in capital income taxation is used either to cut wage taxes or to enhance public services, respectively, while table 2.4 lists the results of changes in government's spending composition in favour of government consumption. In each table the effects of the respective policy reform on the bequest–capital ratio x, the (annual) interest factor R, and, for varying σ, the (annual) growth factor g, as well as its derivative with respect to either the capital income tax ($\partial g/\partial t^r$) or the spending composition parameter ($\partial g/\partial \phi$), are displayed. The first row of each table shows the benchmark case.

First, look at table 2.2. A 5-percentage-point increase of the capital income tax allows for a reduction of the wage tax by 3%-points, while such an increase leads to a decline of the annual interest rate by approximately 0.2%-points. As long as bequests are operative, i.e., $x > 0$, growth unambiguously decreases. For example,

				$\sigma = 0.83$		$\sigma = 1$		$\sigma = 1.43$	
t^r	κ	x	R	g	$\partial g/\partial t^r$	g	$\partial g/\partial t^r$	g	$\partial g/\partial t^r$
0.35	0.38	0.43	1.0483	1.020	0.60	1.02	0.60	1.02	0.62
0.4	0.4	0.27	1.0482	1.0205	0.38	1.0204	0.36	1.0204	0.30
0.45	0.42	0.09	1.0479	1.0207	0.15	1.0207	0.09	1.0205	-0.06
0.5	0.44	0	1.0472	1.0220	2.72	1.0219	2.61	1.0216	2.34
0.55	0.46	0	1.0462	1.0244	2.84	1.0242	2.67	1.0236	2.24

Table 2.3: Increasing the capital income tax and the share of public spending in GDP—the effects on the bequest–capital ratio x, the interest factor R, the growth factor g, and its derivative $\partial g/\partial t^r$.

in the case of $\sigma = 1$, a 5-percentage-point increase in the capital income tax from 35% to 40% reduces the annual growth rate by 0.13%-points. Yet, if bequests are no longer operative, i.e., $x = 0$, the growth effects are reversed, and a further increase in the capital income tax then enhances growth as in Uhlig and Yanagawa (1996).

Second, look at table 2.3. Raising the capital income tax rate by 5 percentage points in this case allows one to increase the share of total government spending in the GDP by 2%-points. The annual interest factor declines, and the decline becomes more pronounced the higher the existing level of capital income taxation.[23] By contrast, incremental increases of the capital income tax by 5%-points enhance growth whether bequests are inoperative *or* operative. Note, however, that if $x > 0$ the growth effects are very small and there seems to exist a growth-maximizing tax rate, which is, for example, between 40% and 45% for $\sigma = 1.43$.

Finally, look at table 2.4. Raising the share of public spending in government consumption in favour of public services unambiguously and severely decreases annual growth and interest rates as factor productivity declines. For example, enhancing ϕ from 60% to 65% reduces the annual interest rate by 0.51%-points and the annual growth rate (in the case $\sigma = 1$) by 0.54%-points. Yet, a 5-percentage-point increase in ϕ enhances the bequest–capital ratio by 2%-points[24], indicating that the negative

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[23]Note, however, that for the chosen parameters values, the critical capital tax rate $\bar{t}^r$ amounts to 36%, implying that, in the benchmark case, a slight increase in t^r actually increases the interest factor.

[24]For the chosen parameter values, bequests would decrease as a reaction to the policy reform

			$\sigma = 0.83$		$\sigma = 1$		$\sigma = 1.43$	
ϕ	x	R	g	$\partial g/\partial \phi$	g	$\partial g/\partial \phi$	g	$\partial g/\partial \phi$
0.6	0.43	1.0483	1.020	-4.94	1.02	-5.47	1.02	-6.83
0.65	0.45	1.0432	1.015	-4.72	1.0146	-5.12	1.0133	-6.14
0.7	0.48	1.0376	1.010	-4.48	1.0088	-4.76	1.0060	-5.45
0.75	0.5	1.0316	1.004	-4.21	1.0023	-4.37	0.9980	-4.74
0.8	0.52	1.0251	0.997	-3.91	0.9951	-3.94	0.9893	-4.02

Table 2.4: Increasing the share of spending in government consumption—the effects on the bequest–capital ratio x, the interest factor R, the growth factor g, and its derivative $\partial g/\partial \phi$.

income effect of the young generation is more severe than the decline in the old's return to savings.

What are the policy conclusions to be drawn from this calibration exercise? Of course, the model cannot exactly mirror the situation in the US. Still, it points to some important insights concerning the relation of capital income taxation and growth: First, the intergenerational transfers within the family do affect this relation and may even reverse positive results found by previous studies. Second, the reallocation of additional revenue from capital income taxation matters in determining the sign of the growth effect. From a growth-maximizing point of view, the analysis suggests enhancing productive government spending (e.g., investment in infrastructure) rather than lowering wage taxes. Third, shifts in the composition of total government outlays towards unproductive spending may severely affect growth.

2.5   Welfare Effects

So far, the analysis has focused on the growth effects of increasing capital taxation and a shift in the spending composition towards government consumption. However, it remains unclear in which way these policy reforms affect the welfare of the living generations, the currently young which is able to fully adjust private decision making to fiscal policy and the presently old generation that has decided on the amount

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under consideration if $t^r < 0.1$.

of savings, s_{t-1}, prior to any policy changes. Yet, this is of special importance in determining the political support for any reform. To address this issue, the following section sheds light on the questions whether a reform capable of generating a positive growth effect additionally leads to a welfare gain for the economy and if such a gain is still possible for a negative growth effect. To this end, the welfare effects of the policy reforms today are evaluated for the currently young and old generation thereby distinguishing the cases of operative and inoperative bequests.

In order to simplify the analysis, the utility function is restricted to the case of log-utilities, i.e. $\sigma = 1$, noting that this is in line with most of the empirical literature. The utility function (2.9) then takes the simple form

$$U(c_t, d_{t+1}, I_{t+1}) = \ln c_t + \delta[\ln d_{t+1} + \lambda \ln I_{t+1}]. \tag{2.39}$$

and the growth factors with inoperative and operative bequests, equations (2.30) (with $x_t = 0$) and (2.35), simplify to

$$g_t = \frac{\delta}{1+\delta}(1 - t^w)(1 - \alpha)\tilde{A} \tag{2.40}$$

and

$$g_t = \frac{R\delta}{R\delta + \frac{\theta}{1+\lambda}} \frac{\lambda}{1+\lambda}\theta, \tag{2.41}$$

respectively, with $\theta = (1 - \kappa)\tilde{A}$ as in the preceding section.

Inoperative bequests

First, consider the welfare effects when the economy is bequest constrained, i.e. $b_{t+1} = 0$ in period $t + 1$. To derive the individual's indirect utility function, henceforth denoted by V_t, one has to determine consumption, c_t and d_{t+1}, and next period's income, I_{t+1}. By combining equations (2.8), next period's income in case of inoperative bequests, and (2.21), the good market equilibrium condition, one obtains:

$$I_{t+1} = (1 - t^w)(1 - \alpha)\tilde{A}K_{t+1} \tag{2.42}$$

$$d_{t+1} = RK_{t+1}. \tag{2.43}$$

Using the first order condition of individual utility maximization, equation (2.10),

one then gets a simple expression for first period consumption:

$$c_t = \frac{1}{\delta} K_{t+1}. \tag{2.44}$$

By inserting (2.42), (2.43) and (2.44) into (2.39) and simplifying terms, the individual's indirect utility function can be written as

$$V_t = (1 + \delta(1 + \lambda)) \ln g_t + \delta \ln R + \delta\lambda \ln[(1 - t^w)(1 - \alpha)\tilde{A}] + M_t \tag{2.45}$$

where M_t is a constant that does not depend on any policy or individual decision variables. Clearly, the welfare of a young individual of generation t is affected through various channels: First, it depends on how growth is influenced by the different policy reforms as analyzed in the preceding sections. Higher growth rates unambiguously enhance welfare as output and thus also individual income, which in turn determines consumption levels, increase. Second, the welfare of generation t is sensitive to changes in the (after tax) interest factor. A higher return to savings clearly increases consumption possibilities as this, other things being equal, has a positive impact on individual's second period income which is completely used for consumption when bequests are inoperative. Finally, the policy reforms directly affect future income which in turn has a positive impact on individual's welfare level due to the specification of the utility function and the bequest motive.

The welfare effects for the currently young generation with respect to the different policy reforms can now be evaluated. To do so, differentiate (2.45) with respect to t^r and ϕ. In case of a revenue neutral tax shift, i.e. the wage tax is endogenously determined and equation (2.28) holds, it is:

$$\frac{\partial V_t}{\partial t^r} = \frac{1 + \delta(1 + \lambda)}{g_t} \frac{\partial g_t}{\partial t^r} + \frac{\delta}{R} \frac{\partial R}{\partial t^r} - \frac{\delta\lambda}{1 - t^w} \frac{\partial t^w}{\partial t^r} \tag{2.46}$$

with $\frac{\partial t^w}{\partial t^r} = -\frac{\alpha}{1-\alpha} < 0$, $\frac{\partial g_t}{\partial t^r} = \frac{\delta}{1+\delta}(1-\alpha)\tilde{A}\frac{\partial(1-t^w)}{\partial t^r} > 0$ and $\frac{\partial R}{\partial t^r} = -\alpha\tilde{A} < 0$. Consequently, there may be a welfare gain for the currently young generation if the positive effects through higher growth and future income levels offset the adverse effect stemming from a declining return to savings. As will be shown below, this holds if the initially level of capital income taxation is sufficiently low.

When combined with an expansion in government spending, i.e. κ is now endogenous and (2.14) holds, an increase in the capital income tax yields the following

comparative static result:

$$\frac{\partial V_t}{\partial t^r} = \frac{1 + \delta(1+\lambda)}{g_t}\frac{\partial g_t}{\partial t^r} + \frac{\delta}{R}\frac{\partial R}{\partial t^r} + \frac{\delta\lambda}{\tilde{A}}\frac{\partial \tilde{A}}{\partial t^r} \tag{2.47}$$

with $\frac{\partial \tilde{A}}{\partial t^r} = \frac{1-\alpha}{\kappa}\tilde{A} > 0$, $\frac{\partial g_t}{\partial t^r} = \frac{\delta}{1+\delta}\bar{t}^r\frac{\partial \tilde{A}}{\partial t^r} > 0$ and $\frac{\partial R}{\partial t^r} \gtrless 0 \Leftrightarrow t^r \lessgtr \bar{t}^r$. The welfare effect is thus unambiguously positive if $t^r < \bar{t}^r$ which is, however, a by far sufficient condition.

Finally, differentiating V_t with respect to ϕ gives

$$\frac{\partial V_t}{\partial \phi} = \frac{1 + \delta(1+\lambda)}{g_t}\frac{\partial g_t}{\partial \phi} + \frac{\delta}{R}\frac{\partial R}{\partial \phi} + \frac{\delta\lambda}{\tilde{A}}\frac{\partial \tilde{A}}{\partial \phi} < 0 \tag{2.48}$$

as $\frac{\partial \tilde{A}}{\partial \phi} = -\frac{1-\alpha}{\alpha(1-\phi)}\tilde{A} < 0$, $\frac{\partial g_t}{\partial \phi} = \frac{\delta}{1+\delta}\bar{t}^r\frac{\partial \tilde{A}}{\partial \phi} < 0$ and $\frac{\partial R}{\partial \phi} = (1-t^r)\alpha\frac{\partial \tilde{A}}{\partial \phi} < 0$. Changing the composition of government expenditures in favor of government consumption therefore clearly reduces welfare for the currently young generation.

By contrast, the welfare effects for the currently old population are obtained by considering the impact of the policy reforms on d_t and I_t as these individuals can no longer adjust to changes in the policy parameters. Rather, decisions on the amount of savings of this generation, s_{t-1}, have been made prior to the policy reforms. Formally the following utility function, thus, has to be analyzed:

$$U(c_{t-1}, d_t, I_t) = \ln c_{t-1} + \delta[\ln d_t + \lambda \ln I_t] \tag{2.49}$$

where c_{t-1} is constant and denotes consumption of a young individual born in $t-1$. Inserting (2.43) and (2.42) for period t into (2.49) and simplifying terms yields:

$$V_t^{old} = \ln R + \lambda \ln((1-t^w)(1-\alpha)\tilde{A}) + \bar{M}_t \tag{2.50}$$

Clearly, a revenue neutral tax reform affects the old's welfare in an ambiguous way: On the one hand it reduces the after tax interest factor, thereby lowering the return to savings and thus old-age consumption. On the other hand, however, a decreasing wage tax enhances the disposable income of the immediate descendant which has a welfare-enhancing effect. As will be shown below, the positive effect dominates for a sufficiently low level of the capital income tax. Regarding the expansion of government expenditures, financed by capital income taxation, such a policy will unambiguously increase the old's welfare as long as the interest rate increases which

holds for $t^r < \bar{t}^r$ according to proposition 2.3. In this case, both old age consumption and the disposable income of the children will be higher implying a welfare gain for the presently old generation. Finally, shifting government expenditures from productive resources to unproductive government consumption clearly reduces welfare for the old as productivity and consequently also income consumption possibilities decline.

The above results are summarized in the following proposition:

Proposition 2.6. *Suppose that parent's degree of altruism is sufficiently low, i.e. $\lambda < \hat{\lambda}$. Then bequests are inoperative and a revenue neutral increase of the capital income tax that decreases the wage tax*

- *enhances welfare for the presently old and the currently young generation if the prevalent tax level is sufficiently small, i.e. $t^r < 1 - \frac{1-\kappa}{(1+\lambda)\alpha} \equiv \tilde{t}^r$.*

When combined with an expansion in government spending, an increase in the capital income tax

- *enhances welfare for the presently old and the currently young generation if the prevalent tax level is sufficiently small, i.e. $t^r < \bar{t}^r$.*

A shift in government expenditures towards government consumption unambiguously reduces welfare for all present generations.

Proof: *According to proposition 2.1, bequests are inoperative, as long as $\lambda < \hat{\lambda}$. The condition for a welfare gain of the presently old generation under the revenue neutral tax reform can be shown as follows: Taking the derivative of (2.49) with respect to t^r gives:*

$$\frac{\partial V_t^{old}}{\partial t^r} = -\frac{1}{1-t^r} + \frac{\lambda\alpha}{(1-t^w)(1-\alpha)} \tag{2.51}$$

Inserting the wage tax (2.28) and rearranging terms, (2.51) will be positive if and only if $t^r < \tilde{t}^r$.

In a similar fashion, conditions for a welfare gain of the currently young generation can be derived: Straight forward calculations show that equation (2.46) will be positive if and only if $t^r < 1 - \frac{\delta(1-\kappa)}{1+\delta(1+\lambda+\alpha(1+\lambda))} \equiv \hat{t}^r$.

By comparing the critical levels $\tilde{t}^r$ and $\hat{t}^r$, it turns out that both living generations will experience a welfare gain as long as $t^r < \tilde{t}^r$ as $\tilde{t}^r < \hat{t}^r$.

Consequently, when bequests are inoperative, a revenue neutral tax reform in favor of capital income taxation may not only increase growth but also enhance welfare for all present generations if the level of capital income taxation is relatively low. A similar result obtains if the increase in the capital income tax is combined with an expansion in public expenditures: For sufficiently low levels of capital income taxation, such a policy reform will have a growth- and welfare-enhancing effect, while a shift of government expenditures from productive resources to unproductive government consumption will not only harm growth but also reduce welfare for all present generations.

Operative bequests

In a next step, turn to the case when bequests are operative, i.e. $b_{t+1} > 0$ in $t+1$. By combining (2.10), (2.11) and (2.21), next period's income, old-age and first period consumption can be written as

$$I_{t+1} = \frac{\lambda}{1+\lambda}\theta K_{t+1} \tag{2.52}$$

$$d_{t+1} = \frac{1}{1+\lambda}\theta K_{t+1} \tag{2.53}$$

$$c_t = \frac{1}{(1+\lambda)\delta R}\theta K_{t+1}. \tag{2.54}$$

Insert these expressions into (2.39) and simplify terms, to obtain the individual's indirect utility function

$$V_t = (1 + \delta(1+\lambda))\ln g_t - \ln R + (1 + \delta(1+\lambda))\ln \theta + \tilde{M}_t \tag{2.55}$$

where $\tilde{M}_t$ is again a constant that does not depend on any policy or individual decision variables. In analogy to the case of inoperative bequests, the welfare of a young individual of generation t is sensitive to changes in the growth and interest rate. However, while higher levels of growth clearly have a welfare enhancing effect, increases in the return to private savings reduce welfare. This is, other things being equal, due to the change in the relative price of consumption implying lower levels of first period consumption. Furthermore, welfare is positively affected through increases in productivity which in turn raises income and consequently consumption levels as captured by θ.

Evaluating the individual's indirect utility function with respect to the different policy reforms, starting with the revenue neutral tax shift, one obtains:

$$\frac{\partial V_t}{\partial t^r} = \frac{1 + \delta(1 + \lambda)}{g_t} \frac{\partial g_t}{\partial t^r} - \frac{1}{R} \frac{\partial R}{\partial t^r} \qquad (2.56)$$

with $\frac{\partial g_t}{\partial t^r} = -\frac{1 + \delta(1+\lambda)}{1+\lambda}\theta < 0$ according to proposition 2.2 and $\frac{\partial R}{\partial t^r} = -\alpha\tilde{A} < 0$. The welfare effect for the young generation is thus generally ambiguous, depending on the relative strength the policy reform exerts on the growth and interest factor. Yet, as will be shown below, a welfare gain obtains for sufficiently large levels of capital income taxation.

When the increase in the capital tax is instead combined with an expansion in government expenditures, i.e. (2.14) holds, the derivative becomes

$$\frac{\partial V_t}{\partial t^r} = \frac{1 + \delta(1 + \lambda)}{g_t} \frac{\partial g_t}{\partial t^r} - \frac{1}{R} \frac{\partial R}{\partial t^r} + \frac{1 + \delta(1 + \lambda)}{\theta} \frac{\partial \theta}{\partial t^r} \qquad (2.57)$$

with $\frac{\partial g_t}{\partial t^r} > 0$ if $t^r < \bar{t}^r$ as can be inferred from (2.36) (for $\sigma = 1$), $\frac{\partial R}{\partial t^r} \gtrless 0 \Leftrightarrow t^r \lessgtr 0$ (proposition 2.3) and $\frac{\partial \theta}{\partial t^r} = \frac{1 - \alpha - \kappa}{\kappa}\tilde{A} \gtrless 0 \Leftrightarrow t^r \lessgtr \bar{t}^r/\alpha$ where κ is determined by (2.14). Consequently, the sign of the welfare effect is determined by the relative strength of three (partly) opposing effects: The growth effect, the impact of the interest factor on the individual consumption/saving decision as well as the effect of the policy reform on individual income and the amount of bequest, as captured by θ.

Finally, shifting government expenditures towards government consumption, one gets:

$$\frac{\partial V_t}{\partial \phi} = \frac{1 + \delta(1 + \lambda)}{g_t} \frac{\partial g_t}{\partial \phi} - \frac{1}{R} \frac{\partial R}{\partial \phi} + \frac{1 + \delta(1 + \lambda)}{\theta} \frac{\partial \theta}{\partial \phi} \qquad (2.58)$$

with $\frac{\partial g_t}{\partial \phi} < 0$ (proposition 2.5), $\frac{\partial R}{\partial \phi} = (1 - t^r)\alpha\frac{\partial \tilde{A}}{\partial \phi} < 0$ and $\frac{\partial \theta}{\partial \phi} = (1 - \kappa)\frac{\partial \tilde{A}}{\partial \phi} < 0$, implying that the welfare effect for the currently young generation is unambiguously negative.

In analogy to the case of inoperative bequests, one also has to analyze the welfare effects for the currently old generation. To obtain the indirect utility function of an individual born in $t - 1$, insert (2.53) and (2.52) (for period t) into the old's utility function (2.49) and simplify terms to reach:

$$V_t^{old} = \delta(1 + \lambda)\theta + \hat{M}_t. \qquad (2.59)$$

It is easy to see that a revenue neutral tax reform does not affect the old's welfare as these individuals encounter any change in their old age consumption level by adjusting private intergenerational transfers. Consequently, the amount of bequest decreases as future income increase and old-age consumption declines. The effect of an expansion in public expenditures, however, enhances the old's welfare for sufficiently low levels of capital income taxation, i.e. $t^r < \bar{t}^r/\alpha$. Then, the positive income effect of higher (net) wages offsets the (possibly) negative effect on individual income due to a reduced amount of bequest and θ increases. Clearly, as compared to the case when bequests are inoperative, an increase in ϕ unambiguously reduces welfare for the old as productivity and thus income and consumption levels decline.

The welfare implications for operative bequests are summarized in the following proposition:

Proposition 2.7. *Suppose that parent's are sufficiently altruistic towards their children, i.e. $\lambda > \hat{\lambda}$. Then bequests are operative and a revenue neutral increase of the capital income tax that decreases the wage tax*

- *may enhance welfare of the currently young generation if the prevalent level of capital income taxation is sufficiently high, i.e. $t^r > 1 - \frac{1+\lambda}{(1+\delta(1+\lambda))\theta}$.*

- *does not affect welfare for the presently old generation.*

When combined with an expansion in government spending, an increase in the capital income tax

- *has an ambiguous effect on the welfare of the currently young generation.*

- *enhances welfare for the presently old generation, if the existing level of capital taxation is sufficiently low, i.e. $t^r < \bar{t}^r/\alpha$.*

A shift in government expenditures towards government consumption unambiguously reduces welfare for all present generations.

Proof: *According to proposition 2.1, bequests are operative, as long as $\lambda < \hat{\lambda}$. The welfare gain for the currently young generation under the revenue neutral tax reform can be shown as follows: Inserting the derivatives of the growth and interest factor into $\frac{\partial V_t}{\partial t^r} > 0$ and rearranging terms yields:*

$$\frac{\alpha \tilde{A}}{(1 - t^r)\alpha \tilde{A}} > \frac{1 + \delta(1 + \lambda)}{1 + \lambda}\theta. \tag{2.60}$$

Solving this inequality for t^r then proves the argument.

When bequests are operative, the welfare effects are no longer as clear cut as in the case of inoperative bequests and generally depend on the relative strength of how the reform affects the growth and interest factor. Still, for the revenue neutral tax reform, there might be a welfare gain for the currently young generation despite a negative growth effect. Thus, political support might not be lacking even in case of declining growth rates. Moreover, such a positive welfare effect is also likely for an expansion of public expenditures if the prevalent capital income tax level is sufficiently low[25]. In this case, one has to balance the negative effect on first period consumption through higher rates of return to savings with a positive growth effect and higher income levels as productivity increases. However, with respect to a change in the spending composition in favor of government consumption, there is no scope for a welfare gain similar to the case of inoperative bequests.

To conclude, the welfare implications of the model critically depend on wether bequests are positive or not. In the latter case, positive growth effects are accompanied by a welfare gain for the economy provided a sufficiently low level of capital income taxation, while in the former one the sign of the growth and welfare effects need not necessarily be the same.

2.6   Conclusions

The focus of the present chapter is to reexamine the relation between capital income taxation and growth within a one-sector endogenous growth model in which intergenerational transfers take the form of bequests within the family. In this model, a fraction of government spending affects the productivity of private production factors while the remaining part of total tax revenue is allocated to unproductive government consumption. The analysis features three specific policy reforms: First, the additional revenue from an increase of the capital income tax is used to cut wage taxes. Second, the additional revenue is used to enhance productive government spending. Third, the government changes the composition of total government outlays in favor of government consumption.

The analysis extends and generalizes previous studies by Uhlig and Yanagawa (1996) and Rivas (2003). The results of those authors are obtained if bequests are

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[25]Note that for $t^r = \bar{t}^r$, the welfare effect is unambiguously positive.

inoperative and the additional revenue from capital income taxation is used either to cut existing wage taxes or to increase the fraction of public services. In these cases, capital income taxation may increase growth, if savings are sufficiently inelastic to changes in the interest rate.

However, if bequests within the family are operative, individuals try to respond to public income redistribution by adjusting private intergenerational transfers. It is shown that this additional channel of private income redistribution overturns the positive growth result due to the shift of the tax burden but cannot completely offset the positive effect stemming from changes in factor productivity. Moreover, increasing the share of government consumption of total outlays unambiguously reduces growth.

These results are generally driven by three channels: First, they depend on how interest rates and savings react to the respective policy reform. Second, public income redistribution policy affects individual income and thus the individual consumption–saving decision. Third, individuals try to offset public income redistribution by adjusting private transfers. Numerical calibration results using US data underscore the theoretical findings. Yet, in the case of operative bequests, adjusting the tax structure as well as increasing the share of government consumption in total outlays leads to a sharp decline in annual growth rates, while the positive impact of increasing public services is relatively small in absolute values.

In an extension, the welfare implications of the different policy reforms are analyzed. It is found that when bequests are inoperative, positive growth effects coincide with a welfare gain for the economy if the level of capital income taxation is not too high. By contrast, in case of operative bequests, the welfare effects are generally ambiguous depending on the relative strength of the effects of fiscal policy on growth and interest rates. However, a shift of government expenditures in favor of government consumption clearly reduces not only growth but also welfare in any case.[26]

The present analysis suggests at least two things: First, the presence of intergenerational transfers does influence the relation between taxation and growth/welfare.

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[26]Note that this latter result is rather obvious since individuals' utility is independent of government consumption. If these benefits are included into the welfare function, however, the result does not necessarily hold as there is a trade off between higher levels of government consumption and higher levels of taxation. Such an extension would therefore be an interesting issue of future research.

Consequently, one has to be cautious with possible policy implications, as these may vary with the regime in which the economy is operating (operative versus inoperative bequests). Second, from a growth-maximizing point of view, investing in a country's infrastructure seems to be superior to cutting existing wage taxes, irrespective of the presence of private intergenerational transfers. However, if the initial state of the economy is such that bequests are operative, extensive taxation of income from capital may then deliver the largest gains in growth, when tax policy crowds out private transfers within the family.

Finally, an interesting issue of future research would be to analyze the sensitivity of the results with respect to the assumption that public expenditures enter the production function as a flow variable. Alternatively, one could assume public capital to be a stock variable, see, e.g., Turnovsky (1997, 2004). This, however, would further increase analytical complexity. Moreover, the present results could be generalized by allowing for heterogeneity in the motivation to make private transfers. Setting up a two period overlapping-generations model where individuals are concerned about their children's disposable income (family altruism) *and* about the amount of bequest itself (joy-of-giving altruism), Kunze (2011) provides a comprehensive analysis of how the pattern of capital income taxation and economic growth depends on parents' degree of altruism towards their children, which in turn determines if bequests are operative or not, and on the relative weight of either the amount of bequest itself or the children's income level in the individual utility function. As a result, it turns out that the sign of the growth effect critically depends on the relative weight attached to the different altruistic motives and therefore on heterogeneity in the motivation to give.

The following chapter introduces another aspect of fiscal policy in the presence of intergenerational transfers: human capital accumulation as engine of economic growth. While intergenerational transfers have been modeled as either exclusively public (pensions) or private (bequests) in the previous chapters, the interplay of two types of transfers in form of private investments into human capital and bequests within the family will be analyzed in the following. The analysis is carried out in the context of social security funding. Specifically, whereas the focus of the first chapter has been on an alternative financing method of public pay-as-you-go pensions, the next chapter examines the growth effects of a fully funded pension scheme. It turns out that the coexistence of private educational spending and bequests generates a

trade-off that may substantially alter the results of the existing literature.

Chapter 3

Funded social security and economic growth

3.1 Introduction

3.1.1 Motivation

The relationship between social security benefits and human capital formation which affects the productivity of future generations has recently received much attention in the theoretical literature. By now, it is generally accepted that the solvency of social security critically depends on the growth of future productivity as, for a pay-as-you-go pension scheme, benefits are directly related to payroll taxes paid by future generations whereas, for a fully funded system, the return to forced savings depends on future labour productivity. However, as the traditional research typically focusses on the adverse effects of social security provision for private savings and physical capital accumulation (see e.g. Feldstein (1974)), the impact of human capital formation for future productivity has been long ignored. Still, faster human capital accumulation may not only serve as a counterweight to population aging but also to the adverse effects of social security on private savings which in turn decrease the relative share of physical capital, as has been argued by Kaganovic and Zilcha (2008).

In view of the looming crisis of existing pay-as-you-go pension schemes, due to the speed at which populations are aging and slow economic growth in most European countries, social security reform proposals are on the immediate public policy

agenda. While some studies suggest reducing pressure on contribution rates by taking into account alternative financing instruments such as environmental taxes (e.g., Wendner (2001); Ono (2007)), consumption taxes (e.g., Hu (1996); Lin and Tian (2003)) or capital income taxes (Kunze and Schuppert (2010)), most of the existing work is concerned about the transition from an unfunded system towards a fully funded one. In this respect, the focus of many studies is either on the comparison of funded vs. unfunded social security systems and their performance with growth (e.g. Docquier and Paddison (2003), Kaganovic and Zilcha (2008), Thogersen (2010)), or on transitional issues between both pension schemes (e.g. Belan et al. (1998), Gyárfás and Marquardt (2001)). By contrast, this chapter addresses the questions how an increase in an existing funded social security system impacts on economic growth and whether a funded or an unfunded pension scheme may bring about faster economic growth depending on preferences with regard to altruism and technology.

These issues are examined within a three period overlapping generations model with family altruism where private investment in human capital of children is the engine of endogenous growth. Whereas fully funded pensions are completely neutral to capital accumulation in the textbook version of overlapping generations models[1], it is by now generally believed that funded social security has a positive impact on growth or is at least neutral (e.g. Zhang (1995), Docquier and Paddison (2003)).

In contrast to this conventional view, the current chapter demonstrates that there is a case for a negative growth effect if altruistic parents face a trade-off between educating their children or increasing their disposable income by leaving bequests. In such a situation, an increase in proportional mandatory contributions reduces the return to education and therefore speeds up capital accumulation as individuals substitute voluntary savings for spending on education. If the direct effect of lower educational spending outweighs the indirect effect of faster capital accumulation, growth decreases. When bequests are inoperative, however, the present results are in line with the existing literature, namely that funded social security is neutral to growth as an increase in forced savings is completely offset by a decrease in voluntary savings whereas educational choices remain unaffected.

Consequently, the neutral effect of funded social security (as in Zhang (1995) and de la Croix and Michel (2002)) is the result of the particular assumption made on

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[1]See de la Croix and Michel (2002).

altruism (dynastic preferences or no altruism at all) and the way human capital is accumulated. In this chapter, we employ the family altruism model, implying that individuals derive utility from the disposable income of their immediate descendants, as has been formalized by Lambrecht et al. (2006). Given this framework, it is also shown that an unfunded pension scheme may bring about faster long-run growth than a fully funded one when bequests are inoperative while the opposite is true when bequests are operative.

Finally, it should be clear that the analysis focusses on changes in steady-state balanced growth equilibria but abstract from transitional issues. Moreover, all the results are positive, not normative, as the current research abstract from welfare implications which are difficult do derive in the present model framework.

3.1.2 Related literature

The existing literature on social security and economic growth can be divided by the way human capital accumulation is modeled and by the way human capital investments are motivated.

For example, the role of both public *and* private investment in education in the relationship between social security funding and economic growth was analyzed for the case of pay-as-you-go social security by Kaganovich and Zilcha (1999). Using a two period overlapping generations model where altruistic parents may enhance their children's human capital endowment by investing into private education, they find a case for the maintenance of the social security system if and only if parents are sufficiently altruistic and have a strong concern for retirement income. Similarly, Kaganovic and Zilcha (2008) study the role of *public* educational funding, in determining the impact on human capital accumulation of alternative social security systems. It turns out that education tax rates and thus also rates of human capital accumulation are higher under a pay-as-you-go pension scheme as compared to a fully funded one.

Contrary, another strand of literature focusses on the growth implications of a pay-as-you-go pension scheme and its incentives for *private* educational spending: Zhang (1995) and Zhang and Zhang (1998) find that a pay-as-you-go pension scheme can be beneficial for economic growth when there are interaction effects with fertility and human capital investments. In their models parents are either concerned about the number of children and/or the utility of their immediate descendants

which in turn motivates altruistic transfers in form of human capital transmission. By contrast, Sanchez-Losada (2000) assumes that private educational spending is motivated by joy-of-giving altruism. He considers the trade-off between the accumulation of physical in form of bequests and human capital and shows that unfunded public pensions can increase growth. If human capital investment is not motivated by altruism but instead by lifetime earnings considerations, Docquier and Paddison (2003) show that the growth effect of a pay-as-you-go system is negative since higher contributions not only reduce the need for private savings but also lowers the discounted value of future earnings and therefore increases the cost of investing in human capital. Finally, Lambrecht et al. (2005) analyze the effect of public pensions on growth when altruistic parents can affect their children's income through investment in education and by leaving bequests. It turns out that an increase in the pension level may enhance growth, in that it alleviates distortions regarding educational choices when bequests are inoperative.

What can be concluded from theses studies is that the impact of human capital accumulation in determining the growth effects of pay-as-you-go social security is by now well documented and critically depends on individuals forecasting horizon, and therefore on their ability to redistribute resources across generations, and on the incentives such a pension scheme generates for human capital investments. By contrast, there are only very few studies so far explicitly taking into account the growth implications of a fully funded pension scheme. As has been argued above, however, human capital accumulation may not only play a crucial role in assessing the growth effects of unfunded social security but also for a fully funded system. Notable exceptions in this field are the studies by Zhang (1995) and Docquier and Paddison (2003) who find that, under some conditions, a fully funded pension scheme is either neutral to growth or may even increase growth.[2] While educational investments are due to lifetime earnings decisions in Docquier and Paddison (2003), they are motivated by dynastic altruism a la Barro (1974) in Zhang (1995). By contrast, in this chapter we assume a form of altruism that allows for a trade-off between bequests and education as parents are concerned about the income of their adult

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[2]Zhang (1995) considers two cases, namely when contributions are either linked to or independent of benefits. Furthermore, he studies the various corner solutions of his model, where for example forced savings completely crowd out private ones. Depending on these specific scenarios, the growth effect may either be zero negative or ambiguous. For the relevant case studied in this paper, however, when private savings are positive and contributions are linked to benefits, fully funded pensions are neutral to growth.

children (not for their utility), which they can affect by either educating them or leaving a bequest[3]. Under this intuitive assumption, the model is more tractable from a technical viewpoint than the recursive form of altruism advocated by Barro (Lambrecht et al., 2005) and allows to provide a full characterization of the effect of funded social security on economic growth.

The remainder is organized as follows. Section 3.2 introduces the model and derives the growth effects of a fully funded pension scheme when bequests are either operative or not. Section 3.3 compares the long-run growth rate under the fully funded scheme with the outcome of an unfunded social security system. It is shown that, in contrast to the existing literature, the relative performance of both systems may critically depend on whether intergenerational transfers are positive or not. Section 3.4 concludes.

3.2   The Model

Consider an overlapping-generations model[4] with a constant population where the size of each generation is normalized to one. Each individual lives for three periods: During childhood individuals are educated by their parents and do not make any economic decision. In the second period of life, each individual gives birth to one child and inelastically supplies h_t efficiency units of labour, his endowment of human capital depending on his parents' spending on education. He receives the market wage w_t and a non-negative bequest b_t from his parents. Income is spent on consumption c_t, private education e_t and savings s_t:

$$I_t \equiv (1 - \tau)w_t h_t + b_t = c_t + e_t + s_t \tag{3.1}$$

where τ is the mandatory contribution rate to the fully funded pension scheme. During old-age, each individual allocates the return to his voluntary savings $R_{t+1}s_t$ plus the return to his mandatory savings, i.e. the return to the pension scheme θ_{t+1}, to second period consumption d_{t+1} and to give a non-negative bequest b_{t+1} to his offspring:

$$d_{t+1} = R_{t+1}s_t + \theta_{t+1} - b_{t+1} \tag{3.2}$$

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[3]See also Chapter 2 for further details and motivation.
[4]The model is taken from Lambrecht et al. (2005) who study the growth effects of a pay-as-you-go pension scheme.

where R_{t+1} is the interest factor at $t + 1$. A balanced funded social security budget requires

$$\theta_{t+1} = R_{t+1}\tau w_t h_t. \tag{3.3}$$

The human capital of an individual in period $t + 1$ is a function of the private investment in education, e_t, and the parent's human capital, h_t:

$$h_{t+1} = De_t^\delta h_t^{1-\delta} = D\bar{e}_t^\delta h_t \tag{3.4}$$

where D is a scale parameter, $0 < \delta < 1$ is the elasticity of the education technology with respect to private educational spending and $\bar{e}_t \equiv e_t/h_t$ private educational spending per unit of human capital. Clearly, education is modeled as a private affair in this framework. The analysis therefore does not include intragenerational externalities and abstracts from the issue of public versus private education finance. Rather, the model focusses on the relationship between funded social security and privately financed human capital formation.

Individual preferences are assumed to be logarithmic and depend on first and second period consumption and on the disposable income of the adult child:

$$U_t = (1 - \beta)\ln c_t + \beta \ln d_{t+1} + \gamma \ln I_{t+1} \tag{3.5}$$

where $0 < \beta < 1$, γ denotes the degree of altruism towards own children and

$$I_{t+1} = (1 - \tau)w_{t+1}h_{t+1} + b_{t+1}. \tag{3.6}$$

Each individual maximizes utility (3.5) subject to the constraints (3.1), (3.2), (3.6) and the non-negativity of bequests $b_{t+1} \geq 0$ by choosing c_t, e_t, s_t, d_{t+1} and b_{t+1}. The first order conditions are:

$$\frac{\partial U_t}{\partial s_t} = -\frac{1 - \beta}{c_t} + \frac{\beta R_{t+1}}{d_{t+1}} = 0 \tag{3.7}$$

$$\frac{\partial U_t}{\partial e_t} = -\frac{1 - \beta}{c_t} + \frac{\gamma(1 - \tau)w_{t+1}D\delta e_t^{\delta-1}h_t^{1-\delta}}{I_{t+1}} = 0 \tag{3.8}$$

$$\frac{\partial U_t}{\partial b_{t+1}} = -\frac{\beta}{d_{t+1}} + \frac{\gamma}{I_{t+1}} \leq 0 \quad (= 0 \text{ if } b_{t+1} > 0) \tag{3.9}$$

The first equation is the standard condition over the life cycle, determining optimal savings. The second equation determines educational investment. The utility for-

gone from consuming less to invest more into children's human capital equals the utility obtained from increasing the disposable income of the child. The third equation gives the optimal amount of bequests. Bequests are positive if the marginal utility from old-age consumption equals the marginal utility from leaving the bequest.

Inserting (3.7) and (3.8) into (3.9) gives

$$(1 - \tau)w_{t+1}D\delta e_t^{\delta-1}h_t^{1-\delta} \geq R_{t+1} \tag{3.10}$$

When bequests are operative, (3.10) holds with equality and the rate of return to private education equals the interest rate. With inoperative bequests, however, the rate of return to private education exceeds the interest rate.

In every period t, firms produce a single output good according to a Cobb-Douglas production function combining physical capital K_t and human capital H_t:

$$Y_t = AK_t^\alpha H_t^{1-\alpha} \tag{3.11}$$

where $A > 0$ is a general index of efficiency and $0 < \alpha < 1$ denotes the capital share. Each firm maximizes profits under perfect competition, implying that production factors are paid their marginal products:

$$w_t = (1 - \alpha)AK_t^\alpha H_t^{-\alpha} = (1 - \alpha)Ak_t^\alpha, \quad R_t = \alpha AK_t^{\alpha-1}H_t^{1-\alpha} = \alpha Ak_t^{\alpha-1} \tag{3.12}$$

where $k_t = K_t/H_t$ is the physical to human capital ratio.

In equilibrium, the market clearing conditions for capital and good market are:

$$K_t = s_{t-1} + \tau w_{t-1}h_{t-1} \tag{3.13}$$
$$Y_t = c_t + s_t + e_t + d_t + \tau w_t h_t \tag{3.14}$$

Inserting the old's budget constraint (3.2) into the good market equilibrium condition, (3.14) becomes

$$d_t + I_t = (1 - \tau(1 - \alpha))Ak_t^\alpha h_t \tag{3.15}$$

3.3   Dynamics and Growth Effects

Inoperative bequests

In a first step, the growth effects of a fully funded pension scheme when bequests are inoperative in period $t+1$ are examined. Then, (3.9) and (3.15) give

$$I_{t+1} = (1-\tau)w_{t+1}h_{t+1} = (1-\tau)(1-\alpha)Ak_{t+1}^{\alpha}h_{t+1} \qquad (3.16)$$

$$d_{t+1} = \alpha Ak_{t+1}^{\alpha}h_{t+1} \qquad (3.17)$$

Combining (3.7), (3.8) and (3.12) one obtains

$$\bar{e}_t^{1-\delta} = \frac{\gamma\delta D}{\beta}k_{t+1} \qquad (3.18)$$

For a given capital stock k_{t+1}, an increase in proportional contributions does not affect educational spending as there are two opposing effects that exactly cancel out: A higher contribution rate not only lowers the perceived return to education and therefore reduces educational spending but also impacts negatively on future incomes which makes parents increase their educational investment in order to alleviate the income loss of their children.

From the non-negative bequest condition (3.10) and (3.18) one can derive an upper bound on the forced savings rate so that bequests are inoperative if the following inequality holds

$$\tau \le 1 - \frac{\alpha\gamma}{\beta(1-\alpha)} \equiv \chi \qquad (3.19)$$

Using (3.4) and (3.18) gives

$$k_{t+1}h_{t+1} = \frac{\beta}{\delta\gamma}\bar{e}_t h_t \qquad (3.20)$$

which in turn allows to determine individual savings s_t and consumption c_t (from (3.13), (3.7) and (3.17)):

$$s_t = \frac{\beta}{\delta\gamma}\bar{e}_t h_t - \tau(1-\alpha)Ak_t^{\alpha}h_t \qquad (3.21)$$

$$c_t = \frac{1-\beta}{\beta}k_{t+1}h_{t+1} = \frac{1-\beta}{\delta\gamma}\bar{e}_t h_t \qquad (3.22)$$

Plugging (3.21) and (3.22) into (3.1) and solving for $\bar{e}_t$ gives

$$\bar{e}_t = \frac{(1-\alpha)\delta\gamma}{1+\delta\gamma} Ak_t^\alpha \tag{3.23}$$

The dynamics of the physical to human capital ratio k_t with inoperative bequests result from combining (3.18) and (3.23)

$$\left[\frac{\delta\gamma D}{\beta} k_{t+1}\right]^{\frac{1}{1-\delta}} = \bar{e}_t = \frac{(1-\alpha)\delta\gamma}{1+\delta\gamma} Ak_t^\alpha \tag{3.24}$$

and converge monotonically towards a steady state $(k,\bar{e})$ which in turn defines a balanced growth path. To assess the growth effect of fully funded social security with inoperative bequests, the long-run educational spending per unit of human capital is derived (note that the growth factor of the economy equals $g = h_{t+1}/h_t = D\bar{e}^\delta$). It is obtained by rearranging (3.24) in steady state:

$$\bar{e}^{1-\alpha(1-\delta)} = \frac{\delta\gamma(1-\alpha)A}{1+\delta\gamma} \left[\frac{\beta}{\delta\gamma D}\right]^\alpha \tag{3.25}$$

Further inspection of equations (3.19) and (3.25) immediately reveals:

Proposition 3.1. *If parent are not sufficiently altruistic towards their child, i.e. $\gamma < (1-\alpha)\beta/\alpha$, then bequests are inoperative and a fully funded pension scheme is neutral to growth.*

The above result is in line with the existing literature, see e.g. Zhang (1995) who assumes dynastic preferences as in Barro (1974), and would also obtain in a model with joy-of-giving altruism where bequests in form of physical capital are absent, see Kaganovich and Zilcha (1999). The intuition is the following: When bequests are inoperative, the return to private education exceeds the interest rate. Therefore, in order to finance second-period consumption, parents are forced to invest part of their income into the lower-paying asset. In such a situation, an increase in forced savings is completely offset by an appropriate decrease in private savings as the return to forced savings equals the private return. Consequently, aggregate savings and parents' educational choices remain unaffected and a funded social security scheme is thus neutral to growth.

Operative bequests

This subsection studies the case when bequests are operative. Then, (3.9) holds with equality and combining (3.9) and (3.15) gives

$$I_{t+1} = \frac{1 - \tau(1 - \alpha)}{1 + \beta/\gamma} A k_{t+1}^\alpha h_{t+1} \tag{3.26}$$

$$d_{t+1} = \frac{1 - \tau(1 - \alpha)}{1 + \gamma/\beta} A k_{t+1}^\alpha h_{t+1} \tag{3.27}$$

From the assumption of non-negative bequests, $b_{t+1} = I_{t+1} - (1 - \tau)w_{t+1}h_{t+1} \geq 0$, it follows:

$$\tau \geq 1 - \frac{\alpha\gamma}{\beta(1 - \alpha)} \equiv \chi \tag{3.28}$$

where χ defines a lower bound on the forced savings rate. If parents are sufficiently altruistic, i.e. $\gamma \geq (1 - \alpha)\beta/\alpha$, it is $\chi \leq 0$ and bequests are always operative. Combining (3.10) and (3.12) determines private educational spending per unit of human capital, $\bar{e}_t$, as a function of the physical to human capital ratio:

$$\bar{e}_t^{1-\delta} = \frac{(1 - \tau)(1 - \alpha)\delta D}{\alpha} k_{t+1} \tag{3.29}$$

which further implies (using (3.4)):

$$k_{t+1}h_{t+1} = \frac{\alpha}{(1 - \tau)\delta(1 - \alpha)} \bar{e}_t h_t \tag{3.30}$$

One can now determine individual savings s_t (from (3.13)) and consumption c_t (from (3.7) and (3.27)):

$$s_t = \frac{\alpha}{(1 - \tau)\delta(1 - \alpha)} \bar{e}_t h_t - \tau(1 - \alpha)A k_t^\alpha h_t \tag{3.31}$$

$$c_t = \frac{(1 - \beta)(1 - \tau(1 - \alpha))}{\alpha(\beta + \gamma)} k_{t+1}h_{t+1} = \frac{(1 - \beta)(1 - \tau(1 - \alpha))}{(1 - \tau)\delta(\beta + \gamma)(1 - \alpha)} \bar{e}_t h_t \tag{3.32}$$

Inserting (3.31) and (3.32) into (3.1) and solving for $\bar{e}_t$ gives

$$\bar{e}_t = \frac{\gamma + \beta\tau(1 - \alpha)}{(\beta + \gamma)B(\tau)} A k_t^\alpha \tag{3.33}$$

where

$$B(\tau) = 1 + \frac{\alpha}{(1 - \tau)\delta(1 - \alpha)} + \frac{(1 - \beta)(1 - \tau(1 - \alpha))}{(1 - \tau)\delta(1 - \alpha)(\beta + \gamma)} \tag{3.34}$$

and $(\gamma+\beta\tau(1-\alpha))/((1-\tau)B(\tau))$ are increasing in τ. Consequently, with operative bequests and given stocks of physical and human capital, k_t and h_t, an increase in forced savings is not completely offset by a decrease in private savings. As a result, aggregate savings increase whereas the impact on educational spending is negative since a higher contribution rate lowers the perceived return to education $((\gamma+\beta\tau(1-\alpha))/B(\tau)$ is decreasing in τ).

By combining (3.29) and (3.33), the dynamics of the physical to human capital ratio k_t are obtained as

$$\left[\frac{(1-\tau)\delta D(1-\alpha)}{\alpha}k_{t+1}\right]^{\frac{1}{1-\delta}} = \bar{e}_t = \frac{\gamma+\beta\tau(1-\alpha)}{(\beta+\gamma)B(\tau)}Ak_t^\alpha \qquad (3.35)$$

which converge monotonically towards a steady state $(k,\bar{e})$ that in turn defines a balanced growth path. Rearranging (3.35) in steady state determines the long-run educational spending per unit of human capital, which captures all positive and negative effects of fully funded social security on the growth factor, i.e. $g = h_{t+1}/h_t = D\bar{e}^\delta$:

$$\bar{e}^{1-\alpha(1-\delta)} = \frac{\gamma+\beta\tau(1-\alpha)}{(\beta+\gamma)B(\tau)}A\left[\frac{\alpha}{(1-\tau)\delta D(1-\alpha)}\right]^\alpha \qquad (3.36)$$

Further analysis of (3.36) gives rise to the following proposition:

Proposition 3.2. *If parents are sufficiently altruistic towards their child, i.e. $\gamma > (1-\alpha)\beta/\alpha$, then bequests are operative and a fully funded pension scheme unambiguously lowers growth if*

$$\beta > \bar{\beta} = \frac{\alpha\gamma(2-\alpha)(1+\gamma\delta)}{(1-\alpha)(1+\gamma-\alpha(1+\gamma\delta))}$$

If $\beta < \bar{\beta}$, however, there exists a growth maximizing size of the funded pension scheme $\hat{\tau} > \chi$ so that an increase in forced savings reduces growth if mandatory contributions are sufficiently large $(\tau > \hat{\tau})$[5].
Proof: *Equation (3.36) can be rewritten as*

$$\bar{e}^{1-\alpha(1-\delta)} = \bar{C}\frac{(1-\tau)^\alpha(\gamma+\beta\tau(1-\alpha))}{C-\tau(1-\alpha)m} \qquad (3.37)$$

with $\bar{C} = \left(\frac{\alpha}{\delta D(1-\alpha)}\right)^\alpha A\delta(1-\alpha)$, $C = \alpha(1-\delta)(\beta+\gamma)+m$ and $m = 1+\gamma\delta-(1-\delta)\beta$.

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[5]For example, suppose $\alpha = 0.4$, $\delta = 0.3$, $\beta = 0.25$ and $\gamma = 0.7$. Then, $\bar{\beta} = 0.74$ and $\hat{\tau} = 0.175$.

The logarithmic derivative of $\partial \bar{e}^{1-\alpha(1-\delta)}/\partial \tau$ then has the same sign as the function

$$\Psi(\tau) = C(\alpha\beta\tau + \beta(1 - 2\tau) - \gamma) + m(\beta\tau^2(1 - \alpha)^2 + \gamma(1 - \alpha\tau)))$$

which decreases from

$$\Psi(\chi) = \frac{\alpha(\beta + \gamma)}{(1 - \alpha)\beta} (\alpha(1 + \gamma\delta)(\alpha + (1 - \alpha)(\beta + \gamma)) - (1 - \alpha)\beta(1 + \gamma))$$

to

$$\Psi(1) = -\alpha(1 + \gamma)(\gamma + (1 - \alpha)\beta) < 0$$

Depending on the sign of $\Psi(\chi)$, the growth effect will therefore either be negative or ambiguous. It is straight forward to show that $\Psi(\chi) \gtrless 0 \Leftrightarrow \beta \lessgtr \bar{\beta}$.

When bequests are operative, the rates of return to education and savings are equal and individuals save to finance old-age consumption and to give a positive amount of bequest to their child. An increase in mandatory contributions, all other things being equal, then lowers the rate of return to education, thereby rendering savings relatively more attractive as a means of enhancing the disposable income of the descendant. As a result, educational spending declines which is bad for growth. This effect is the more severe the more patient individuals are. However, as individuals substitute voluntary savings for private educational spending to provide a larger amount of bequest to their offspring, there is an offsetting effect since aggregate savings increase. Faster capital accumulation in turn translates into higher wages per unit of human capital which increases the rate of return to education. The balance of these effects determines the overall effect of fully funded social security on economic growth.

The above result stands in sharp contrast to the existing literature which typically finds a neutral effect if both bequests and private savings are positive and social security benefits are linked to contributions, see Zhang (1995). Moreover, the neutrality result would also obtain under joy-of-giving altruism if parents care about their children's stock of human capital and the amount of bequest itself as in Sanchez-Losada (2000).

3.4   Funded vs. unfunded social security

This section investigates equilibria of an unfunded social security programm and compares them with the fully funded programm in the previous section. It turns

out that an unfunded social security system may bring about faster growth than a fully funded one when bequests are inoperative whereas the opposite is true with operative bequests, reflecting the different incentives these pension schemes create for private education funding conditional on parents' possibilities to affect their children's disposable income.

The fundamental difference between both pension schemes however is the existence of intergenerational transfers. While a pay-as-you-go pension scheme does include transfers from the current working generation to retirees, a fully funded one does not. As a result, the social security budget (3.3) for a pay-as-you-go pension scheme becomes

$$\theta_{t+1} = \tau w_{t+1} h_{t+1} \tag{3.38}$$

as contributions in period $t+1$ are rebated to the current old. Moreover, the market clearing conditions (3.13), (3.14) and (3.15) are now given by

$$K_t = s_{t-1} \tag{3.39}$$

$$Y_t = c_t + s_t + e_t + d_t \tag{3.40}$$

$$d_t + I_t = Ak_t^\alpha h_t \tag{3.41}$$

since the government does no longer accumulate wealth in form of forced savings. Given these equations and the different meaning of τ, the model can now be solved in an analogous manner as in the previous section (see Lambrecht et al. (2005) for further details). When bequests are inoperative, i.e. (3.19) holds, the long run educational spending per unit of human capital (note that the subscript 'uf' denotes the solution of the unfunded pension scheme) can then be derived as

$$\bar{e}_{uf}^{1-\alpha(1-\delta)} = (1-\alpha)A \left(\frac{\alpha\beta}{\gamma\delta D} \right)^\alpha F(\tau) \tag{3.42}$$

where

$$F(\tau) = \frac{1-\tau}{\tilde{B}(\tau)(1-(1-\alpha)(1-\tau))^\alpha}$$

and

$$\tilde{B}(\tau) = 1 + \frac{1-\beta}{\gamma\delta} + \frac{\alpha\beta}{\gamma\delta(1-(1-\alpha)(1-\tau))}$$

By contrast, when bequests are operative, i.e. (3.28) holds, the educational spending

per unit of human capital is given by

$$\bar{e}_{uf}^{1-\alpha(1-\delta)} = \frac{\gamma A}{\bar{B}(\tau)(\beta+\gamma)} \left(\frac{\alpha}{(1-\tau)\delta D(1-\alpha)} \right)^{\alpha} \tag{3.43}$$

where

$$\bar{B}(\tau) = 1 + \frac{1-\beta+\alpha(\beta+\gamma)}{\delta(\beta+\gamma)(1-\alpha)} \frac{1}{1-\tau}$$

As has been shown by Lambrecht et al. (2005), an increase in unfunded social security harms growth when bequest are operative since the sole effect of proportional taxes is to reduce the return to human capital. When bequests are inoperative, however, there exists a growth maximizing size of the pension scheme $\bar{\tau}$ if individuals are sufficiently patient, i.e.

$$\beta > \frac{\alpha(1+\gamma\delta)(2-\alpha)}{1-\alpha} \tag{3.44}$$

In this case, growth increases with the size of the pension scheme if the contribution rate is sufficiently small ($\tau < \bar{\tau}$). There are several effects working in opposite directions. First, the provision of social security benefits increases individuals' lifetime income and therefore allows them to increase spending on consumption and education which is beneficial for growth. Second, an increase in proportional contributions not only reduces private savings but also the return to education which in turn slows down physical capital accumulation and decreases educational spending. Finally, there is a negative general equilibrium effect as lower levels of physical capital accumulation translate into lower wages per unit of human capital, thereby decreasing the return to education even further.

As will be shown in the following proposition, the sign of the growth effect from an unfunded social security system plays a crucial role in determining whether a fully funded or an unfunded social security system displays higher long-run growth:

Proposition 3.3.

- *If parents are not sufficiently altruistic towards their child, i.e. $\gamma < (1-\alpha)\beta/\alpha$, then bequests are inoperative and an economy with an unfunded pension scheme brings about higher long-run growth than an economy with a fully funded system if parents are sufficiently patient, i.e. (3.44) holds, and contributions are not too high ($\tau < \bar{\tau}$).*

- *If parents are sufficiently altruistic towards their child, i.e. $\gamma > (1-\alpha)\beta/\alpha$,*

then bequests are operative and an economy with a fully funded pension scheme displays higher long-run growth than an economy with an unfunded social security system.

Proof: *When bequests are inoperative it is easy to see from (3.25) and (3.42) that $\bar{e}^{1-\alpha(1-\delta)} = \bar{e}_{uf}^{1-\alpha(1-\delta)}$ if $\tau = 0$. Therefore, as long as the contribution rate is within the growth enhancing range for the unfunded pension scheme, growth will unambiguously be higher under the latter system. When bequests are operative, however, the above claim follows immediately by comparing (3.36) with (3.43).*

3.5   Conclusion

This chapter puts some caution on conventional views about social security. Using a one-sector endogenous growth model in which intergenerational transfers take the form of bequests within the family and where private investment in human capital of children is the engine of growth, the impact of a fully funded social security system on economic growth is studied and its performance is compared to an unfunded pension scheme. Thereby, the analysis complements and qualifies previous studies by Lambrecht et al. (2005) and Zhang (1995), respectively.

More specifically, it is shown that a fully funded pension scheme may harm growth when individuals face a trade-off between educating their children and increasing their children's disposable income by leaving bequests. In this case, an increase in proportional mandatory contribution distorts parents' educational choices as it reduces the return to education so that individuals substitute private educational spending for voluntary savings. If the reduction in private education offsets the positive effect through faster capital accumulation economic growth declines. By contrast, when bequests are inoperative, funded social security is neutral to growth, in line with most of the existing literature, as an increase in forced savings is completely offset by an appropriate decrease in private voluntary savings. Furthermore, an unfunded pension scheme may bring about faster economic growth than a funded one, provided that bequests within the family are inoperative. Whereas funded social security does not alter the incentives to invest into children's education in such a situation, an unfunded system may result in higher educational spending as the provision of old-age social security benefits enhances individuals' lifetime income which in turn allows them to spend more on consumption and education which is beneficial for growth.

The emphasis of this chapter is on the relationship between private incentives for human capital formation and social security benefits. Though the impact of social security on human capital investment has long been ignored in the literature, the effects of alternative programs on future labour productivity are highly relevant in determining the growth implications of these systems (Kaganovic and Zilcha, 2008). Specifically, faster human capital accumulation may serve as a counterweight to population aging and the negative incentives of old-age social security benefits for physical capital accumulation. While several studies have recently shown that unfunded social security may increase growth as it provides further incentives to invest into children's education (see e.g. Sanchez-Losada (2000); Lambrecht et al. (2005)), the present research adds to the ongoing debate regarding the desirability of transition from pay-as-you-go social security regime to a fully funded one by providing an additional argument against fully funded social security. However, the results critically depend on individuals' ability to encounter public policies by redistributing income across generations. More specifically, it turns out that operative bequests within the family may not only overturn the neutrality of fully funded social security with respect to economic growth but also change the relative growth performance of alternative social security schemes. Consequently, one has to be cautious with possible policy implications, as these may vary with the regime in which the economy is operating (operative versus inoperative bequests).

Still, the analysis suggests at least two things: first, the growth effects of pay-as-you-go and fully funded pension schemes are not as clear cut as has been proposed by most preceding studies, in particular when taking into account the incentives of these systems for private human capital investments. Second, from a growth maximizing point of view, a pay-as-you-go scheme is superior to a fully funded one if bequests are inoperative whereas the opposite is true if bequests are operative. As a result, the ongoing discussions regarding a transition to a fully funded system should not only take into account the effect on private education funding as an important factor of increasing labor productivity, but also whether private intergenerational transfers within the family are predominantly operative or not.

Finally, as has been pointed out by Zhang (1995) and Kaganovic and Zilcha (2008) respectively, fertility and public educational spending may be other key determinants of the relationship between alternative social security systems and economic growth. Therefore, an interesting issue of future research would be to analyze the sensitivity

of the results with respect to the assumption that individuals are not only concerned about the income of their immediate descendants but also about the number of children and that education funding is a public instead of a private affair. Both issues, however, would further increase analytical complexity.

So far, the focus of the analysis in the previous chapters has been on the growth and welfare effects of various tax policies when different kinds of intergenerational transfers are present. The next chapter, however, draws attention to another phenomenon which has been on top of the agenda in recent years: fiscal decentralization. In a similar model setup as in the present chapter, when growth is driven by the accumulation of human capital, the implications of fiscal decentralization for growth and welfare are discussed. The model setup features different levels of governments, namely local and central governments. In contrast to the previous chapters, the central government does not decide about a tax rate but instead on the amount of education subsidies to the local governments, which is taken as an indicator of the degree of fiscal decentralization. The analysis reveals that a system in which public education is jointly financed by local and central governments is superior to a funding scheme where either local or central governments exclusively finance educational investments. Moreover the proceeding chapter addresses the issue of conflicting objectives between local and central governments and its implications for growth and welfare.

Chapter 4

Fiscal decentralization and economic growth

4.1 Introduction

4.1.1 Motivation

Throughout the world, both industrialized and developing countries have tried to restructure their public sectors by fostering fiscal decentralization in recent years. While the prior aim of developing nations was to enhance economic efficiency as a response to the failure of centralized planning, in particular in the former Soviet Union and Eastern Europe, the objectives in most industrialized nations have been distinct.[1] For example, in the United States major programs like welfare, Medicaid, legal services or housing have been partially delegated to the states in hope of improving the provision of these services as local authorities are closer to the inhabitants and therefore more sensitive to regional needs and requirements. For similar reasons, Wales and Scotland have established their own regional parliaments within the United Kingdom under the Blair government whereas in Italy even the separation of the country into two independent states has been discussed. Most recently, however, intensified tendencies towards fiscal centralization may also be observed. Examples include the creation and expansion of the European Union as a new top level of government within Europe or the health care reform in the US. Consequently, the existence of these opposing forces clearly raises the question if

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[1]See Oates (1999) for a comprehensive survey of the literature.

fiscal decentralization is actually beneficial to economic performance or if further decentralization may hinder economic development.

From a theoretical point of view, fiscal decentralization, in general, describes the devolution of fiscal responsibilities of the federal government to state and local governments, thereby allowing to increase economic efficiency. More specifically, the provision of public goods by subnational governments is beneficial to economic efficiency as individual preferences and cost differentials are likely to vary across jurisdictions and thus render the output of regional specific levels of public goods optimal on efficiency grounds. This argument has first been emphasized by Tiebout (1956) in a model where highly mobile households are sorted into demand-homogenous regions of residence according to their preferences. In fact, there exist two observations supporting the argument: First, there are some basic informational imperfections. Due to the closeness of local governments to the inhabitants of their jurisdictions, they are much better informed about local preferences and cost conditions whereas the central government lacks these information. Second, there are typically political constraints that prevents the central government from providing higher levels of public goods to some jurisdictions than others.

Despite these strong arguments in favor of fiscal decentralization, however, some studies also point to certain drawbacks originating from higher degrees of fiscal decentralization, e.g. the loss of scale economies and interjurisdictional tax competition in case of a mobile tax base or the inability of politicians to properly account for interregional spillovers (see, e.g. Oates (1999)).

Consequently, as should be clear from the above explanations, fiscal decentralization is a debated phenomenon with many dimensions. One particular important dimension of fiscal decentralization, which has, however, mostly been neglected in the economic debate so far, is economic growth. Researchers focussing on this link have to a great deal be inspired by the work of Oates (1993) who presumes that regional specific investments into infrastructure and human capital could enhance an economy's growth rate, thereby yielding a second strong argument in favor of fiscal decentralization. Still, these theoretical results and presumptions stand in sharp contrast to recent empirical findings as well as the developments in favor of fiscal centralization.

The aim of the present chapter is therefore to shed light on the relationship between fiscal decentralization and economic growth in order to further examine

the presumptions made by Oates and, at the same time, trying to dissolve the discrepancy between the empirical literature and economic theory.

4.1.2   Related literature

Academic research has recently focussed on the relationship between decentralization and growth both in the empirical and in the theoretical literature.[2] On the empirical front, evidence for a positive relationship as conjectured by Oates (1993), however, appears to be mixed. While some studies confirm the positive impact of higher degrees of decentralization on economic growth (Lin and Liu, 2000; Akai and Sakata, 2002; Thiessen, 2003; Stansel, 2005), others face difficulties in establishing a positive relationship and, in fact, obtain either no dependency or a negative one (Davoodi and Zou, 1998; Zhanga and Zou, 1998; Woller and Phillips, 1998; Xie et al., 1999). Still, some contributions also point to the existence of an optimal (growth-maximizing) degree of fiscal decentralization (Thiessen, 2003; Akai et al., 2007). More specifically, the promotion of decentralization may enhance growth if the initial level is sufficiently low, while the opposite holds when starting from large levels of fiscal decentralization. In this case, the relationship clearly turns out to be hump-shaped. In sum, the empirical findings critically depend on the employed data set and estimation techniques and evidence is far from being clear.

On theoretical grounds, by contrast, there are only few papers studying the growth-decentralization nexus. Madies and Ventelou (2005) analyze the effects of tax base sharing on the economy's growth path within a non co-operative game between net tax revenue maximizing and overlapping governments (central and regional). They focus on the effects which may be crucial in determining whether a decentralized tax system may lead to higher growth rates in comparison to a centralized one. More recently, Brueckner (2006) finds a positive linkage between fiscal federalism and economic growth by setting up an overlapping generations model in which public-good levels are tailored to suit the differing demands and preferences of a heterogenous population. Within this framework, a higher degree of fiscal decentralization then provides increased incentives to save and to invest into human capital, thereby fostering growth. Also, Nishimura (2006) presents an endogenous growth model in which a country is subdivided into several jurisdictions. He then proves the existence of a critical degree of complementarity between these jurisdic-

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[2]See Martinez-Vazques and McNab (2003) for a comprehensive survey of this topic.

tions, determining whether fiscal decentralization is superior to fiscal centralization in fostering economic growth. The latter case obtains if complementarity is low.

These papers provide deeper insights into the theoretical foundations for a possible non-monotonic relationship between fiscal decentralization and economic growth. However, they do not explicitly derive an optimal degree, but instead focus on clarifying the effects through which decentralization may affect economic growth rather generally. By contrast, there exists only four studies so far explicitly performing the latter task: Davoodi and Zou (1998) and Xie et al. (1999) extend the standard Barro growth model to allow for public spending of different levels of government. In this way, the growth maximizing spending share of a subnational government turns out to be positive (matching the respective exponent of the Cobb-Douglas production function), which in turn implies a growth-maximizing level of fiscal decentralization. Similarly, Sato and Yamashige (2005) derive the optimal degree of fiscal decentralization in a dynamic model, depending on the economy's initial stage of development. Finally, Ogawa and Yakita (2009) compare growth and welfare maximizing degrees of decentralization within a two-region model with overlapping generations and endogenous growth and find that the growth maximizing degree of fiscal decentralization chosen by the central government is excessive for welfare maximizing local governments.

Likewise, the focus of the present work is on the optimal relationship between fiscal decentralization and long-run economic growth. This issue is examined in the context of educational funding. More specifically, three different types of education funding schemes are considered and their outcomes are compared with respect to growth and welfare levels. To do so, a two region endogenous growth model with overlapping generations featuring matching grants from central to local governments and where endogenous growth is driven by human capital accumulation which in turn builds on private and public educational spending is set up.

In the first funding system, public education is jointly financed by local and central governments where the amount of educational subsidies by the central government is taken as an indicator of fiscal decentralization. This setup is then similar to the one analyzed by Ogawa and Yakita (2009). However, the present analysis extends their framework in two specific ways: First, it is assumed that human capital is not only accumulated through public involvement but also through private fund-

ing.[3] This allows one to study the impact of private educational spending on the growth-decentralization relationship. Second, it is examined how the relationship between fiscal decentralization and growth is affected by the postulation of governments' objectives. In Ogawa and Yakita (2009) local governments are assumed to maximize current residents' welfare levels while the central government cares about the economic long run growth rate. This work, however, also considers the opposite case, namely when local governments maximize the long run economic growth rate while the central government is concerned about the residents' local welfare levels.

In the second funding system, the case of complete fiscal decentralization, local authorities completely finance regional education by means of locally collected taxes whereas under federal funding the central government levies nation-wide taxes to finance education in both regions. The latter case corresponds to complete fiscal centralization. These two frameworks have been analyzed by de la Croix and Monfort (2000) who compare their outcomes with respect to speed of convergence and growth. By contrast, the focus of the present analysis lies on the performance of the different funding schemes in terms of growth and welfare.

To sum up, the present analysis departs from previous studies in several respects: First, it allows to study both the cases of partial and complete decentralization whereas most preceding studies simply focus on the polar cases of complete (de)centralization. Second, it explicitly takes into account the role of private funding of education in determining the growth and welfare maximizing degrees of fiscal decentralization. Finally, the role of government objectives' in determining the optimal degree of fiscal decentralization is highlighted.

Using this framework the following results are obtained: First, there exists a growth-maximizing degree of fiscal decentralization for the mixed funding scheme which turns out to be insufficient from the viewpoint of a welfare maximizing local government. More specifically, if the initial level of fiscal decentralization is sufficiently low, the promotion of fiscal decentralization may not only enhance growth but in addition lead to a welfare gain for local residents. Furthermore, the presence of private educational spending increases the optimal degree of fiscal decentralization: the more productive private spending is in fostering human capital accumulation, the less should public educational spending be subsidized by the central government

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[3]For the importance of private educational spending for human capital accumulation and growth see, e.g. Kaganovich and Zilcha (1999); Blankenau and Simpson (2004).

and a higher degree of fiscal decentralization is thus optimal. Third, the comparison of the different funding systems does not only reveal higher growth rates for the mixed funding scheme but also (after some finite point in time) higher welfare levels than for the federal and regional systems. This is due to the fact that the central government may counterbalance the suboptimal choice of the local tax rate from the growth-maximizing perspective by promoting the degree of fiscal decentralization which induces the local government to increase its own level of taxation. Finally, it is shown for the mixed system that maximum growth and welfare levels may also be achieved by altering governments' objectives, namely by assuming growth-maximizing local governments and a short-sighted central government caring about regional welfare. However, in this case, any degree of fiscal decentralization between zero and one becomes optimal as local governments may counteract any change in the degree of fiscal decentralization and thus the public educational subsidy by adjusting the regional level of taxation, thereby rendering the central governments education policy ineffective.

The remainder of this chapter is organized as follows. Section 4.2 sets up the basic model framework. Section 4.3 examines the mixed funding scheme and derives the growth- and welfare-maximizing degree of fiscal decentralization while Section 4.4 describes the federal and regional funding schemes and compares their outcomes to the mixed system. Section 4.5 focusses on the role of governmets' objectives and Section 4.5 concludes.

4.2   The Model

The model extends previous studies by Ogawa and Yakita (2009) and de la Croix and Monfort (2000) to include private educational spending as an important determinant of human capital accumulation. Furthermore, the outcomes of alternative models of education financing are compared with respect to their growth and welfare levels. Finally, in an extension, it is examined how the results are changed when the objective functions of local and central governments are altered. The basic framework is given by a two-region, three period overlapping generations model where a subscript $i(= 1, 2)$ denotes the region while $t(= 1, 2, ...)$ refers to the time period.

4.2.1 Production

In each region i, a large number of identical firms produce a homogenous output good under perfect competition. The production of a representative firm in period t is represented by the following Cobb-Douglas type production technology with constant returns to scale

$$Y_{i,t} = K_{i,t}^{\alpha} L_{i,t}^{1-\alpha} \tag{4.1}$$

where $K_{i,t}$ and $L_{i,t}$ are the physical capital and effective labour employed in region i at date t and $\alpha \in (0,1)$. Profit maximization under perfect competition implies that the marginal product of human and physical capital equals the wage $w_{i,t}$ and interest rate $R_t (= 1 + r_t)$, respectively:

$$w_{i,t} = (1 - \alpha) K_{i,t}^{\alpha} L_{i,t}^{-\alpha} = (1 - \alpha) k_{i,t}^{\alpha} \tag{4.2}$$

$$R_t = \alpha K_{i,t}^{\alpha-1} L_{i,t}^{1-\alpha} = \alpha k_{i,t}^{\alpha-1} \tag{4.3}$$

where $k_{i,t} = K_{i,t}/L_{i,t}$ is the physical capital to effective labour ratio of region i in period t.

Throughout this chapter, it will be assumed that population size is assumed to be constant and normalized to one. Consequently, the labour market clearing condition implies that the amount of effective labour used in the production process equals the per capita human capital stock, henceforth denoted by $h_{i,t}$, in region i at period t, i.e. $L_{i,t} = h_{i,t}$. Furthermore, labour is assumed to be immobile whereas capital is completely free to move across regions, implying the equalization of regional capital-labour ratios and thus also of wages per unit of human capital, i.e. $k_{i,t} = k_t$ and $w_{i,t} = w_t$ for $i = 1, 2$.

4.2.2 Households

Each individual lives for three periods. During the first period of life, when young, individuals are completely passive and do not make any decisions. They benefit from educational spending and accumulate their own stock of human capital in the region of residence. Their consumption is fully included in their parents' consumption. During the second period of life, when adult, each individual inelastically supplies $h_{i,t}$ efficiency units of labour to regional firms, his endowment of human capital depending on the amount of public educational spending and on his parents'

spending on education. An individual receives the market wage $w_{i,t}h_{i,t}$[4] which constitutes his sole source of income when young. Adults distribute this income among own consumption $c_{i,t}$, private educational spending $x_{i,t}$ and savings $s_{i,t}$:

$$(1 - \tau_{i,t} - \tau_{c,t})w_{i,t}h_{i,t} = c_{i,t} + x_{i,t} + s_{i,t} \tag{4.4}$$

where $\tau_{i,t}$ and $\tau_{c,t}$ are the income tax rates set by the local and central government, respectively, as will be further explained below. During old-age, second period consumption $d_{i,t+1}$ is financed by savings and their proceeds $R_{t+1}s_{i,t}$. Old individuals completely consume their income and nothing is bequeathed. Second period's budget constraint is thus

$$d_{i,t+1} = R_{t+1}s_{i,t} \tag{4.5}$$

The human capital of an individual of region i in period $t+1$ is a function of his parents' private educational spending, $x_{i,t}$, the public investment in education, $e_{i,t}$, his parents' human capital, $h_{i,t}$, and the other region's stock of human capital, $h_{j,t}$:

$$h_{i,t+1} = Be_{i,t}^{\theta}x_{i,t}^{\eta}(h_{i,t} + \epsilon h_{j,t})^{1-\theta-\eta} \tag{4.6}$$

where B is a scale parameter and $0 < \theta$, $\eta < 1$, with $\theta + \eta \le 1$, are the elasticities of the technology of education with respect to spending on private and public educational spending, respectively. The specification of the human capital production technology in (4.6) features two types of spill-over: First, there is a local externality as part of the adults regional human capital $h_{i,t}$ is inherited by the young individuals. Second, there also exist cross-regional spill-over effects since an individual's stock of human capital hinges on the other region's stock $h_{j,t}$, thereby introducing convergence force into the model. The strength of this latter externality is parameterized by the parameter $0 \le \epsilon \le 1$, capturing the possibilities of knowledge transmission between regions.

Furthermore, private and public human capital expenditures are clearly modeled as complements. This modeling captures the fact that a large part of public expenditures finance primary and secondary education while private expenditures are predominantly used to finance college education and on-the-job-training (Kaganovich and Zilcha, 1999; Blankenau and Simpson, 2004). Consequently, public expendi-

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[4]Thus, $w_{i,t}$ is the wage rate per efficiency unit of labour in region i at period t.

tures ensure the acquisition of general skills whereas private educational spending is to obtain more specific training and skills. A combination of both types of skills then contributes to the human capital accumulation of future generations.

Individual preferences are assumed to be logarithmic and depend on life-cycle consumption levels and on next period's stock of human capital in order to provide individuals with an incentive to invest into private educational spending. Consequently, the life-cycle utility function of an individual living in region i and born in period t is

$$U(c_{i,t}, d_{i,t+1}, h_{i,t+1}) = \ln c_{i,t} + \beta \ln d_{i,t+1} + \lambda \ln h_{i,t+1} \tag{4.7}$$

where $0 < \beta < 1$ is a discount factor and λ denotes the degree of altruism towards the own child which is expressed via the offspring's human capital. Due to the positive correlation between human capital and future earnings, this specification assumes that parents care about the quality or the economic success of their children as measured by the children's lifetime income, an idea originally developed by Becker and Tomes (1979).

Each individual maximizes utility subject to the constraints (4.4), (4.5), (4.6) and the non-negativity of private educational spending $x_{i,t} \geq 0$ by choosing $c_{i,t}$, $s_{i,t}$, $d_{i,t+1}$ and $x_{i,t}$. Assuming interior solutions, one obtains:

$$c_{i,t} = \frac{1}{1 + \beta + \lambda\eta}(1 - \tau_{i,t} - \tau_{c,t})w_{i,t}h_{i,t} \tag{4.8}$$

$$s_{i,t} = \frac{\beta}{1 + \beta + \lambda\eta}(1 - \tau_{i,t} - \tau_{c,t})w_{i,t}h_{i,t} \tag{4.9}$$

$$x_{i,t} = \frac{\lambda\eta}{1 + \beta + \lambda\eta}(1 - \tau_{i,t} - \tau_{c,t})w_{i,t}h_{i,t} \tag{4.10}$$

$$d_{i,t+1} = \frac{\beta}{1 + \beta + \lambda\eta}R_{t+1}(1 - \tau_{i,t} - \tau_{c,t})w_{i,t}h_{i,t} \tag{4.11}$$

From equation (4.10) it is easy to see that the amount of private educational spending critically depends on its output elasticity with respect to human capital, namely η. Clearly, an increase in η enhances private educational spending, whereas there is no private funding if η is zero and private spending therefore does not contribute to the process of human capital accumulation. In this case, the model is equivalent to the one used by Ogawa and Yakita (2009). In the following analysis, the main interest is therefore to study the impact of private educational spending on the decentralization-growth relationship by focussing on changes in this parameter.

Making use of equations (4.8)-(4.11) the regional indirect utility function can be written as

$$V_{i,t} = (1 + \beta + \lambda\eta) \ln[(1 - \tau_{i,t} - \tau_{c,t})w_{i,t}h_{i,t}] + \theta\lambda \ln e_{i,t} + M_{i,t} \qquad (4.12)$$

where $M_{i,t}$ is a constant satisfying

$$M_t = \lambda \ln B + \lambda\eta \ln(\lambda\eta) + \beta \ln(\beta R_{t+1}) - (1 + \beta + \lambda\eta) \ln(1 + \beta + \lambda\eta) + (1 - \theta - \eta)\lambda \ln h_{i,t}.$$

4.2.3   Government

There are two types of governments in the model, a local government in each region as well as a central government. Following Ogawa and Yakita (2009), the case in which local governments are assumed to maximize their residents' utility is analyzed in a first step. To do so, each local government sets an income tax rate $\tau_{i,t}$ in order to finance local public education $e_{i,t}$. Consequently, local government's budget constraint amounts to

$$e_{i,t} = \tau_{i,t}w_{i,t}h_{i,t} + T_{i,t} \qquad (4.13)$$

where $T_{i,t}$ is the transfer made by the central government. The transfer is assumed to take the form of an education subsidy from central to local governments:

$$T_{i,t} = (1 - \delta)e_{i,t}. \qquad (4.14)$$

where $0 \leq 1 - \delta \leq 1$ denotes the matching grant rate for local public education. In the following analysis, δ is taken as a measure of fiscal decentralization since it represents the autonomy of local governments in financing their own budgets. For example, the higher δ, the less local governments depend on fiscal assistance through the central government. In particular, the cases $\delta = 1$ and $\delta = 0$ correspond to complete fiscal decentralization and centralization, respectively, and will be discussed in greater detail below.[5]

In order to finance these subsidies, the central government raises a uniform income

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[5]Note that, from a theoretical point of view, it would also be possible to allow for $\delta > 1$. Then, the central government would effectively tax local educational spending, a case which is, however, outside the scope of the present analysis.

tax rate $\tau_{c,t}$. The corresponding budget constraint is then given by

$$\tau_{c,t}(w_{1,t}h_{1,t} + w_{2,t}h_{2,t}) = (1 - \delta)(e_{1,t} + e_{2,t}) \tag{4.15}$$

It is further assumed that the central government's objective is to maximize the nation-wide growth rate by choosing the appropriate level of the matching grant. However, the assumptions about governments' objectives will be altered in an extension to demonstrate how the results are affected by these specific assumptions. In any way, the objectives of local and central governments do not coincide which seems to be a realistic feature of real world economies, capturing possible tradeoffs between fiscal decentralization and growth.

4.3 Alternative education funding systems

4.3.1 Mixed funding scheme (MF)

Throughout this section assume $0 < \delta < 1$ which means that both the central and the local government have an active role in the economy and contribute to some extend to financing educational spending. Given this restriction, it is analyzed how the presence of private educational spending affects the relationship between fiscal decentralization, growth and welfare in equilibrium. The results of this section will closely be discussed against the two polar cases of complete federal ($\delta = 0$) and regional ($\delta = 1$) funding below and their outcomes will be compared with respect to growth and welfare levels.

To start with the analysis, first turn to the optimal choice of the welfare maximizing local government. Maximizing residents' utility (4.7) subject to

$$e_{i,t} = \frac{1}{\delta}\tau_{i,t}w_{i,t}h_{i,t} \tag{4.16}$$

gives the welfare maximizing level of taxation in region i as

$$\tau_{i,t} = \frac{\theta\lambda(1 - \tau_{c,t})}{1 + \beta + \lambda(\eta + \theta)}. \tag{4.17}$$

Inserting (4.17) into (4.16) and making use of the government's budget constraint

(4.15), the tax rate of the central government is given by

$$\tau_{c,t} = \frac{\theta\lambda(1-\delta)}{\theta\lambda + \delta(1+\beta+\lambda\eta)}. \tag{4.18}$$

Finally, the equilibrium tax rate set by the local government amounts to

$$\tau_{i,t} = \frac{\theta\lambda\delta}{\theta\lambda + \delta(1+\beta+\lambda\eta)}. \tag{4.19}$$

From this equation, it can easily be inferred that $\partial\tau_{i,t}/\partial\delta > 0$ and $\partial\tau_{i,t}/\partial\eta < 0$. These comparative static results are summarized in a first proposition:

Proposition 4.1. *The welfare maximizing tax rate for the local government is*

(i) *increasing in the degree of fiscal decentralization*

(ii) *decreasing in the output elasticity of human capital with respect to private educational spending.*

A large transfer system (a lower δ) reduces local governments' incentives to raise their own revenues by setting higher tax rates. Rather, they anticipate that increased public spending on education requires a larger central government tax rate which in turn provides inducements to lower the overall tax burden by alleviating local levels of taxation. By contrast, as can be inferred from part (ii) of the above proposition, local governments will set lower taxes the more important private educational spending is in fostering human capital accumulation. In this case, a lower tax rate leaves individuals with more income out of which to fund their educational spending. Consequently, when compared to the related model where private spending on education is absent ($\eta = 0$), local tax rates will unambiguously lower to account for the positive impact of private educational spending on human capital accumulation.

Note further that local governments are assumed to be short-sighted as they set the local tax rate to balance the tradeoff between the positive utility effect through higher levels of public education with the negative effects stemming from lower levels of consumption, savings and private education funding, thereby ignoring the impact of educational spending on long-run capital accumulation. This assumption may be justified as we implicitly assume a majority voting process to determine the local

level of taxation.[6]

In a next step, following de la Croix and Monfort (2000), the dynamics of the model in terms of three variables, the capital-labour ratio, k_t, the ratio of workers' consumption in region 2 to that in region 1, $z_t = c_{2,t}/c_{1,t}$, as well as the growth factor in region i, $g_{i,t} = h_{i,t+1}/h_{i,t}$ are analyzed. As, in equilibrium, wages and tax rates are identical across regions, z_t is also a measure of the ratio of regional human capital, $z_t = h_{2,t}/h_{1,t}$. To see how z_t evolves over time, substitute (4.2), (4.10), (4.16) into (4.6) to obtain the dynamic equations of the stock of human capital in each region:

$$
\begin{aligned}
h_{1,t+1} &= B e_{1,t}^{\theta} x_{1,t}^{\eta} (h_{1,t} + \epsilon h_{2,t})^{1-\theta-\eta} \\
&= B[\lambda\eta\delta]^{\eta}[\theta\lambda]^{\theta} \left[\frac{(1-\alpha)k_t^{\alpha}}{\theta\lambda + \delta(1+\beta+\lambda\eta)} \right]^{\theta+\eta} h_{1,t}(1+\epsilon z_t)^{1-\theta-\eta} \quad (4.20)
\end{aligned}
$$

$$
\begin{aligned}
h_{2,t+1} &= B e_{2,t}^{\theta} x_{2,t}^{\eta} (h_{2,t} + \epsilon h_{1,t})^{1-\theta-\eta} \\
&= B[\lambda\eta\delta]^{\eta}[\theta\lambda]^{\theta} \left[\frac{(1-\alpha)k_t^{\alpha}}{\theta\lambda + \delta(1+\beta+\lambda\eta)} \right]^{\theta+\eta} h_{2,t}(1+\epsilon z_t^{-1})^{1-\theta-\eta} \quad (4.21)
\end{aligned}
$$

Dividing (4.21) by (4.20) then determines the dynamics of the regional human capital differential:

$$
z_{t+1} = \frac{h_{2,t+1}}{h_{1,t+1}} = \frac{h_{2,t}(1+\epsilon z_t^{-1})^{1-\theta-\eta}}{h_{1,t}(1+\epsilon z_t)^{1-\theta-\eta}} = z_t \left(\frac{1+\epsilon z_t^{-1}}{1+\epsilon z_t} \right)^{1-\theta-\eta} \quad (4.22)
$$

The growth factor of region 1 (2) is obtained from dividing equation (4.20) ((4.21)) by $h_{1,t}$ ($h_{2,t}$), respectively:

$$
g_{1,t} = \frac{h_{1,t+1}}{h_{1,t}} = B[\lambda\eta\delta]^{\eta}[\theta\lambda]^{\theta} \left[\frac{(1-\alpha)k_t^{\alpha}}{\theta\lambda + \delta(1+\beta+\lambda\eta)} \right]^{\theta+\eta} (1+\epsilon z_t)^{1-\theta-\eta} \quad (4.23)
$$

$$
g_{2,t} = \frac{h_{2,t+1}}{h_{1,t}} = B[\lambda\eta\delta]^{\eta}[\theta\lambda]^{\theta} \left[\frac{(1-\alpha)k_t^{\alpha}}{\theta\lambda + \delta(1+\beta+\lambda\eta)} \right]^{\theta+\eta} (1+\epsilon z_t^{-1})^{1-\theta-\eta} \quad (4.24)
$$

Finally, to see how the capital-labour ratio evolves over time, divide the aggregate stock of physical capital, which, according to the capital market clearing condition, is given by the sum of individual regional savings, i.e. $K_{t+1} = s_{1,t} + s_{2,t}$, by the sum

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[6]In fact, this assumption ensures analytical tractability as it rules out any tax competition between local regions.

of regional human capital stocks, $h_{1,t+1} + h_{2,t+1}$, to reach

$$k_{t+1} = \frac{\beta \delta^{1-\eta}}{B[\lambda\eta]^{\eta}[\theta\lambda]^{\theta}} \left[\frac{(1-\alpha)k_t^{\alpha}}{\theta\lambda + \delta(1+\beta+\lambda\eta)} \right]^{1-\eta-\theta} \frac{1+z_t}{(1+\epsilon z_t)^{1-\theta-\eta} + z_t(1+\epsilon z_t^{-1})^{1-\theta-\eta}}$$

(4.25)

The dynamics of the model are completely described by equations (4.22), (4.23), (4.24) and (4.25). From (4.22) it can easily be inferred that the interregional differential converges monotonically towards a steady state, namely $z_{t+1} = z_t = z = 1$, so that the capital-labour ratio and the growth factor will also converge to a steady state.

Given these findings, the policy choice of the growth maximizing central government in the steady state, where $z_{t+1} = z_t = 1$ and $k_{t+1} = k_t = k$, can now be examined. To do so, derive the long-run growth rate of the economy as follows. Making use of the above equations, the steady state capital-labour ratio from (4.25) is given by

$$k = \left\{ \frac{\beta \delta^{1-\eta}}{B(\lambda\eta)^{\eta}(\theta\lambda)^{\theta}(1+\epsilon)^{1-\theta-\eta}} \left[\frac{1-\alpha}{\theta\lambda + \delta(1+\beta+\lambda\eta)} \right]^{1-\theta-\eta} \right\}^{\frac{1}{1-\alpha(1-\theta-\eta)}}$$

(4.26)

The long run growth factor g can then be obtained by inserting (4.26) together with $z_t = 1$ into (4.23) or (4.24):

$$g^{MF} = \Psi \delta^{\frac{\eta+\alpha\theta}{1-\alpha(1-\theta-\eta)}} \left[\frac{1-\alpha}{\theta\lambda + \delta(1+\beta+\lambda\eta)} \right]^{\frac{\theta+\eta}{1-\alpha(1-\theta-\eta)}}$$

(4.27)

where

$$\Psi = \beta^{\frac{\alpha(\theta+\eta)}{1-\alpha(1-\theta-\eta)}} \left(B(\lambda\eta)^{\eta}(\theta\lambda)^{\theta}(1+\epsilon)^{1-\theta-\eta} \right)^{\frac{1-\alpha}{1-\alpha(1-\theta-\eta)}}$$

Taking the first derivative of the growth factor with respect to δ gives

$$Sign\left[\frac{\partial g^{MF}}{\partial \delta} \right] = Sign\left[\frac{\eta+\alpha\theta}{\delta} - \frac{(\theta+\eta)(1+\beta+\lambda\eta)}{\theta\lambda + \delta(1+\beta+\lambda\eta)} \right].$$

(4.28)

Solving the above equation for δ, the optimal degree of fiscal decentralization, δ^*, is obtained as

$$\delta^* = \frac{\lambda(\eta+\alpha\theta)}{(1-\alpha)(1+\beta+\lambda\eta)}$$

(4.29)

This gives rise to the following proposition:

Proposition 4.2.   *(i) There exists a growth maximizing degree of fiscal decentralization δ^* so that increasing fiscal decentralization may enhance growth for $\delta < \delta^*$ while it reduces growth when $\delta > \delta^*$.*

(ii) Suppose that $\lambda < \frac{1+\beta}{\alpha\theta}$. Then, an increase in the output elasticity of private educational spending increases the optimal degree of fiscal decentralization, i.e. $\partial\delta^*/\partial\eta > 0$.

Two remarks are in order. First, the above result clearly extends the so called Barro rule (see Barro (1990)), according to which the growth-maximizing level of taxation equals the production share of the accumulated factor ensuring the endogenous growth process. In this model, the sum of both tax rates set by the local and central government amounts to[7] $\tau_{i,t}^* + \tau_{c,t}^* = \frac{\theta}{\theta+\eta}(1-\alpha)$ which is unambiguously lower than the corresponding production share if private educational spending is positive ($\eta > 0$). Such deviation stems from the fact that the negative impact of higher taxation on capital accumulation *and* private educational spending must be balanced with the positive effect resulting from increased spending on public spending in fostering human capital accumulation. Second, with respect to the impact of private educational spending in determining the growth-maximizing degree of fiscal decentralization, the above proposition shows that the more productive private spending is in fostering human capital accumulation, the less should public educational spending be subsidized by the central government so that a higher degree of fiscal decentralization becomes optimal. This, however, only holds if parents' degree of altruism and therefore the prevalent level of private spending is sufficiently low as, then, the (possibly) positive effects of a higher output elasticity on the level of private spending and the equilibrium capital stock exceed the negative effect on the level of public educational funding.

In a next step, growth and welfare maximizing levels of fiscal decentralization will be compared. As local and central governments have different objectives, the growth maximizing level of fiscal decentralization δ^* set by the central government must be suboptimal from the perspective of the local welfare maximizing government. More specifically, the question is whether such level will be excessive or insufficient for local welfare. To address this issue, the regional indirect utility at the steady state

---

[7]To see this, substitute (4.29) into (4.19) and (4.18), respectively.

equilibrium is derived as follows:

$$
\begin{aligned}
V_t^{*,MF} &= \ln c_t^* + \beta \ln d_{t+1}^* + \lambda \ln h_{t+1}^* \\
&= \quad (1 + \beta + \lambda\eta + (1-\eta)\kappa) \ln \delta + t(1+\beta+\lambda) \ln g^{MF} \\
&\quad - (1 + \beta + \lambda(\theta+\eta) + (1-\theta-\eta)\kappa) \ln(\theta\lambda + \delta(1+\beta+\lambda\eta)) + \bar{M} \quad (4.30)
\end{aligned}
$$

where
$$
\kappa = \frac{(1+\beta)\alpha + \beta(\alpha-1) + \lambda\alpha(\theta+\eta)}{1 - \alpha(1-\theta-\eta)}, \quad (4.31)
$$

$$
\bar{M} = (1+\beta+\lambda\eta) \ln(1+\beta+\lambda\eta) + \theta\lambda \ln(\theta\lambda) + \kappa \ln \left(\frac{\beta(1-\alpha)^{1-\eta-\theta}}{B(\lambda\eta)^\eta (\theta\lambda)^\theta (1+\epsilon)^{1-\eta-\theta}} \right) \quad (4.32)
$$

and c_t^*, d_{t+1}^* and h_{t+1}^* denote the steady state levels of consumption and the stock of human capital, respectively[8]. Taking the derivative of (4.30) with respect to δ gives

$$
\begin{aligned}
\frac{\partial V_t^{*,MF}}{\partial \delta} &= - \frac{1 + \beta + \lambda(\theta+\eta) + (1-\theta-\eta)\kappa}{\theta\lambda + \delta(1+\beta+\lambda\eta)}(1+\beta+\lambda\eta) \\
&\quad + \frac{1 + \beta + \lambda\eta + (1-\eta)\kappa}{\delta} + t(1+\beta+\lambda)\frac{1}{g^{MF}}\frac{\partial g^{MF}}{\partial \delta} \quad (4.33)
\end{aligned}
$$

Clearly, regional welfare is affected by all factors impacting on individuals' consumption and education levels, as well as through changes in the growth factor. However, when evaluating (4.33) at $\delta = \delta^*$, the growth effect will be zero, i.e $\partial g^{MF}/\partial\delta = 0$. In this case it is

$$
Sign \left[\frac{\partial V_t^{*,MF}}{\partial \delta} \right]\bigg|_{\delta=\delta^*} = Sign \left[\frac{\theta(1+\beta+\lambda\eta)(1+\alpha\beta)(1-\alpha)}{\lambda(\theta+\eta)(\theta\alpha+\eta)} \right] > 0. \quad (4.34)
$$

Proposition 4.3. *The degree of fiscal decentralization for growth-maximization is insufficient from the viewpoint of a welfare maximizing local government.*

Due to the shortsightedness of local governments with respect to the time horizon and interregional externalities, they do not take into account the positive effect of educational spending on long-run capital accumulation when setting the local tax rate. Consequently, welfare and growth maximizing levels of local taxation decouple and the optimal tax rate chosen by the local government turns out to be insufficient from the perspective of the growth maximizing central government.

---

[8]The steady state levels of consumption and human capital are obtained by evaluating (4.8), (4.11) and (4.20) at the steady state, specifically, by inserting (4.18), (4.19), (4.26), $h_t^* = h_0 g^t$ and $z = 1$ where needed.

However, the central government may counteract this dilemma by promoting fiscal decentralization which in turn increases the local level of taxation.

Furthermore, according to the above proposition, the promotion of fiscal decentralization, provided an initial low level, i.e. $0 < \delta < \delta^*$, may not only enhance growth but in addition lead to a welfare gain for the residents. By contrast, if the prevalent level of fiscal decentralization is sufficiently large, i.e. $0 < \delta^* < \delta$, there is a tradeoff between lower levels of growth but (possibly) higher residents' welfare levels. Viewed from the opposite side, the promotion of fiscal centralization seems to be superior in this case.[9]

So far, the focus of the analysis was on a mixed funding system. It has been shown that there exists an optimal degree of fiscal decentralization and how this degree should be adapted to the presence of private educational spending. However, to further assess the relevance of this setting, the outcome of the mixed funding system with the two polar cases of complete fiscal (de)centralization regarding their implications for growth and welfare will be compared.

4.3.2 Federal funding (FF) and regional funding (RF) schemes

For $\delta = 0$, education is completely financed by the central government, corresponding to the case of complete fiscal centralization. The federal government levies a common, nation-wide income tax which is determined by means of majority voting at the regional level to maximize local welfare as in the preceding section. Tax revenues, however, are equally shared between the two regions, reflecting the central government's inability to discriminate against one region by providing regional specific levels of education. Consequently, it is:

$$e_t = \frac{1}{2}\tau_{c,t} \sum_{i=1,2} w_{i,t} h_{i,t} \tag{4.35}$$

---

[9]Interestingly, these implications are exactly the opposite of what has been shown by Ogawa and Yakita (2009): They consider a net equalization scheme in form of an equalization transfer and find that the promotion of fiscal decentralization will increase growth but reduce welfare, provided that fiscal decentralization is initially low. Consequently, though the maximum growth rate and the welfare level under the net equalization scheme and the mixed funding system considered here may be identical, policy implications still turn out to be different.

and $\tau_{i,t} = 0$. The outcome of the majority voting process, i.e. maximization of (4.12) with respect to $\tau_{c,t}$, is

$$\tau_{c,t} = \frac{\theta\lambda}{\theta\lambda + 1 + \beta + \lambda\eta} \tag{4.36}$$

Using the same procedure as in the preceding section, the growth factor of both regions and the regional indirect utility at the steady state are obtained as:

$$g^{*,FF} = \Psi \left(\frac{1 - \alpha}{1 + \beta + \lambda(\eta + \theta)} \right)^{\frac{\eta+\theta}{1-\alpha(1-\theta-\eta)}} \tag{4.37}$$

and

$$V_t^{*,FF} = \bar{M} - (1 + \beta + \lambda(\theta + \eta) + (1 - \theta - \eta)\kappa) \ln(1 + \beta + \lambda(\theta + \eta))$$
$$+ t(1 + \beta + \lambda) \ln g^{*,FF} \tag{4.38}$$

with Ψ, κ and $\bar{M}$ as above.

Now, have a look at the case $\delta = 1$. Then, education is completely financed at the local level which corresponds to the case of complete fiscal decentralization. Therefore, regional education funding only rests on regional resources and may thus differ across regions. Local tax rates are, again, determined by means of a majority voting process. Consequently, it is:

$$e_{i,t} = \tau_{i,t} w_{i,t} h_{i,t} \tag{4.39}$$

and $\tau_{c,t} = 0$. The optimal regional tax rate is given by

$$\tau_{i,t} = \frac{\theta\lambda}{\theta\lambda + 1 + \beta + \lambda\eta} \tag{4.40}$$

The growth factor of both regions and the regional indirect utility at the steady state are obtained as:

$$g^{*,RF} = \Psi \left(\frac{1 - \alpha}{1 + \beta + \lambda(\eta + \theta)} \right)^{\frac{\eta+\theta}{1-\alpha(1-\theta-\eta)}} \tag{4.41}$$

and

$$
\begin{aligned}
V_t^{*,RF} = {}& \bar{M} - (1 + \beta + \lambda(\theta + \eta) + (1 - \theta - \eta)\kappa) \ln(1 + \beta + \lambda(\theta + \eta)) \\
& + t(1 + \beta + \lambda) \ln g^{*,RF}
\end{aligned}
\tag{4.42}
$$

where Ψ, κ and $\bar{M}$ are the same constants as before.

Comparing the growth factors of the different systems, equations (4.27), (4.37) and (4.41), yields:

Proposition 4.4. *The equilibrium with federal funding has the same growth factor as the equilibrium with regional funding. The equilibrium with mixed funding, however, displays higher equilibrium growth, i.e.*

$$
g^{*,FF} = g^{*,RF} < g^{*,MF}
\tag{4.43}
$$

Proof: *To show the above inequality note that $g^{*,RF} \gtrless g^{*,MF}$ is equivalent to*

$$
\left(\frac{1}{1 + \beta + \lambda(\eta + \theta)} \right)^{\eta + \theta} \gtrless \left(\frac{\lambda(\eta + \alpha\theta)}{(1 - \alpha)(1 + \beta + \lambda\eta)} \right)^{\eta + \alpha\theta} \left(\frac{1 - \alpha}{\lambda(\eta + \theta)} \right)^{\eta + \theta}
$$

The minimum of the expression on the left hand side with respect to α equals

$$
\min_{\alpha \in [0,1]} \left[\left(\frac{\lambda(\eta + \alpha\theta)}{(1 - \alpha)(1 + \beta + \lambda\eta)} \right)^{\eta + \alpha\theta} \left(\frac{1 - \alpha}{\lambda(\eta + \theta)} \right)^{\eta + \theta} \right] = \left(\frac{1}{1 + \beta + \lambda\eta} \right)^{\eta + \theta}
$$

From these equations it is easy to see that the inequality holds.

The equality of the equilibrium growth factor with regional and federal funding has already been shown by de la Croix and Monfort (2000) in a model without private educational spending. The intuition behind this result is the following: After convergence of both regions to the steady state, federal and regional system are equivalent as the fiscal spill-over incorporated in the federal funding system is no longer operative. Rather, both regions end up with the same stock of human capital. This of course also holds for the mixed funding system.[10] The important difference between the mixed funding and the regional/federal funding system, however, is

---

[10]Note, that the present analysis does not explicitly consider the speed of convergence towards the steady state of each system, but instead focuses on the long run growth and welfare effects. Nevertheless, there may be trade offs between long-run growth and short-run convergence as has been shown by de la Croix and Monfort (2000) and also Ogawa and Yakita (2009).

the number of policy instruments that governments may decide on: While in the regional and federal funding system the local and central government's tax rate, respectively, is set in order to maximize local welfare levels, which in turn ultimately determine the long-run growth rate, central and local government's policy variables are chosen to comply with different objectives in the mixed funding system. Therefore, the central government may counterbalance the suboptimal choice of the local tax rate from the growth-maximizing perspective by promoting the degree of fiscal decentralization which induces the local government to raise its own level of taxation. This, eventually, leads to the superiority of the mixed funding system with respect to the growth rate.

In a next step, the different models are compared regarding their long-run welfare implications. Inspection of equations (4.30), (4.38) and (4.42) shows:

Proposition 4.5. *There exists a date t^* so that for all $t \geq t^*$ the regional indirect utility at the steady state for the equilibrium with mixed funding will be higher than the equilibria with federal and regional funding which are identical, i.e.*

$$V_t^{*,FF} = V_t^{*,RF} < V_t^{*,MF} \tag{4.44}$$

Proof: *Rearranging the inequality $V_t^{*,RF} \gtreqless V_t^{*,MF}$ yields*

$$(1 + \beta + \lambda\eta + \kappa(1 - \eta)) \ln \left(\frac{\theta\lambda + \delta^*(1 + \beta + \lambda\eta)}{\delta^*(\theta\lambda + \beta + \lambda\eta)} \right) + \theta(\lambda - \kappa) \ln \left(\frac{\theta\lambda + \delta^*(1 + \beta + \lambda\eta)}{\delta^*(\theta\lambda + \beta + \lambda\eta)} \right)$$
$$+ t(1 + \beta + \lambda) \ln \left(\frac{g^{*,RF}}{g^{*,MF}} \right) \gtreqless 0$$

The first expression on the left hand side is positive while the sign of the second one is ambiguous. Due to proposition 4.4 the third expression is always negative. Noting that the left hand side of the above equation is monotonically declining in t and defining t^* as the smallest number for which the above expression holds with equality, then proves the argument.

In the steady state, not only the growth factors of the federal and regional funding systems are equal, but also the welfare levels. The intuition is the same as before: After both systems have converged to the steady state, the stocks of human capital are identical and so are consumption levels and savings. Comparing these outcomes with the mixed funding system, however, shows that there is a trade off between the level of welfare and its growth rate: Though welfare may be higher in the

short run for the federal and regional system, the mixed funding scheme exhibits higher welfare growth as has been shown in the preceding proposition. Therefore, there exists a finite point in time after which steady state welfare will be higher in the latter system for all subsequent periods. This possible trade off mirrors the conflicting objectives under mixed funding: While levels of taxation in the federal and regional system are exclusively chosen to maximize the local level of welfare, the growth-maximizing central government negatively affects this choice in the mixed funding system by taking into account the obvious interrelations of higher taxes on the growth process, thereby rendering the choice at the local level suboptimal (as compared to the alternative funding schemes) from the perspective of local welfare maximization.

To sum up, the mixed funding system is not only superior to the alternative schemes with respect to the growth performance but also regarding the long-run welfare levels (after some finite period of time). Consequently, a certain degree of fiscal decentralization is always superior to the cases of complete fiscal (de)centralization. Moreover, it has been shown that there exists indeed a critical degree of fiscal decentralization, delivering the highest growth performance, which is however insufficient from the viewpoint of the welfare maximizing local government. The next section examines to what extend the results depend on the assumptions about governments objective functions.

4.4   Remarks on governments' objectives

So far, a situation in which short-sighted local governments care about their residents' welfare level by setting the local tax rate while the central government's objective was to maximize the long-run economic growth rate by adjusting the degree of fiscal decentralization has been considered. However, these assumptions are somewhat arbitrary and one can well imagine the opposite scenario, namely a short-sighted central government choosing decentralization levels in order to maximize the welfare of the residents within the different regions and a local growth maximizing government deciding about the tax rate. Therefore, the aim of this section is to highlight the role of government objectives in determining the growth-decentralization relationship.

Accordingly, the local government maximizes the economic long-run growth rate

with respect to the local tax rate $\tau_{i,t}$. Using the same procedure as in the preceding section, the optimal solution is obtained as

$$\tau_{i,t} = \frac{\theta}{\theta + \eta}(1 - \alpha)\delta \tag{4.45}$$

The growth maximizing level of local taxation is determined by the balance of two opposing effects: On the one hand, a larger tax rate reduces the disposable income of local residents and therefore savings, consumption levels and private educational spending decline. This in turn diminishes human capital accumulation and thus growth. On the other hand, however, public educational spending is increasing in the local level of taxation. Consequently, a higher tax rate fosters the process of human capital acquisition and growth. Furthermore, the growth maximizing local tax rate is positively related to the degree of fiscal decentralization, which captures the negative effect of lower central public education funding through a smaller matching grant rate on the local level of taxation. However, from substituting (4.45) into the regional indirect utility function (4.12) and making use of (4.15) and (4.16), one obtains

$$V_{i,t}(\delta) = const \tag{4.46}$$

Therefore, as can be formally inferred from the above equation, any degree of fiscal decentralization between the two polar cases of complete fiscal centralization and decentralization, i.e. $0 < \delta < 1$, turns out to be welfare maximizing for the mixed funding system. The intuition behind this result is the following: An increase in the degree of fiscal decentralization δ leaves the total tax burden unaltered as the opposing effects of a higher growth maximizing local level of taxation and a lower central government's tax rate exactly cancel out. Similarly, the level of local public educational funding remains unchanged when δ increases. In this case, the positive effect of larger local education funding is offset by the direct negative effect stemming from the reduction of the matching grant rate. Consequently, a change in the degree of fiscal decentralization does not alter an individual's regional welfare level. The findings are summarized in the following proposition:

Proposition 4.6. *Assume that the central government maximizes current residents' utility while the local government cares about the long-run growth rate. Then, in equilibrium, any degree of fiscal decentralization between zero and one turns out to be optimal, i.e. $0 < \delta^* < 1$.*

Similarly to the preceding section, the central government can affect the local government's decision about the tax rate by changing the degree of fiscal decentralization. However, such decision becomes completely obsolete with respect to governments' objectives as the local government counteracts any decrease in the matching grant rate by adjusting its own level of taxation, thereby keeping the total tax burden and the level of local public education funding unchanged. Thus, an increase in the degree of fiscal decentralization has no impact on regional welfare levels.

Despite the fact that the local government can render each decision of the central government about the degree of fiscal decentralization ineffective, it is not clear which scenario of governments' objective functions leads to a better performance in terms of maximum attainable growth and indirect steady state level of utility. To answer this question, the maximum growth factor and the steady state utility level are derived as follows:

$$g^* = \Psi \left(\frac{1-\alpha}{\lambda} \right)^{\frac{(1-\alpha)\theta}{1-\alpha(1-\theta-\eta)}} \left(\frac{1-\alpha}{\eta+\theta} \right)^{\frac{\eta+\theta}{1-\alpha(1-\theta-\eta)}} \left(\frac{\eta+\alpha\theta}{1+\beta+\lambda\eta} \right)^{\frac{\eta+\alpha\theta}{1-\alpha(1-\theta-\eta)}} \tag{4.47}$$

and

$$V_t^* = \kappa \ln \left(\frac{\beta(1-\alpha)^{1-\eta-\theta}}{B(\lambda\eta)^\eta(1+\epsilon)^{1-\eta-\theta}(1+\beta+\lambda\eta)^{1-\eta}} \right) \tag{4.48}$$

$$+ \left(1 + \beta + \lambda\eta + \kappa(1-\eta) \right) \ln \left(\frac{\eta+\alpha\theta}{\eta+\theta} \right) \tag{4.49}$$

$$+ (\lambda - \kappa\theta)\theta \ln \left(\frac{\theta}{\theta+\eta}(1-\alpha) \right) + t(1+\beta+\lambda) \ln g^* \tag{4.50}$$

where Ψ and κ are the same constants as in the preceding sections. By comparing equation (4.27) with (4.47) and (4.30) with (4.50), respectively, one obtains:

Proposition 4.7. *The maximum attainable levels of growth and welfare in the mixed funding scheme are independent of governments' objective functions, i.e. $g^* = g^{*,MF}$ and $V_t^* = V_t^{*,MF}$.*

The above proposition shows that not the distribution of governments' objectives is important in attaining the maximum outcome of the model in terms of growth and welfare levels, but rather the existence of different government levels itself.

4.5   Conclusions

In view of the opposing forces towards either fiscal decentralization or fiscal centralization, the effects of these forces on economic growth have been a major focus of debate and discussion with respect to recent public policy reforms. While the empirical literature on the relationship between fiscal decentralization and economic growth is widely inconclusive, theoretical conjectures predominantly suggest a positive linkage. The aim of the present research is therefore to supplement the scarce theoretical analysis on this topic in order to shed light on the theoretical linkage of fiscal decentralization and growth, thereby trying to dissolve discrepancies of the empirical findings.

Using a simple overlapping generations model with endogenous growth, two regions and different layers of governments with conflicting objectives, the present analysis not only reveals that there exists a growth maximizing degree of fiscal decentralization, but also that some degree of fiscal decentralization will always be superior as compared to the cases of complete fiscal (de)centralization. The analysis is carried out in the context of education funding, more specifically, three different funding schemes are considered and their performance in terms of long-run growth and welfare levels are compared.

The findings suggest that a mixed funding scheme, where the central government subsidizes local educational spending and the extent of this financial assistance serves as an indicator of fiscal decentralization, displays higher growth rates and welfare levels than the alternative systems, where education is either financed exclusively by the central or local governments. This is due to the fact that the central government may counterbalance the suboptimal choice of the local tax rate from the growth-maximizing perspective by promoting the degree of fiscal decentralization which induces the local government to increase its own level of taxation, whereas growth and welfare levels in the alternative funding systems are ultimately determined by the local and central governments's choice about the tax rate in order to maximize local welfare levels.

Furthermore, there exists a growth-maximizing degree of fiscal decentralization for the mixed funding scheme which turns out to be insufficient from the viewpoint of a welfare maximizing local government. Consequently, the promotion of fiscal decentralization may not only enhance growth for initially low levels of fiscal de-

centralization but also lead to a welfare gain for local residents. Yet, the presence of private educational spending increases the optimal degree of fiscal decentralization as local public educational spending should be less subsidized by the central government the more productive private spending is in fostering human capital accumulation.

Finally, for the mixed system, it is shown that maximum growth and welfare levels may well be achieved by altering governments' objectives, namely by assuming growth-maximizing local governments and a short-sighted central government caring about regional welfare. However, in this case, any degree of fiscal decentralization between zero and one becomes optimal as local governments may counteract any change in the degree of fiscal decentralization and thus the public educational subsidy by adjusting the regional level of taxation, thereby rendering the central governments education policy ineffective.

To sum up, the theoretical findings partly confirm Oate's conjecture that fiscal decentralization is conducive to higher growth, thereby yielding a second strong argument in favor of fiscal decentralization besides the well known efficiency argument. This, however, only holds if the initial degree of fiscal decentralization is sufficiently small. Furthermore, the existence of a growth maximizing degree of fiscal decentralization may not only explain the opposing forces towards either decentralization or centralization as well as the opposed empirical findings, but also points to the fact that the theoretical linkage is not as clear cut as proposed by some previous studies. Consequently, policy implications have to be carefully balanced with respect to possible advantages and disadvantages.

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Erklärung

Ich versichere, dass ich diese Dissertation selbstständig verfasst habe. Bei der Erstellung der Arbeit habe ich mich ausschließlich der angegebenen Hilfsmittel bedient. Die Dissertation ist nicht bereits Gegenstand eines erfolgreich abgeschlossenen Promotions- oder sonstigen Prüfungsverfahrens gewesen.

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