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Paper

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Between Tax Competition and Harmonisation: A Survey on Tax Competition

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Abstract

This paper gives an overview on the research done in the fields of tax competition, coordination and harmonisation. The survey is divided in two main parts, in the first section we compare the standard tax competition literature that sees tax competition as a bad, to public choice contributions that advocate tax reductions. In the second part we consider theories of endogenous growth, which focus on analysing the taxation question. After introducing the fundamental contributions, we discuss extensions in the line of an open economy, an OLG setting and the transitional dynamics in greater detail.

Keywords: Tax Competition, Tax Coordination, Endogenous Growth Theory

JEL-Codes: E6, F4, H2, O4

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1 Introduction

Tax competition versus tax coordination is a frequently addressed topic in academic discussion. Dozens of books and a multiplicity of reports and papers have been published in the last two decades. This paper tries to give a broad overview on relevant literature streams concerning tax competition and tax coordination. This incorporates the foundation of modern tax competition models as well as public choice theory regarding public expenditure policy and its financing. Beside these core literature streams, there is the important literature stream, dealing with tax competition and tax coordination within economic growth theory. In the second part of the survey, we will especially concentrate on the developments in this sector. In addition, three further aspects of the literature can be considered, but should not be discussed here; first tax competition and tax coordination within economic geography theory, second developments within the European Union towards a coordinated tax policy and third work done in the field of econometrics.

Before we start, it is important to define some key notations and to encircle the whole topic: If we use the expression tax within this paper, we mean direct taxes. The tax bases of indirect taxes (VAT) are already harmonised within the European Union (European Council, 1977). The main focus of this paper is the discussion of capital taxation in different economic models. For the terms ‘tax competition’, ‘tax coordination’ and ‘tax harmonisation’ we will use the standard meaning: Tax competition is a governmental strategy of attracting capital and high value human resources by minimizing the overall taxation level. If we talk about tax harmonisation, the tax bases or even the tax rates of two jurisdictions are harmonised. Tax coordination is everything in between.  

The paper is organised as follows: Section 2 introduces the discussion on tax competition vs. relevant public choice contributions. Section 3 discusses in detail the taxation question in models of endogenous growth. A special focus is set on models considering open economies (section 3.2.1), models with an OLG setting (section 3.2.2) and the models with special interest in transitional dynamics (section 3.2.3). Finally section 4 concludes.

\footnote{For a general overview about taxation, externality problems and tax systems in Europe, see Cnossen (2002).}
2 Tax Competition and Tax Coordination Models in Contrast to Relevant Public Choice Approaches

A literature survey about tax competition and tax coordination has to start with the two contributions to this literature that act as foundation stones. The first important contribution goes back to Oates (1972, 143). He notes, "The result of tax competition may well be a tendency toward less than efficient levels of output of local services. In an attempt to keep taxes low to attract business investment, local officials may hold spending below those levels for which marginal benefits equal marginal costs, particularly for those programs that do not offer direct benefits to local business." The second foundation stone acts like a starting point for the whole tax competition literature and comprises two articles: Zodrow and Mieszkowski (1986) and Wilson (1986), whereby both of them formalise the ideas from Oates in formal economic models. In these two models a source-based tax levied by local jurisdictions results in underprovision of local public services.

In general, the tax competition literature is based on three standard propositions. First economic theory tells us that tax competition results in a fiscal externality, which implies too low tax rates, relative to the social optimum. As the tax rates are too low, it secondly follows that the tax revenues are too small and, thus, public expenditures have to be cut. Finally, these cuts lead to a reduction in the level of output.

In contrast to the tax competition literature, the general level of tax rates according to public choice theory are seen as too high, as policy makers try to maximise their own utility. Therefore, cutting tax rates is supported, because this acts as a chance to avert the Leviathan and, at the same stage to reduce the government waste. This surplus can then be used for more reasonable expenditures which yield higher economic growth. A detailed analysis of these propositions with a rich number of related literature can be found in Josten and Truger (2003).

Summarising, both theory streams on a first glance use the same line of argumentation. Both theories start with the level of tax rates, predict the change in investments and finally anticipate the consequences for economic growth. However, the underlying reasoning between these single steps is not the same, and, therefore one of the main conclusions - the effect on the economic growth rate - is diametrical different, lower versus higher economic growth. Therefore we will cover both literature streams within one section, one after the other. Using this analysis, we will continue with an overview about the tax coordination literature, as tax coordination is a kind of synthesis of the two theories.

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2 Fiscal externalities are sometimes also called horizontal tax externality. They "arise because tax setters do not take account of their tax policy's implications on the tax base available to other jurisdictions of the same level. With mobile tax bases and in the absence of coordination, these externalities can spark a race to the bottom in tax rates by jurisdictions competing to attract the same tax base. Falling tax rates on mobile bases, in turn, erode fiscal revenue and shift the relative tax burden from mobile to immobile production factors." (Jametti and Brühlhart 2004, 3)
2.1 Tax Competition Literature

The tax competition literature is basically built on the so-called interregional (or fiscal or horizontal) externality. This externality describes the effect, \textit{"when actions that one region’s government takes to increase the welfare of its own residents lead to reductions in the welfare of residents in other regions."} \cite{Wilson1999}. In the tax competition literature this externality is normally called the fiscal externality\textsuperscript{3}. The fiscal externality — theoretically simplified — causes the following sequence of events, which was already analysed by Oates \cite{Oates1972}. If one jurisdiction lowers its tax rate on capital — as the mobile factor in production — it will gain capital at the expense of other jurisdictions. Thus, the tax base in this other jurisdictions will fall and in the medium run their tax revenues will decline. The fiscal or horizontal externality has not to be mixed up with the vertical externality\textsuperscript{4}, which leads to completely opposite outcomes for the tax rate. Vertical tax competition implies too high tax rates compared to the social optimum due to the fact that lower-level authorities do not fully internalize the impact of their own decisions on the size of the federal tax base. \cite{Jametti2004}

Knowing these fundamental cohesions, it was up to Zodrow and Mieszko\v{w}ski \cite{ZodrowMieszko1986} and Wilson \cite{Wilson1986} to publish the first formal models based on these ideas. As the model configuration in Zodrow and Mieszko\v{w}ski \cite{ZodrowMieszko1986} is simpler, we let their model serve as the basic model for this chapter. Afterwards we will list a number of articles that have extended this basic framework in various directions.

To form an adequate model, Zodrow and Mieszko\v{w}ski \cite{ZodrowMieszko1986} formalized their ideas in a simple framework, which should serve as a starting point for several extensions. In their framework they assume a large number of homogenous jurisdictions (1), population and land are fixed in each jurisdiction and therefore the population in each region is normalized to be equal to one (2). Furthermore, markets are perfectly competitive (3). Moreover, the taste of all residents in all jurisdictions is identical (4). The only single good in the economy is produced by capital and the fixed factor land (or, alternatively, labor) in each jurisdiction (5). Each jurisdiction finances the public goods via two local tax instruments — a "property tax" that applies to capital income and a head tax, which is assumed to be fixed exogenously at the same level for all communities (6). Government services that are "publicly provided private goods", benefit only residents, have no spillover effects to other jurisdictions, and can be modelled as purchases of the single private good. (7) This assumption explicitly rules out the fiscal externality. In providing the public good the local government acts as a social planner and tries to maximize the welfare of the residents (benevolent governments) (8). In addition, they assume a fixed national capital stock that is perfectly mobile across local jurisdictions (9) and finally a Nash equilibrium in which each jurisdiction takes as fixed the after-tax return to capital and the tax rates set by other jurisdictions (10). Summing up this is \textit{"a model of identical jurisdictions where the effects of reductions in the exogenous level of head taxation on the amount of property taxation and on the level of local public}

\textsuperscript{3}Besides the fiscal externality, Wilson also lists the pecuniary externality as another type of interregional externality \cite{Wilson1999}

\textsuperscript{4}Tax competition among different vertical ordered administration units; e.g. national-, province- and municipal government.
services can be easily analyzed by examining a single representative jurisdiction.” (Zodrow and Mieszkowski, 1986, 359)

The main results of this kind of model framework can be easily summarised: In the case of a large number of either small or large jurisdictions this model provides a perfectly elastic supply of capital and thus no jurisdiction can affect the after-tax return to capital. It follows that all single jurisdictions will shift any tax from mobile capital to the immobile factor of production, namely labor / land. The predicted outcome is the so called “race to the bottom”, if all jurisdictions start with a positive capital tax. However, as explained above, the head tax is exogenously given and this avoids the assumed result. Starting from an efficient equilibrium and a pure funding of public expenditures by the head tax, jurisdictions do not impose a capital tax if the head tax is below the social optimal level. The introduction of such a tax would lead to an outflow of mobile capital. Furthermore this would lead to lower local wages and land rents and thus to a reduction of public expenditures below the efficient level in order to reduce their reliance on the tax (Zodrow, 2003, 655).

In the years from 1986 onwards many papers were published with the aim to relax these strict assumptions, stated above. Wilson (1991) and Bucovetsky (1991) relax the strict assumption of homogeneous jurisdictions and extend the model with respect to asymmetric tax competition between large and small jurisdictions. Both papers assume two identical countries in all respects, except population size. In contrast to trade theory, where the bigger country has advantages in a tariff war, tax competition on the mobile factor capital results in advantages for the small country. As the large region chooses the higher equilibrium tax rate, because it faces a less elastic capital supply with respect to changes in its tax rate than does the small region, we infer that, an increase in the tax rate chosen by one region expands the consumption possibilities frontier available to the other region. (Wilson, 1991, 424). Bucovetsky (1991) formalizes these ideas only for quadratic production functions, while Wilson (1991) confirms these results for the standard neoclassical model assumptions. The main results can be found in three theorems in Bucovetsky (1991, 175, 178, 180) which say, there exists a Nash equilibrium in the positive return regime in which \( t_1 \geq t_2 \); in any Nash equilibrium in which \( t_1 \geq t_2 \) residents of jurisdiction 2 are strictly better off than those in jurisdiction 1 and finally if differences in population between jurisdictions are great enough, then the utility residents of the small jurisdiction attain in Nash equilibrium exceeds the best they could do in any allocation which treats all residents of the nation equally.

Lee (1997) extends the model to a world with imperfectly mobile capital. In contrast to the base model Lee (1997) considers a case with two countries but also with two periods. In the first period capital is perfectly mobile - as in the standard literature, however, moving capital in the second period induces transactions costs. Distinguishing two cases these transaction costs can now be small or large, giving different results. If transactions costs are small, capital will move and we get the standard result in the literature, namely underprovision of the public good. But imposing high transactions cost yields a diametrally opposed result: overprovision of the public good. This result heavily depends on the assumption that all consumers in the two countries share the capital stock, but the national governments do not take into account the external effect of tax setting in only one jurisdiction. In other words, an increase in the tax rate in a jurisdiction will decrease the net return to capital. This,
in turn, will decrease the income of the resident in that jurisdiction as well as the income of residents in other jurisdictions, because all consumers in the economy share the national capital stock. However, a jurisdiction does not take into account this negative externality imposed on other jurisdictions when it sets the tax rate, leading to too high tax rates and the overprovision of the public good relative to the socially efficient level. (Lee 1997, 223) This negative externality outweighs the positive externality for large transaction costs.

Another important assumption in the base framework lies in the source-based capital taxation. This assumption was relaxed in several steps. First, Bucovetsky and Wilson (1991) introduce both, residence-based capital and labor income taxation. Clearly, as capital is still the mobile factor and labor fixed, any tax on capital is distortionary, but the tax on wage income is not distortionary. Therefore in the absence of residence-based tax instruments governments would choose only to tax labor, however, this still yields an underprovision of the local public good. Only in the case, where residence-based taxation is available they find an efficient equilibrium outcome. They conclude, that in the absence of residence-based taxes on capital income, not taxes on wage income, is responsible for the underprovision of public goods. (Bucovetsky and Wilson, 1991, 335) In a second step, Wilson (1995) relaxes the assumption of immobile labor and reconsidered the question on the provision of a local public good, financed by multiple tax instruments. He distinguishes two tax instruments, on the one hand a property tax on land and capital and on the other hand a residence-based tax on mobile workers (head tax). Finally he concludes, when a head tax is available, the Samuelson Rule for efficient public good provision always holds in equilibrium. [...] In fact, the strongest case for underprovision occurs under circumstances where local governments choose not to tax property. (Wilson 1995, 335) In other words, considering the model extensions Wilson observes no tendency of governments to underprovide public goods, even if capital is taxed. Even more he finally concludes, that the equilibrium for the system of jurisdictions is fully efficient in the case of head taxation. (Wilson, 1995, 350). In a third step, Brueckner (2000) goes even a step further and introduces heterogeneity of consumer preferences into the former model type with mobile labor. In this case the final results do not change but the equilibrium is equivalent to the outcome in a standard tax-competition model with immobile consumers. The most important feature of his results is given by the fact, that high-demand communities have high tax rates and small capital stocks, while low-demand communities have low tax rates and large capital stocks. Thus, in pursuit of a high public-good level, high-demand communities end up driving out investment, with capital relocation to low-demand communities, where taxes are lower. (Brueckner, 2000, 287) Although we ended up in a fairly complicated model this is a very intuitive and above this, reasonable result.

Although the fundamental papers assume two regions and also trade of goods between these regions, the models always only inherit only one good, hence trade theoretical aspects cannot be discussed. Wilson (1987) introduces a second good and in doing so he adds trade considerations to the base model. However, explicitly including trade, he cannot confirm the general result of underprovision of the public good. Instead, the equilibrium aggregate public

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5In more detail the chosen tax mix depends critically on the degree of scale economies, which are defined as declining per-capital cost of public good provision, see (Wilson 1995, 334)
good output for the whole economy may actually exceed the efficient output level. (Wilson 1987, 837) In addition he notes, capital taxation causes an inefficient distribution of public goods outputs across regions, and this inefficient distribution is accompanied by an inefficient pattern of trade. (Wilson 1987, 837) Formally and in the simplest framework, identical jurisdictions specialize in production, with some regions choosing relatively low taxes, low public expenditures and production of capital-intensive goods, and vice versa, what Wilson (1987, 837) calls a wasteful diversity in public goods supply. Razin and Sadka (1991) extend the analysis to different cases with respect to the degree of coordination between a small country and the rest of the world. They especially focus on the differences between residence and source taxation and efficiency questions. Janeba and Wilson (1999) extend the base model considerations from Wilson (1987) with respect to trade protection questions. They conclude, that tax rates can be too high in the absence of a tariff, but tax rates are too low when the central government sets the tariff optimally. (Janeba and Wilson 1999, 20)

The papers we have mentioned here are only a part of the whole literature in this area. For a more detailed overview about pure tax competition literature, see Wilson (1999) or Zodrow (2003).

2.2 Corresponding Public Choice Literature

While the tax competition literature is in fact based on one basic model that has been extended in several papers, the public choice literature is widespread in its approaches. The two basic contributions go back to the 1980s. Brennan and Buchanan (1980) and McLure (1986) both view tax competition within jurisdictions as something positive. For these authors the governments act as driven by an invisible Leviathan who is ruling the decision process. Therefore, "competition in general and competition among governments in particular is beneficial because it reduces government waste and disciplines politicians. Policymakers tend to overspend and absorb government resources for their own objectives and with little or no benefit to citizens." (Janeba and Schjelderup 2002, 2) A slightly different approach is used by Rauscher (1998), who analyses so called benefit taxes, as for example, road pricing schemes, environmental taxes, and all kinds of fees that are paid for public-sector services (Rauscher 1998, 3).

Basically, within the public choice literature, we can distinguish between the analysis of parliamentary democracies and presidential democracies, or, in other words between the US- and the European type of democracy. For an analysis see, e.g. Persson, Roland, and Tabellini (2000) and Persson and Tabellini (2000). The basic analysis of a political system has also been extended into two directions. First models working with a two country case and second the introduction of voting, which was both introduced explicitly in Persson and Tabellini (1992) for the first time. Besley and Smart (2002), in addition, split politician into two categories: benevolent and rent-seeking.

Finally, three papers should be added to the list of public choice contributions although it seems difficult to categorise them into a fixed scheme. The most recent contribution is Keen and Kotsogiannis (2003), who take a closer look on both horizontal and additionally vertical externalities across states and between levels of governments. In contrast to stan-
ard public choice theory, revenue sharing between the authorities in this model causes a
Pareto improving result. Wilson and Gordon (2003) also analyse tax competition within a
Leviathan model in respect to vertical and horizontal structures. Specifically they examine
the case of fiscal decentralization and they show that in such a setting, based on Oates
(1985), a property tax dominates a head tax on efficiency grounds. Once more these results
are in clear contrast to the results presented by the tax competition literature. Finally,
Wilson and Wildasin (2004) build a model with an endogenous political market structure,
dependent on economic integration. These endogenous structures are introduced by allowing
different groups to form lobbies and these groups compete for political favours by donating
money depending on the government’s subsequent choice of tax rates. This setting leads
to an efficient outcome for one single region, although not, however, in the case of many
regions.

2.3 Tax Coordination Literature

Although it is probably the most interesting issue, there are only few contributions that
combine the economic tax competition literature – implying too low tax rates – and the
political economy approaches of the public choice theory – implying too high tax rates. It
was up to Edwards and Keen (1996) to combine the theoretical concept of a government
as a benevolent maximiser of their citizens’ welfare and the concept of a government as a
Leviathan. "In their paper they derived conditions under which policy-makers are neither
evenly benevolent nor wholly self-serving." (Edwards and Keen 1996, 113) Their setup is
based on an objective function combining two variables, first, the welfare of the representa-
tive citizen and, second, a so called "waste" variable, which comprises the costs of political
distortions. In this setting the result on each single citizen faced by a coordinated capital
tax increase is ambiguous. "It turns out that a negative welfare effect is the more likely, i) the
lower the marginal excess burden of the tax system in the situation without tax coordination
and ii) the higher the marginal propensity of the public sector to waste resources, the latter
depending on the policy maker’s objective function." (Fuest 2000, 358)

This basic paper was extended in further contributions. Fuest (2000) and Fuest and Huber
(2001) add bureaucrats who act beside politicians, whereby both groups behave rational and
self-interested. A coordinated tax increase in this model leads to a higher level of public
goods expenditures, which, thereafter, raises welfare and also the costs of political distortions
– as long as politicians dominate the tax setting process. If the bureaucrats dominate in this
interaction a coordinated tax increase leads to negative welfare effects. Another extension
in this direction, namely a two-country-model with capital mobility, where tax policy is also
determined by voting is presented by Grazzini and Ypersele (1997).

Another model type, but with the same intentions, is presented by Gottschalk and Peters
(2004). Within a two-country model, they set up a two stage game; "at the first stage the
domestic and foreign electorate vote for political representatives who, in turn, subsequently
negotiate on tax rates at the second stage.” (Gottschalk and Peters 2004, 2) It turns out
that political coordination will yield an inefficient high extent of redistribution even in the
absence of a Leviathan.
Beside these contributions that combine the two major literature streams, there are some more papers that directly address the tax coordination topic. Sorensen (2000), Sorensen (2001) and Sorensen (2004) develop general equilibrium models and i) analyse fiscal competition for mobile capital and its effect on the resource allocation, the income distribution and social welfare; ii) give a broad overview about the actual discussion in the EU, whereby he argues in favour of a fully harmonised corporation tax within the EU; and iii) highlights the fundamental differences between global tax coordination and regional coordination.

3 Tax Competition and Tax Coordination Models within Economic Growth Theory

Why do economies grow at such different rates and why do we still face such tremendous differences in the levels of output in the 21st century? These questions keep puzzling many economists around the world although the revolutionary work by Solow (1956) dates back already half a century. Even within the European Union in the year 2005 we face big differences, both in the levels and the annual growth rates. Convergence in the standards of living is one of the main goals of the European Union, however, the EU acts in many fields as single legislation and prevents active policies to reduce the existing gaps. Monetary policy is assigned to the European Central Bank for twelve out of the fifteen old member countries; many of the reform countries in the former east will adopt the Euro within the next years. Fiscal policy is constrained by the Stability and Growth Pact which is binding for all member countries except Denmark. Thus taxation remains probably the last important policy instrument in the hand of national governments. However, as we have seen in the preceding chapter, from a theoretical point of view, it is not clear what to tax and at which rate. Instead we are facing a big debate about this problem and especially about the effects of various tax instruments on economic growth.

Within the last fifteen years economic research in this field has relied on models based upon the endogenous growth literature. Most of these articles use the Lucas-Uzawa framework which goes back to the article by Lucas (1988). Lucas set up a model where (1) human capital is produced using only existing human capital, (2) within a closed economy setting, (3) using a single, infinite lived household and (4) without uncertainty. Some other contributions rely on an AK setting or the model framework introduced by Romer (1986). While Wilson (1986) and Zodrow and Mieszkowski (1986) introduced a static model of tax competition with an exogenous head tax, endogenous growth theory has opened the discussion to dynamic settings. Now all tax rates can be taken as policy variables in various model settings, attempting to maximise either long run growth – looking basically at the steady state outcomes – or the short run effects in an analysis of the transitional dynamics of different taxing regimes.

3.1 The Fundamental Contributions

After the path-breaking contribution for the entire endogenous growth theory in 1988, Lucas also laid the cornerstone for the investigation of tax policy within endogenous growth models with his paper in 1990. Without explicitly referring to his previous work, he sets up a model
with a single representative household, who maximises utility from consumption of a single produced good and of leisure. This household lives infinitely long and discounts the sum of future utilities. This model has only one sector, nevertheless allows human capital accumulation via time spend upon improving skills. He introduces flat tax rates on labor and capital income – thus a first best allocation is not possible. The model is fully described by the production function, the ability to accumulate human capital, by the marginal products of labor and capital and by describing three margins – he especially wants to focus on. These are: "the division of production between consumption and investment, the division of time between income-directed activities and all other activities [...] the division of income-directed time between the production of goods and the accumulation of human capital [...]" (Lucas 1990, 295) Comparing a first best allocation, where he sets the tax rates on labor income and capital income equal to zero, to a second best allocation he investigates the effects on these three margins. He asks himself: "What is the best tax structure for the economy I have just described?" (Lucas 1990, 298) He compares these results to the static case proposed by Ramsey (1927) and applies the two basic principles of taxation proposed there: (1) Inelastic production factors should be taxed more heavily and (2) symmetric goods should be taxed at the same rate. From the second principle he concludes that a tax on capital levied on investments distorts the consumption decision of the households, as a capital tax increases the tax burden on later consumption goods. But capital as a factor can only be taxed by one tax rate; so the second principle cannot hold simultaneously. He concludes, "the full solution to the Ramsey problem, then, must involve heavy initial capital taxation followed by lower and ultimately zero taxation." (Lucas 1990, 300) This conclusion confirms the previous results by Chamley (1986) who also found a zero capital tax rate in the long and a tax rate equal to one in the very short run – depending on the credibility of government commitments. Summing up, in this one sector endogenous growth model with human capital accumulation, where the government finances its purchases of goods and services via capital and labor income taxation, the capital income tax will initially be high, in order to tax the initial capital stock. However, once the system converges to a balanced growth path, the capital tax rate will converge towards zero. Therefore this first result is in line with the tax competition literature we saw in the previous chapter.

In contrast to the pure theoretical article from 1988, in the 1990 contribution Lucas also carried out a simulation, applying his theoretical work for the United States. The estimations on the elimination of the capital tax, while ensuring revenue-neutrality by increasing the tax on labor motived Lucas to the well known conclusion that cutting the tax would "deliver the largest genuinely free lunch I have seen in 25 years in this business." (Lucas 1990, 314) Such a cut in capital taxation would yield an increase in the capital stock by about 35 percent, meaning a duplication of the annual growth rate of the US capital stock. Although these effects seem to be tremendous, the effect on welfare is very low, due to the diminishing returns to capital and the reduced consumption because of the vast increase in capital. In the long run he predicts an increase of less than 1% in consumption and 0.03% in welfare. Summing up we observe a significant level effect but an insignificant growth effect.

The reason behind this outcome is based in the model setting. Since Lucas (1990) uses a one sector model where human accumulation only depends on the leisure decision, physical capital does not enter the human accumulation process as an input. Thus, the household
only bears the cost of forgone wage. Therefore the decision to accumulate additional human capital is unaffected by the taxation of capital. So is the growth rate. In turn, the huge level effect is based on the substitution of the distortionary capital tax by a less-distorting labor tax.

These first quantitative results by Lucas were re-examined in the following years with similar model settings. First, King and Rebelo (1990) use a two-sector endogenous growth model, where they allow for physical capital in the production of human capital. As Lucas (1990) they allow for diminishing point in time returns to human capital, but, in contrast to Lucas, labor supply is now inelastic and depreciation is not longer zero but equal to 0.1. They do not extend the theoretical findings of Lucas with respect to the tax rates, but they investigate an increase in one or both tax rates by 10% in simulations. Contrary to Lucas (1990), they find significant growth effects. Rebelo (1991) extends the theoretical results discussed above, first to a model consisting of two sectors and second to a model including 2 factors.

Jones, Manuelli, and Rossi (1993) do not only carry out a further simulation, but also enlarge the existing model by incorporating a labor-leisure choice and a modification of the human capital accumulation process. Compared to the previous models with two sectors, where human capital is produced either only with human capital or with a combination of human and physical capital they set up the production function of human capital including human capital and market goods. Thus, only parts of the inputs in the human capital accumulation process are taxed and parts go untaxed – Jones et al. (1993) emphasize the role of direct labor services in the accumulation process which act like a non-market good. Besides, they leave all other features (e.g. including depreciation in the model, various parameter settings) unchanged. Despite these changes they confirm the theoretical result from Lucas (1990) that the tax on capital approaches zero in the long run. As human and physical capital in this model are not longer symmetric, due to different production functions, the tax on human capital needs not any longer converge to zero in the long run. Nevertheless, “if transfers disappear asymptotically, then for the functional forms that we use, the labor tax rate and the consumption tax rate converge to zero.” (Jones et al., 1993, 498) Further simulations show that these results hold for the elastic and inelastic labor supply cases. Summing up, the simulations demonstrate that all tax rates converge to zero in the long run, after having an initial period of high taxation. The simulations yield a significant growth effect of 5.5%.

Laitner (1995) includes the transition dynamics to the three models proposed by Lucas (1988), whereas the second model of Jones et al. (1993) is a generalisation of the third model in Lucas (1988). Taking into account the period of high taxation at the beginning seen in all these simulations, the overall growth effect reduces to 3.3%. Devereux and Love (1994) carry out an analysis of the transition dynamics of the model framework introduced by King and Rebelo (1990) and especially focus on different scenarios in the dynamics induced by changes in capital income, wage and consumption taxation.

6In Lucas (1988) time is the only input in the accumulation of human capital, whereas King and Rebelo (1990) allow physical capital as an input in the production of human capital.
Stokey and Rebolto (1995) provide a comparison of the models by Lucas (1990), King and Rebolto (1990) and Jones et al. (1993). They carry out a sensitivity analysis of the critical measure to explain the varying simulation results. The varieties between Lucas (1990) and Jones et al. (1993) are based on calibration differences for the same form of CRRA-utility function. On the one hand Lucas sets the value of the coefficient of risk aversion equal to 2 and the elasticity of labor supply to 0.5. However, Jones et al. (1993) use a simulated value for the elasticity of labor supply which they get by calibrating their model. They find a more elastic labor supply than Lucas (1990)7. Therefore taxation has a greater distortionary effect. The reason for the deviating results from King and Rebolto (1990) lies in the lower share of human capital in its own production as well as a depreciation rate of 10 %. In the end Stokey and Rebolto (1995) point out that the simulation results depend on two types of parameters which are differently difficult to calibrate. On the one hand, there are the factor shares in the production of human capital and physical output and the depreciation rates which all drive the impact of various forms of taxation directly in the respective production and accumulation functions. On the other hand there are two parameter values, which are difficult to measure and which are directly linked to the taxation setting in the model.

- The elasticity of intertemporal substitution
- The elasticity of labor supply

The multiplication of the elasticity of intertemporal substitution with the change of the after tax interest rate gives the change in the growth rate. In the case of a common tax rate on all forms of income, the interest rate in the steady state compared to the social planner solution is reduced by the factor $1 - \tau$. If different kinds of income are taxed at different rates the situation gets more complicated. Depending on the measurement of leisure, the elasticity of labor supply determines the effect from taxation on the interest rate.

3.2 Extensions to the Fundamental Model

Until now we have discussed different questions regarding taxation within the framework of an endogenous growth model. In these models we have observed one- or two-sector settings, various forms of human capital accumulation procedures, and different production functions. But until now they all have in common that they only analyse a single economy and therein a single representative infinitely lived household. First we extend this assumption to the case of a world economy. Thereafter, we will relax the assumption of an infinitely lived household by introducing an OLG framework. Third, we take a closer look on transitional dynamics.

3.2.1 The Open Economy Case

In an open economy setting we account for some of the main differences: As at least two countries are considered, the capital flows between the countries will respond to differences in the after tax return in single countries. Depending on the taxation principle used, the tax policy will, or will not, change these capital flows and, therefore, will influence the capital accumulation. Basically we distinguish between a residence principle (also called worldwide

\footnote{e.g. for a coefficient of risk aversion equal to 2 they get an elasticity of labor supply from 4.99.}
tax system and a source principle (also called territorial tax system). Along with these two principles there is a number of intermediate systems that account for exemptions, deductions and reductions. Both principles cause different externalities which should not be discussed in detail in this article.

The case of a small open economy was already discussed in the Neoclassical growth model and should not be discussed in detail in this review. Chamley (1985), Chamley (1986) and Judd (1985) found an asymmetric connection between labor and capital taxes in the long run for the closed economy. While the optimal long run tax on labor is positive the optimal tax rate on capital is only positive in the short run, when the factor is on relatively inelastic supply, but is zero in the long run. This is the same result seen in the previous chapter. Using the Chamley-Judd framework of an open economy case the result stays the same – with a worldwide tax system optimal taxation within the Neoclassical model suggests a zero capital tax rate from some point in time $T$ onwards and a positive tax rate for the time $t < T$. However, we have an instantaneous adjustment, if a source based system is in place, thus in contrast to the closed economy case we do not observe transitional dynamics. Within the Neoclassical growth model Rauscher (2005) explicitly models the ideas of the public choice theories presented in chapter 2.2. He models the government as a Leviathan within a dynamic Neoclassical setting. Again, with perfectly mobile capital and a source tax regime, capital taxation tends to zero. While the optimal tax rate on capital decreases with capital mobility, the effect on the growth rate is unclear and, depending on the parameterisation, possible in both directions.

Turning to the class of endogenous growth models it is hard to figure out a continuous thread throughout the literature. We will first have a look at models, based on an AK-setting, continuing with contributions that extend the Lucas framework. These first contributions we look at, extend the closed economy analysis of Barro (1990), who found an optimal income tax rate $\tau = \frac{g}{y} = \alpha$, where $g$ over $y$ gives the fraction of the public services for each household to per capita output and $\alpha$ is the elasticity of $\frac{g}{y}$ in the production function.

Beside the importance of discussion tax policy issues in an AK framework, Barro (1990) is the starting point of another literature stream, which deals with the question, how the public sector by providing public goods affects the optimal tax setting. In contrast to the distortionary effects of taxation the provision of public goods as a relevant input good has positive effects. This type of question should not be considered in detail in this survey, nev-

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8 Under a residence principle, the worldwide income which accrues to a resident of a country should be subject to the taxes of that country; non-residents are not taxed on income originating in the country.

9 Under a pure source system income is taxed in the country where that income originates, regardless of the physical or legal residence of the recipient of the income. Thus residents are not taxed on their foreign-source income.

10 See e.g. Franel, Razin, and Sadka (1991) for a more detailed treatment.

11 E.g. capital export and import neutrality, or national neutrality.

12 Correia (1996) extends these results to a financially integrated world in an open economy context, without major changes in the base results.

13 The production function in Barro (1990) has the following from: $\bar{y} = A \left( \frac{k}{y} \right)^\alpha$. If the elasticity is modelled equal to $1 - \alpha$, the optimal tax rate is given by $\tau = 1 - \alpha$, which is seen more often in later literature contributions.
Nevertheless we want to mention the most important contributions in this discussion. Devereux and Love (1995) extend the Barro framework by considering human capital and labor income taxes as well as government spending shocks; Turnovsky (1996) considers the optimal choice between capital and consumption taxes. Corsetti and Roubini (1996) complete the previous work by allowing the governments to run into debt. In a further step, Turnovsky (2000) introduces the labor leisure decision into this framework. Most recently Doménech and García (2002) summarize and generalize these contributions to finally conclude, that the correct allocation of public spending is more important for welfare than the choice of the tax structure. (Doménech and García, 2002, 3).

Back to the open economy question, Devereux and Mansoorian (1992) extend the Barro model to an small open economy framework. They consider two countries with identical preferences and populated by representative agents. Each country produces two input goods – a public and a privately produced good – and specialises in the production of one good, whereas the households consume both goods. In addition, the government provides public inputs. Again the optimal result is found with \( \tau_{ip} = 1 - \alpha \), where \( \tau_{ip} \) is the tax rate on the public input good and \( \tau_{ic} = 0 \), where \( \tau_{ic} \) is the tax rate on the public consumption good. This is always the most efficient outcome, independent of international coordination. An inefficient outcome arises when a government decides to produce a public consumption good and finances its production via taxation. This distortion is carried over to the foreign country and therefore, causes a spillover effect. In the model these spillover effects are explained by a level and a growth effect. Both effects are driven by the elasticity of marginal utility. Without discussing the exact modeling the implications of the international spillover effects of taxes can be summarised as follows, “Increasing taxes in the home country reduces the level of home output, and the rate of growth of home output, but may increase or decrease the rate of growth of foreign output. In terms of welfare impacts, the first two effects are clearly negative, while the third may be positive or negative.” (Devereux and Mansoorian, 1992, 255) In this model setting we can only abstract from this spillover and return to the efficient result from above in a special case, namely if the elasticity of marginal utility (\( \sigma \)) is set to unity, thus the CIES utility function turns into a log utility function. In the general case (\( \sigma \neq 1 \)) the final outcome depends upon the size of the elasticity of marginal utility. If \( \sigma < 1 \), then the international spillover effect of taxes is negative, thus, the tax rates are set too high and international tax coordination would decrease the tax rate, leading to higher growth. Vice versa, if \( \sigma > 1 \), then the international spillover effect of taxes is positive, thus the tax rates are set too low and international tax coordination would increase the tax rate, leading to lower growth. Summing up, in the case of two countries, where governments provide public inputs and a government consumption good, the optimal case of \( \tau = 1 - \alpha \) still holds, but only in a special case – in the general case we can observe an externality which leads to a too high or too low taxation and thus to possible welfare gains by coordination.

Following these ideas Lejour and Verbon (1997) set up a similar model, but now using

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14 Park and Philippopoulos (1999) use almost the same model, but analysing a federal tax/transfer scheme instead of two countries. They get the same results.

15 The utility of the representative household is additively separable between the private and the public good.

16 In that case \( \tau_{ip} = 1 - \alpha \) and \( \tau_{ic} > 0 \); tax rates are higher and growth rates are lower in every country compared to the Nash equilibrium case.
the learning-by-doing approach based upon [Arrow (1962) and Romer (1986)]. Again we have two identical countries but now populated with two groups, workers and capitalists and a government that only provides a public good. They assume imperfect capital mobility and no trade, both of which is in contrast to [Devereux and Mansorion (1992)]. Workers do not have to pay taxes, capitalists pay a source-based tax on capital income. Nevertheless, they incorporate a growth externality, which can be compared to the spillover effect before. [Lejour and Verbon (1997)] explicitly determine a tax-base externality. Based on this model setting, they determine optimal tax and growth rates for uncoordinated and coordinated governments. In the case of externalities — as we can observe here, the uncoordinated case cannot yield an optimal outcome in the Nash equilibrium, as the governments do not account for the effects in the other country. In the coordinated case they assume a central authority that accounts for these spillover effects. This coordination affects the level via the tax-base externality and the growth rate via the growth externality. They explicitly determine the two externalities for the coordinated case (see [Lejour and Verbon, 1997, 492]) and state a condition such that the growth externality dominates the tax base externality. (Then a decrease in the foreign tax rate results in an increase in the home tax base.) In the noncoordinated case the produced amount of the public good is inefficiently high, thus economic growth is lower than in the coordinated case. This result turns around if the tax base effect dominates the growth externality. To sum up, compared to the cooperative case, [Lejour and Verbon (1997)] observe a tendency for too much government spending in the non-coordinated case, hence the possibility of higher economic growth in the case of coordination. Therefore, they conclude that a source-based taxation seems to be preferable to a residence-based regime.

Both [Devereux and Mansorion (1992)] and [Lejour and Verbon (1997)] describe the effects from a tax base and a growth externality determined in a two country model on economic growth. The later summarise the differences between the two contributions very well. "So, the spillover in Devereux and Mansorion is driven by the changes in relative demand for home-produced and foreign produced goods, respectively, and the effects these changes have on saving behaviour. In our model the growth externality is, however, driven by the reallocation of savings to both countries as a result of tax changes. Moreover, in Devereux and Mansorion both the tax-base and growth externality can be negative, in which case government spending is unambiguously excessive. In our model the externalities will always work in different directions." (Lejour and Verbon, 1997, 492)

17 A change in the tax on capital income has a level effect. Assume a decrease in the foreign tax rate on capital income. This will induce a reallocation of the invested capital from the foreign into the home country having a negative (level) effect on the tax base in the home country.

18 A change in the tax on capital income has also a growth effect. Assume again, a decrease in the tax rate in the foreign country, thus foreign net returns increase, holding everything else fixed. As the income of the capitalists (who invest in both countries) is bigger, they save more, thus the new tax rate induces a higher growth of savings. Now these capitalists will also invest more in the home country, which now increases the growth of invested capital, the growth of labor income and finally the tax base in the home country.

19 This externality is a result of the endogenous growth setting, as in an exogenous growth model an increase in the tax rate in the home country would have no effect on the total stock of invested capital in the foreign country.
The work of Roubini and Milesi follow a completely different research question, namely the implications on the long run taxation of labor income with endogenous human capital accumulation. To solve for this question they distinguish between different ways to model leisure in an endogenous growth model\(^{20}\) and solve for the long run effects on taxation.\(^{21}\) Along the way, they also looked on the implications of their setting in an open economy (see [Roubini and Milesi-Ferretti, 1994]). Based on a two sector small open economy with mobile physical capital and immobile labor they follow the endogenous growth framework introduced by Lucas. In their study they distinguish between four leisure settings and the two possibilities to model human capital accumulation.\(^{22}\) Except for the case ‘no leisure’ and ‘human capital production requires only human capital’ which yields an optimal tax rate of human capital larger than zero all capital tax rates in the long run are optimally zero. Hence the initial result seen in Lucas also holds for the open economy setting with various forms of leisure. In addition if the government is allowed to borrow the economy will immediately jump into the steady state situation. Looking at the two principles of taxation (residence vs. source) and their implications on the growth rate they show that applying the residence principle leads the same result as in the closed economy case (different growth rates in the long run), whereas a source based taxation causes the growth rates to converge.

The work by Razin and Yuen is also based on the Uzawa-Lucas framework and they also search for long run growth optimising tax rates in an open economy setting but their focus lies in explaining convergence in long run growth rates. [Razin and Yuen, 1996]\(^{23}\) extend the original two sector endogenous growth setting by introducing endogenous population growth.\(^{24}\) Comparable to an OLG setting, agents can split their endowed unit of time among three activities: Working, learning in schools – the driving force for human capital accumulation – and child-rearing – the driving force for population growth. Obviously only human capital accumulation can sustain per capita income growth. They first investigate the closed economy case before they analyse the open economy setting. Calculating the balanced growth path in the closed economy framework taxes drop out of the final equations, hence they conclude, "Consequently, changes in government tax policies will not have any long-term growth effects in this economy." ([Razin and Yuen, 1996, 244]) This holds for both labor and capital income taxes and confirms the previous research done. However, changes in the capital income tax have effects on savings and thus on capital accumulation – this

\(^{20}\) Based on a very general form of utility function, including consumption, leisure time and leisure activity as arguments, one can distinguish four general cases by setting different elasticity parameters equal to zero. These four approaches are: The ‘no leisure’-, the ‘raw time’-, the ‘home production’- and the ‘quality time’ approach.

\(^{21}\) Milesi-Ferretti and Roubini [1998] seems to be a summary of the two NBER articles in compact form, giving a broad overview on different technology settings to produce human capital, different leisure decisions and different tax and subsidy instruments in the Lucas tradition. Turnovsky [2000] works in the same direction, considering an elastic labor supply, but based on the Arrow tradition.

\(^{22}\) Following Lucas [1988] where only time is devoted to the accumulation process or following King and Rebelo [1990] and incorporating also physical capital in the accumulation of human capital.

\(^{23}\) Razin and Yuen [1992] is the anterior working paper, where they describe the model setting and results in more depth but omit calibrations and simulations and in Razin and Yuen [1999] they survey tax coordination matters in the same model.

\(^{24}\) They do so by incorporating the population at large \((N_t)\), which is weighted with an altruism parameter \((\xi)\), as a determinant of agents utility within an instantaneous utility function; hence the utility function gets \(\sum_{t=0}^{\infty} \beta^t N_t \left( \frac{c^{1-\sigma}}{1-\sigma} \right)\) see equation (1) on page 241 in Razin and Yuen [1996]
changes, if we allow for full capital mobility in a second step. Then "the relative growth rates of per capita incomes in A and B depend on the capital tax rates in the two countries and the relative bias in preference towards quantity versus quality of children (…)." (Razin and Yuen, 1996, 249), where A and B represent two countries. Clearly the final outcome now depends on the applied tax principle. Under the source principle, capital income from foreign source is not taxed and all agents in one country are taxed at the same rate resulting in equal growth rates. Within the residence principle tax rates, returns on capital, and also growth rates, will not converge. In addition their calculations reveal a connection between the capital income tax and the agents decision how they weight quality (e.g. more education) versus quantity (e.g. more children). Comparing the two cases where people either prefer to have more children or prefer to have better educated children they conclude, "when people are more biased towards quality than quantity (…), the country with a higher capital tax rate will exhibit faster growth in per capita income and slower growth in population." (Razin and Yuen, 1996, 249). Summing up this is a new and result - in opens the opportunity that the country with a higher capital tax rate achieves a higher per capita growth rate.

To summarize this subchapter we note that there is a great variety in questions discussed in a small open economy framework. For this research overview the consequences on tax coordination of an open economy setting, compared to a closed economy setting is of specific relevance. As shown by Devereux and Mansoorian (1992) and Lejour and Verbong (1997) modelling governments that compete over the tax base by setting different tax rates, induces several externalities (tax-base externality and growth externality), which affect wealth in different directions. Nevertheless - and this should also be the bottom line here - both papers conclude, that tax coordination will have positive welfare effects for the economies by reducing the negative externality.

3.2.2 From Infinite Dynasties to Finitely Lived Agents

All models presented till now use a representative agent framework. In this setting all people in the model world are not only simplified to a uniform representative agent who has the same preferences, but this agent is also thought as a dynasty and, thus, living infinitely long. This idea simplifies the overall analysis as it does not account for intergenerational substitution effects. The finite-horizon growth framework goes back to the work of Diamond (1965) and was extended by Blanchard (1983).

Jones and Manuelli (1992) were the first to examine tax effects in a finite life time model. As it was the first contribution in this line of research, they started with a competitive equilibrium model hosting infinitely lived agents. In this model an increase in either the capital or labor income tax yields a decrease in the growth rate where the negative intertemporal substitution effect is the essential driving component. As all households have the same preferences this effect works independently of the amount of income redistribution. In a second step they develop a one sector OLG model where they show non-monotone effects

\[ \text{see equation (8) on page 249 in Razin and Yuen (1996)} \]

An increase in the tax rate reduces consumption today in order to obtain the same after tax unit of consumption next period. Hence the relative price of future consumption rises and reduces the demand of consumption today and thus the growth rate.
from changes in the tax rate on growth. An increase in the tax rate on the one hand reduces the after tax return on capital, thus reduces the savings rate and thus reduces growth. On the other hand with higher tax revenues, the transfer payments from the government to the young households will increase, leading to higher income and, hence, higher growth. Via simulations Jones and Manuelli (1992) also estimate the optimal tax rate and find values between 0.27 and 0.65, thus, clearly positive values. In a third step they also develop a three period model and they also run the simulations with this model. They find a bigger range of possible parameter values which leads to positive growth effects through capital taxation. Again the growth rate shows a non-monotonicity which turns out to be a function of the intertemporal elasticity of substitution \( \sigma \). They show two possible arrays (\( \sigma \) near 1.0, but excluding 1 and \( \sigma \) near 1.8) which generate growth, but in-between these two arrays, they find a band where no tax rate (\( \sigma \) near 1.4) can sustain growth. They sum up their findings stating, "finite lifetimes and growth are not inconsistent given an active government policy aimed at redistribution income." (Jones and Manuelli 1992, 187)

The possibility of rising growth rates in an OLG growth model was again picked up by Uhlig and Yanagawa (1996) who were inspired in their work by the econometric work by Burman and Randolph (1994). In an econometric research they found a strong negative short run effect but a long run effect that can also yield positive results in some regressions. The work from Uhlig and Yanagawa (1996) broadens and extends the analysis of Jones and Mannelli (1992) in several aspects: Growth effects are rather immediate than asymptotic; in their model setting there are no transfer payments from the old to the young generation and they investigate the effects of a multiperiod OLG model. They start with a two period base model without population growth where one agent lives per generation and consumes one good per period. The growth framework is based upon the work of Romer, thus, they incorporate many competing firms. The government taxes labor and capital income to finance a given stream of expenditures, which is assumed to be a constant fraction of total output; the government has to run a balanced budget in every period. Within this model Uhlig and Yanagawa (1996) show an inverse relationship between capital and labor taxation\(^{29}\) and constant growth over time\(^{30}\). As a benchmark model, they consider an economy where only the young generation receives labor income in the form of wages. Now an increase in the capital tax rate has two implications, first, it leads to lower savings or in other words to decreasing after-tax interest payments to the older generation and, second, it leads to a lower labor tax rate, hence higher wages and so higher income. If the labor income tax effect dominates the savings effect than the model predicts higher growth. Given a Cobb Douglas utility function, the savings function will be constant, thus the saving rate has no effect on interest rates and further on the income of the older generation. Therefore an increase in the capital income taxation rate will only induce the second effect, namely a decreasing labor tax rate, which yields increasing income of the younger generation, which in turn induces an unambiguous growth effect. In that case it is optimal to tax away the whole capital stock and to use these revenues to subsidise the agents instead of taxing labor income. If utility is modelled as a two period CIES function with an intertemporal elasticity of substitution

\[\text{equation (12) on page 1529}\]
smaller than one, the savings function is decreasing in the interest rate, hence increasing the capital income taxation will increase the growth rate, as there is no trade-off effect. Thus the crucial part is the setting of the savings function. The important determinant is given by the interest factor elasticity of savings which in turn is driven by the intertemporal elasticity of substitution ($\sigma$), the interest rate and the discount factor of future consumption. For $\sigma \leq 1$ there is the unambiguous result stated above, for $\sigma > 1$ the elasticity gets positive, leading to decreasing savings because of a lower after-tax returns. Summing up, in the two period OLG framework “a marginally higher capital income tax leads to a marginally higher growth rate across equilibria if and only if the interest elasticity of savings is not too big.” (Uhlig and Yanagawa, 1996, 1531) In a second model they investigate whether the result holds if the older generation also receives wages. In this case they find possible parameter combinations in their simulations that allow for decreasing growth rates for an initial increase in the capital income tax – which is the typical result in the standard literature. However Uhlig and Yanagawa (1996) argue that the necessary parameter ranges are rather extreme and unrealistic; in addition these results do not longer appear if they extend their model to a multiperiod OLG setting. But in this setting this is also only true for the first periods, as the simulations show that an increase in the capital taxation leads to decreasing growth rates if the agents work five or more periods (in a model with seven periods). Summing up Uhlig and Yanagawa (1996) show for a two period OLG growth model that an increase in the capital tax rate is likely to induce higher growth rates, however, this finding can easily be reversed if the older generation also earns labor income or a multiperiod OLG is considered.

A further generalisation goes back to Meijdam (1998) who combines the Blanchard-Yaari OLG model with the Lucas-Uzawa model. He investigates the consequences of capital income and labor income taxes vis-à-vis a subsidy on human capital. A second main extension is the introduction of endogenous labor supply – leisure is modelled due to the Beckerian approach of quality time; human capital accumulation is modelled in the line of Lucas (1988), population growth is not considered, but would not change the result. A very important additional component in a two sector OLG model is the setting of the initial human capital stock of agents. In Meijdam (1998) individuals are endowed with average human wealth when they are born, hence all generations have equal human wealth. Thus the growth rate of average total wealth does not depend on the human capital share. The consequences of a subsidy on human capital are straightforward, they clearly increase economic growth. An increase in the capital tax rate increases total wealth and time devoted to learning, hence he confirms the results from Uhlig and Yanagawa (1996). Within Bertola (1996) one sector economy setting this effect was only possible within some constraints however, now human capital is the driving force of growth. Therefore, the labor productivity can be assumed to increase with age and still he finds a tax rate on capital that sustains growth. The capital income tax in this model reduces the rate of return on savings and, thus, in-

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31 see the Technical Appendix
32 This model hosts the Lucas case with infinite living agents as well; there an increase in the capital tax rate has no result on the long-run growth rate.
33 Labor productivity has to decrease with age and the elasticity of intertemporal substitution has to be strictly less than one.
34 An important divergent assumption in this model is the elasticity of intertemporal substitution equal to one.
creases the attractiveness of investment in human capital, the source of growth. The really interesting result in this model is given by the fact that an increase in labor taxation also yields the same effects on the growth rate – this is in clear contrast to the standard literature. This result is based on the OLG setting but also on the leisure structure. The preference setting introduced by Becker permits values larger than one for an elasticity of substitution between consumption and leisure. "As a consequence of this, taxation of labor income causes a larger shift from the formal to the informal sector, leading to an increase of the incentive to accumulate human wealth, while accumulation of physical capital becomes less attractive. Because of the OLG-structure, this causes an implicit transfer from present to future generations which increases growth." (Meijdam, 1998, 12) (the informal sector is meant to be the educational sector) Recapitulating, in a two sector OLG model with Beckerian preferences about leisure, not only subsidies in human capital and increasing capital tax rates but also increasing tax rates on labor income yield higher growth. Due to the OLG setting, the estimation of welfare effects is only possible through simulations. These simulations relax the previous results as they show that the welfare improvements are at the expense of the current generations and those of the near future. Therefore, these welfare improvements will probably not be carried out within a direct democracy.

Recent contributions emphasis the role of finite life time models as a possible factor that just reduces the positive growth effect of tax reductions. While Song (2002) still finds a positive effect of increasing income taxes on growth, although he stresses the length of the horizon and the elasticity of factor substitution as the two most important factors influencing the effects on the growth rate, Hendricks (1999) shows that this need not be true in a more sophisticated model. Hendricks has extended the OLG-endogenous growth literature in several theoretical and empirical directions in the last years. In Hendricks (1999) he shows that a realistic life-cycle model together with three more modifications to the base model seen so far, reduces the growth effect presented at the beginning of this chapter, but also stands in contrast to the findings of this subchapter. The other three extensions are: First, he treats good inputs in human capital accumulation as being tax deductible, second, he models generations as being not altruistic linked – as it is clearly the case in an infinite lifetime model and, third, in his model setting learning productivity does not grow over the life-cycle at exactly the rate of per capita income growth. Further, he investigates all three kinds of constant point in time returns to human capital accumulation settings, which is modelled via a production function of exponential form. Including flat tax rates on labor and capital income (specifically he divides labor income taxation in two separate forms: taxing working people and taxing retired people) and also consumption taxes; a government that is not committed to a balanced budget, which pays lump sum transfers to households, education subsidies and consumes a public good, forms a realistic but highly sophisticated model.

He sets up a similar model as Meijdam (1998) and shows a positive growth effect for increasing capital income taxes, whereas a negative growth effect for increasing labor income taxes.

see King and Rebelo (1990) or Jones et al. (1993)

see Uhlig and Yamagawa (1996) or Meijdam (1998)

In Hendricks (2001) he investigates the intergenerational transmission of human capital and its results on fiscal policy; in Hendricks (2003) he addresses the question how intercohort persistence affect the sensitivity of human capital to income taxation. However both papers go beyond the scope of this survey.

The exact model setting is worked up in Hendricks (1996).
Based on this model he concludes that income taxes have only a small growth effect. The smaller impact on the growth rate is mainly driven by the finite horizon setting, diminishing returns and the tax treatment of goods inputs in human capital accumulation. Hence, in this model an increase in the taxation of capital income does not any longer yield higher growth.

To sum up this subchapter we have seen that relaxing the assumption of infinite living agents can result in converse results to the previous subsection. Instead of higher growth induced by a reduction in capital taxes in an OLG setting such a tax reform has to be financed by higher labor income taxes, which basically reduces the income of the younger generation, hence consumption and hence growth. This effect stands in contrast to higher after tax savings, which enforces the growth rate. Depending on certain parameter settings either the first or the latter effect dominates.

3.2.3 Transitional dynamics in endogenous growth models

All fundamental contributions we have considered above have a constant growth rate of the analysed variables in the steady state. In a second wave of contributions this assumptions was relaxed and transitional dynamics were considered, e.g. an initial sectoral imbalance and the subsequent way back into the steady state was analysed. Following this question we could first characterise the most important variables and secondly pin down several restrictions on these variables.

Mulligan and Sala-i Martin (1993) were the first to consider initial imbalances to have a closer look on the transitional period. But they did not solely concentrate on these theoretical issues, but also gave a link to empirical implications and to the first real business cycle consideration. Based on the fundamental article of Lucas (1988) they considered the standard two sector model where both the production and learning functions are Cobb-Douglas. Three results are important to list: First, they could express the model in terms of one state variable only, hence the model is simpler than the neoclassical model. Second, if the point-in-time production possibility frontier is linear the transition takes no real time. On the other hand, if the point-in-time PPF is strictly concave, there is transition in real time. In this latter case, the models are always globally saddle path stable. (Mulligan and Sala-i Martin, 1993, 769) Third, transition involves a substitution and a consumption smoothing effect, where the latter dominates, which means that agents invest in physical capital through efforts in the final output sector and not through higher savings, if physical capital is relatively low.

Along this research line Chamley (1993) and Caballe and Santos (1993) further work on transition dynamics. Although both papers use quite different settings, they end up with similar results. On the one hand Chamley (1993) includes externalities into the AK based model, while on the other hand Caballe and Santos (1993) do not include externalities into their Lucas based setting. However, they include physical capital as input into the produc-

40The results are summarised in Table 4 on page 422.
41We have already mentioned Laitner (1995) and Devereux and Love (1994) in section 3.1.
tion of human capital. They assert the finding in Mulligan and Sala-i Martin (1993), that the standard neoclassical model is a special case of the Lucas-Uzawa framework. Both try to answer analytically the impact of initial conditions on the transitional dynamics and on the long-term balanced growth path and possibly end up with multiple steady states. The main results are well summarized in the paper of Caballe and Santos (1993): As in the fundamental contributions, human capital is the key factor for growth. While an injection of human capital from a given steady state solution always yields a clear result, namely the transition to a new steady state with higher levels of physical and human capital, an injection of physical capital results in three different cases, (a) the normal case where the level of human capital goes up and the economy ends up in a higher steady state, (b) the exogenous growth case, where the level of human capital stays constant and the economy converges back to the initial steady state and (c) the paradoxical case where the level of human capital goes down and the economy ends up in a lower steady state. Further they show that only the elasticity of intertemporal substitution for consumption (EISC) and the elasticity of the marginal productivity of labor with respect to capital (EMPLK) determine expansion of human capital, hence in which case we finally end up. If EISC is greater than EMPLK we obtain the normal case, we end up in the exogenous growth case if the two are equal and if EISC is smaller than EMPLK, then we obtain the paradoxical case.

In Ortigueira (1998) several fiscal policy instruments are added to the above introduced framework and analysed in more detail. The main emphasis again lies in the transition dynamics, if a distortionary capital income tax is introduced and secondly on the measurement of welfare costs. He emphasises the major role of capital income taxation in the transition period. Ladron-de Guevara, Ortigueira, and Santos (1997) review the above presented papers and additionally add two distinctive new features to the Uzawa-Lucas type model framework. In the first extension, similar as in Mulligan and Sala-i Martin (1993) they consider a case with physical capital as an input of the human capital technology. However in contrast to the previous papers, they consider more generalized functional forms for production. Nevertheless they find a unique steady state ray, hence the model behaves like the original Uzawa-Lucas model. Secondly they consider a model where leisure is added in the utility function of the agents. In contrast to the first extension, where the paradoxical case introduced in Caballe and Santos (1993) got less likely, now this case gained more plausibility. In this model extension multiple steady states become possible.

Bond, Wang, and Yip (1996) carry out a similar review as Ladron-de Guevara et al. (1997), considering also a two sector endogenous growth model, however, without externalities. This paper can also be seen as a generalization of previous work, introducing more general functional forms and other policy tools. Santos and Ortigueira (2002) add a distinctive result to the generalized model type introduced in Bond et al. (1996). They show, that for certain parameter values and tax schemes, every equilibrium orbit (excepting the steady state solution) is non-interior; i.e., there are times in which one of the sectors is inactive. (Santos and Ortigueira, 2002) 5 In other words they show that in multisector models there is a
limited number of easily checkable, universal conditions, which guarantee the interiority of equilibrium solutions.

The most recent contribution in this literature stream is de Heij (2003). His contribution lies in bringing different extensions of the base model into one model and solving this model explicitely. He considers a model, which accounts for physical capital in the human capital technology and for an endogenous consumption - leisure decision. In addition he includes taxation of income, capital income and labor income. Still he keeps the possibility of multiple balanced growth paths, which are caused by the labor-leisure choice. In such a model capital income taxation has a positive effect on the growth rate, which is again a consequence of the labor-leisure choice.

In recent years the analysis of transition dynamics was more and more carried out in DSGE models. Already the above listed papers emphasis the close link to papers in the line of real business cycle theory – the predecessor of today’s DSGE theory. However the papers we have considered here are clearly based on the Uzawa-Lucas framework and clearly non stochastic. At this point Asea and Turnovský (1998) should also be mentioned in this line, as they consider a ‘stochastic’ endogenous growth model (Asea and Turnovský 1998, 57) in the tradition of the AK growth model, but this stochastic model as well as today’s state of art DSGE models considering fiscal policy questions, like , Ambler (2000) Klein and Rios-Rull (2003) or Kim and Kim (2005) are beyond the scope of this review.

To sum up the analysis of transitional dynamics is not really a question of tax competition, even less of tax coordination. Those articles we have considered here focus there attention on closed economies, therefore they cannot discuss these questions at all. This is somehow a missing analysis in the whole mass of research done in the field of tax policy. If feasible, this would be an important research question, even more, as the considered papers emphasis the important role of capital income taxation along the transition paths to a steady state. An in fact, these are the interesting cases to consider, as a steady state solution is less realistic for real questions.
4 Conclusions

In the first part we have introduced the basic static framework based upon Wilson (1986) and Zodrow and Mieszkowski (1986) and have discussed some of the existing extensions. The main message of these papers lies in the negative implication of taxing the mobile factor capital. Hence, capital tax rates should be reduced. Thereafter we have seen the contrary view of public choice contributions, where tax competition is welfare enhancing, as governments have to reduce wasteful public revenues. Thus, capital tax rates should at least not decrease. Tax coordination between countries, hence somehow a synthesis of those two streams, has only reached minor attention in the theoretical literature. We could not find a clear thread on this topic but nevertheless some interesting contributions, like Edwards and Keen (1996).

The second part deals with papers considering (capital) taxation within endogenous growth theory and discusses a great number of papers in greater detail. First, we look at the fundamental contributions like Lucas (1988), Lucas (1990), King and Rebelo (1990) or Rebelo (1991). All this contributions have in common, that capital should be optimally not taxed at all, after an initial taxation of the capital stock.

In the subsequent work we focus on the discussion of several extensions to the fundamental contributions. In an open economy we assert the previous finding. However, the result is less clear as several externalities interact with each other. The result is turned around, if one considers an OLG setting. Then capital taxation increases the growth rate, as taxing human capital – which is relevant for the determination of the growth rate – can be reduced. In the end, Hendricks shows in several contributions that this effect can be relaxed again. Finally we have looked on several contributions working on transitional dynamics. However, as already mentioned these papers do not give us new insights on the question of tax coordination.

To finally conclude, the question of tax coordination has played a minor role in theoretical contributions we have found. Questions of tax competition have dominated in the last decades. Nevertheless the question of tax coordination has become an important one in todays policy discussions in the European Union and hence will have to be discussed also theoretically. In all this standard models, capital taxation is modelled with one capital tax rate, independent of the tax base and independent of any deductions, reductions and exclusions. In fact, most of the debates of tax coordination are centered in this field, and not so much in setting the tax rate itself. Still, if we consider the tax rate in the models as an effective tax rate measure and not just as a statutory tax rate, we can answer also questions of tax coordination. This coordination could then be modelled by distinguishing three cases, (1) the two countries set their own tax (tax competition case); (2) the two countries set the same tax rate (tax harmonisation case) and (3) the countries set a tax rate somehow inbetween these two cases, implying some form of coordination to internalize externalities (tax coordination case). The welfare implications, the growth rates and also the transitional dynamics of these cases could then be compared.
References


