Fiscal Federalism and Tax Competition: a Double-Edged Sword?

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Abstract

Over the past decades there has been in many countries a progressive movement towards the devolution of fiscal powers to sub-central governments, a process which is commonly known as fiscal devolution or fiscal decentralization. This has generally been advised on grounds of improving government efficiency and accountability. In particular, advocates of fiscal decentralization point tax competition as the main mechanism that promotes economic development. The European Union (EU) provides, in this context, an ideal ground for looking at the effects of tax competition. We show that tax competition brings growth-maximizing policies. Yet, this translates into a 'race to bottom' on the taxation of mobile factors, together with a 'race to the top' on the taxation of immobile factors. Hence, fiscal devolution limits the scope for redistribution and brings potentially large regional asymmetric effects. Against this background, we examine several possible tax harmonization scenarios that may be considered in the EU context. In a nutshell, capital tax harmonization is able to avoid a race to bottom in capital taxation but implies a race to the top in labour taxation. Only labour income tax harmonization is able to avoid the latter, while leaving room for a positive capital tax.

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1. Introduction

The process of European economic and political integration can be viewed through the lenses of the fiscal federalism tradition, as a process of increased centralization of regulatory, political and fiscal powers. In particular, the creation of the European Single Market during the 1990s has integrated national markets, by abolishing national regulations, border controls and discriminatory regimes for foreign competitors. The underlying rationale was that this would facilitate trade between member countries, promote economic efficiency and fuel economic growth. Since then, a large body of literature has developed on the wider economic and political implications of the removal of barriers to the mobility of productive factors across the European Union (EU) on fiscal policy (Persson and Tabellini, 1992). In this context, the desirability - or otherwise - of fiscal policy harmonization and coordination in the EU, triggered famously by the Delors report, has become the focus of vivid academic discussions and heated political debates.

Over the past decades there has also been in many countries, both developed and developing, a progressive shift of fiscal powers towards sub-central governments (World Bank, 1998). This process is frequently referred to as fiscal decentralization or fiscal devolution. The early contributors to the fiscal federalism literature, pioneered namely by Tiebout (1956), viewed the devolution of fiscal powers to lower layers of government as playing a 'potentially useful role' in economic development (p. 242, Oates 1993). Two of the main economic forces at stake in this strand of the literature are grounded on population mobility and informational advantages of local jurisdictions over the preferences of local voters. Together, those would ensure that policies are tailored locally to different household types and promote economic efficiency[2]. Another strand of the literature emphasizes the so-called 'market-preserving' role of tax competition between sub-central jurisdictions (Weingast, 1995) to reach a similar

[2] A recent example of how such 'Tieboutian' environment can affect fiscal policy, and thereby the allocation of resources in the economy and long-term growth prospects, is given by Brueckner (2006), in the context of an overlapping-generations model.

conclusion. In other words, the early literature broadly viewed fiscal federalism as an institutionally optimal solution which would promote economic development, on the grounds of increased political accountability[3]. We focus in particular on the mechanism of interjurisdictional tax competition. This allows us to highlight the scope for potential efficiency-enhancing reforms as well as the main trade-offs faced by policymakers when attempting to design an appropriate fiscal architecture in a federation of countries or regions.

Jurisdictions attempt to offer the best possible business environment for firms to invest and set profitable businesses. An important part of this is to grant competitive tax regimes. Accordingly, recent data reveals that the average tax-to-GDP ratio amongst OECD countries reached 34.3% in 2016, the highest level since 1965, when the collection of this series on government revenue statistics started. Yet, the sources of tax revenues have been changing dramatically over the past decades. The share of personal income taxes, social security contributions and value-added taxes were higher in 2014 than at any point since 1965, at around a quarter of GDP on average in 2014. Namely, VAT revenues reached an all-time high of 6.8% of GDP, or about a fifth of total tax revenues on average in 2014. Relative to the levels seen in 2007, just at the outset of the Great Recession, the share of social security contributions to total revenues have also quickly increased, from 24.7% to 26.8% in 2009. On a diverging path, the share of corporate taxes to total revenue in 2014 was 8.8%, down from 11.2% only in 2007 (OECD, 2016)[4].

A substantial fall in statutory corporation tax rates observed across OECD countries, particularly since the early 1980s, has been documented and the focus substantial research

[3]Note that nothing is here implied regarding the specific design of such institutions. A common view, in this context, is that the optimal design of federal institutions is likely to vary according to geography, culture, political regime and degree of economic development, among other regional or local characteristics (see for example Martinez-Vazquez and McNab (2003), among others).

[4]Despite some clear common trends, as for example ten OECD countries had in 2015 a standard VAT rate above 22% - against only four in 2008 -, individual countries do show significantly differing trends. For instance, in terms of the total tax burden, Norway experienced a fall of around 4 percentage points between 2007 and 2015, while Greece recorded an increase of 5.6 percentage points. Similarly, the rise of VAT rates has frequently been counteracted by a declining share of revenues from other indirect taxes, such as specific consumption taxes - namely on alcoholic drinks or fuel - and import tariffs.

(see namely Devereux et al. 2002, Devereux et al. 2008 and Overesch and Rincke 2011, among others). Indeed, between 1982 and 2007, the statutory tax rates across OECD countries dropped on average from 47 percent to 27.5 percent. Although this trend seemed to a large extent driven by small countries, virtually all OECD countries have reduced their statutory corporate tax rates during this period (Loretz, 2008). Globalization is frequently pointed as the main driver lying behind this trend (Onaran et al., 2012). For instance, Winner (2005) finds a negative impact of capital mobility on the capital tax burden across OECD countries between 1965 and 2000, whereas it exerted a positive impact on the labour tax burden[5].

In this paper, we explore the effects of fiscal federalism on economic growth and redistribution through the lenses of tax competition. We do so by focusing specifically on the EU case, as an emerging federal structure. Since the creation of the European Single Market, we can consider the EU as a whole as a closed economy consisting of a group of decentralized jurisdictions with full fiscal and political discretion and perfect capital mobility between each other. The central government can be considered to have negligible fiscal capacity. We reconsider the main trends in taxation since the early 1990s and before, whenever data is available. Our main aim is to assess the current institutional option, with fully decentralized fiscal policy, against other possibly desirable options, such as partial or full tax harmonization. The effects of such options are considered in the context of an endogenous growth model with a role for government, following namely Zodrow and Mieszkowski (1986), Barro (1990) and Alesina and Rodrik (1994). The model features two types of publicly-provided goods, a productive public good and a merit good, similarly to Hatfield (2015). The latter enters a Constant Elasticity of Substitution (CES) utility function, while the former is a

[5]However, existing empirical evidence shows significant volatility with respect to measures and datasets used (Adam et al., 2013). On the one hand, the downward trend observed in personal income tax rates until recently suggests this cannot be explained only by the forces of globalization and capital mobility. On the other hand, the path of corporate tax revenues, relative to GDP, do not seem to exactly follow that of the tax rates (Loretz, 2008). This can be partly attributed to the broadening of corporate tax bases in the 1990s and 2000s, frequently associated with comprehensive tax reform packages. The above does not imply that governments do not engage in tax competition and firms do not engage in strategic tax planning in order to minimize tax costs. On the contrary, recent studies point towards significant revenue losses across OECD countries related to transfer pricing strategies of multinational firms (Davies et al., 2014).

labour-augmenting factor of production[6]. The use of a CES utility function allows us to consider different degrees of substitutability between these items and private consumption. Focusing on the optimal policy for the merit good, the conflict between economic growth and redistribution arises clearly in this context. The spirit of our paper is thus closest to Alesina and Rodrik (1994). The consequences of the Bertrand-type tax competition between jurisdictions induced by full capital mobility are explored against this background.

The contribution of this paper is twofold. First, we show that a world of perfect capital mobility and full fiscal powers for decentralized governments maximises economic growth. Yet, this comes at a cost. Sub-central governments are forced into a race to the bottom in capital taxation, which is accompanied by a race to the top in the labour income tax burden. Secondly, we bring forward several tax harmonization scenarios under this framework, worth considering namely in the EU context. In face of the increased squeeze in the public finances of EU member countries and the desirability of having a fiscal mechanism in place that allows countries to better respond to asymmetric shocks, the conditions for a far-reaching reform to the EU fiscal framework are set. The options outlined here can be considered as the main paths ahead that can be chosen by European policymakers.

In the next section, we explore the main trends in corporate taxation in the EU. In section 3, the baseline theoretical model is outlined. In section 4, we consider optimal policy issues. Namely, we compare various possible scenarios, under full centralization and decentralization of fiscal powers, also considering several possible tax harmonization alternatives. In the final section, we draw some concluding remarks.

[6] We can think of the productive public good as being, by and large, any sort of government investment that can contribute directly towards increasing the productive potential of the economy. This 'public capital' item can thus range from direct investments on R&D activities, financial support for high-tech SMEs or productive infrastructure and human capital formation investments. The merit good can in turn be understood as a purely redistributive good or as a good or service which could be privately provided. Items such as in-kind benefits, family allowances, social care, social housing, or recreational and cultural services can, in this context, fit into this category (Fiorito and Kollintzas, 2004).

2. Recent trends in corporate taxation across EU countries

Soon after the European Single Market was established, in 1992, the so-called Ruding Committee, appointed by the European Commission to analyze and propose tax reforms in a landscape of increasing economic integration between member states, recommended a minimum statutory tax rate of 30% on corporate income in all EU countries. Only Ireland exhibited at the time a corporate tax rate lower than this threshold[7]. By the beginning of the twenty-first century, one third of EU member states had statutory corporate tax rates at or below that point (Devereux et al., 2002). By 2016, all but three EU member states[8] had corporate tax rates below 30% and the EU-28 average top corporate tax rate had fallen to 22.5%, from 32% in 2000 (European Commission, 2016).

From Figures 1 and 2, we can explore more in depth some of the above mentioned trends[9]. Indeed, what perhaps stands out the most is the marked downward trend in corporate tax rates. Three out the four large countries identified had corporate tax rates above 50% in 1983, averaging 52.2% with the exception of Italy which then had a steady increase until its peak in 1997 at 52%. Just twenty years later, by 2003, all had corporate tax rates below 40%, with the average down to 35.8%. In 2017, the corporate tax rate in the United Kingdom hit an all-time low of 19% and the other three European large economies have their corporate tax rates around 30%.

[7]At 10% in 1992, which then slightly increased to 12.5% in 2003, as can be seen from Figure 1. Note however that these numbers "hide" the full story of the Irish case. The effective 10% corporate tax rate was introduced in 1981 (at the time only for trading manufacturing profits, but the definition of 'manufacturing' was later updated to include, for instance, financial services) to replace the previous Export Sales Relief system, first introduced in 1956. This system, under which all exports were effectively exempt from corporate taxation, had to be phased out under Ireland's EU membership, in order to comply with European treaties. From 1998, this tax regime was again at odds with EU legislation and was replaced by the current 12.5% corporation tax, which applies to all firm' trading profits.

[8]The only exceptions are Belgium, France and Malta. In the case of Belgium, a 3% crisis surcharge applies since 1993 and the recent rise seen in France can be explained by a temporary surcharge applied between 2011 and 2015 to large companies only. In Malta. the top statutory tax rate does not take into account the corporate tax refund system.

[9]We use available data from the European Commission and the Institute for Fiscal Studies for 12 EU countries, from 1982 until 2017. These countries are, in alphabetical order, Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain and United Kingdom. We then divide them into two sub-groups of large and small economies for illustrative purposes and analytical convenience.

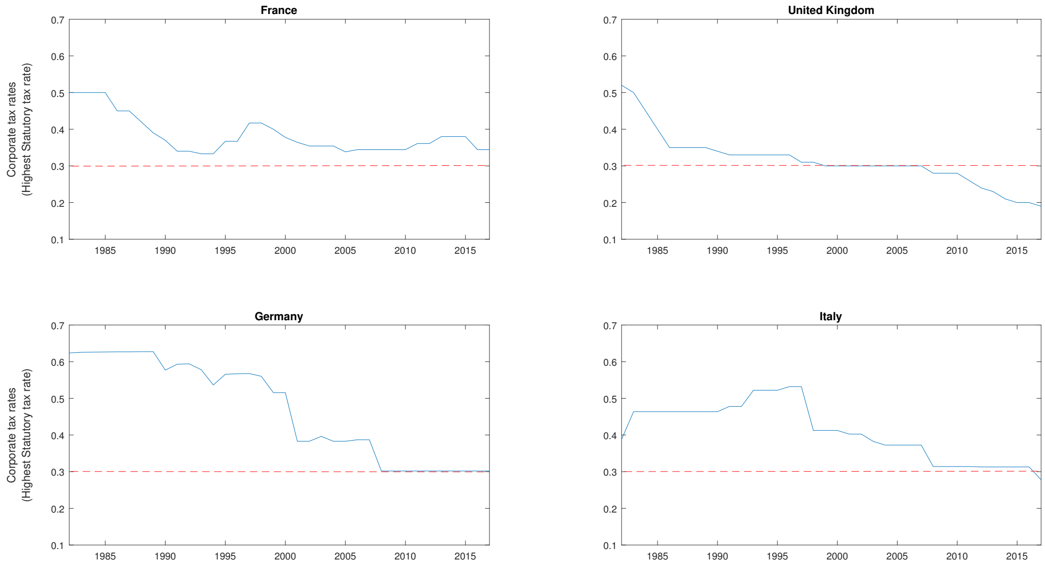

Figure 1: Corporate tax rates of 4 large EU economies (1982-2017).

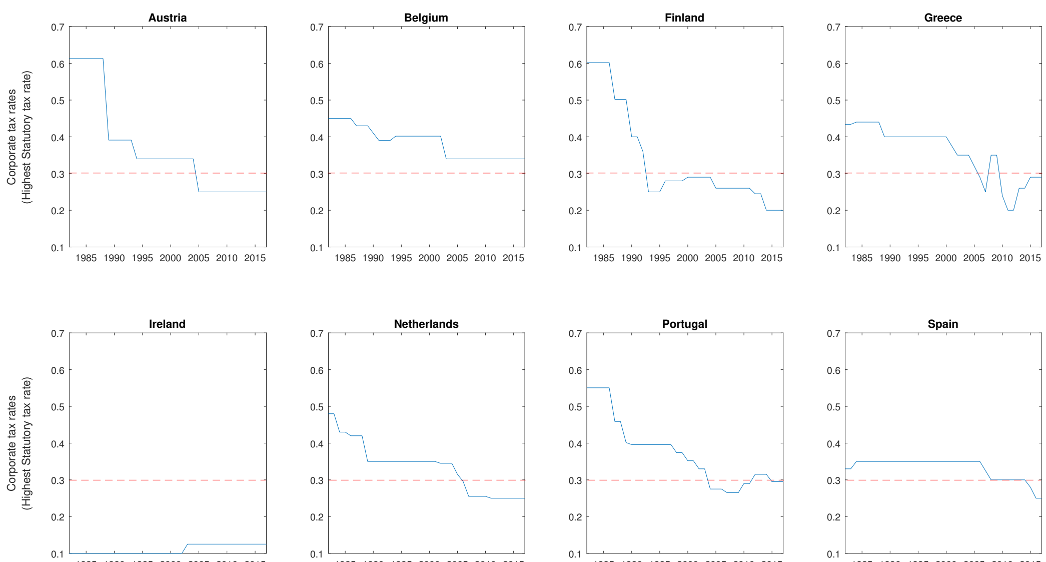

Figure 2: Corporate tax rates of 8 small EU economies (1982-2017).

The average amongst the 12 countries stands in 2017 just above 25%. All the 8 small EU economies have their corporate tax rates consistently below 30% since 2010, with the exception of Belgium (and a small corporate tax hike in Portugal between 2012 and 2014). Furthermore, if we look further at Figures 1 and 2, we can identify that (i) corporate tax cuts were not at all exclusive to smaller EU economies (the absolute decrease was actually slightly larger for the four largest economies) and that (ii) since 1992, when the European Single Market was launched, all the EU economies reduced their corporate income tax rates, with the exception of France and Ireland, which remained fairly stable over the period.

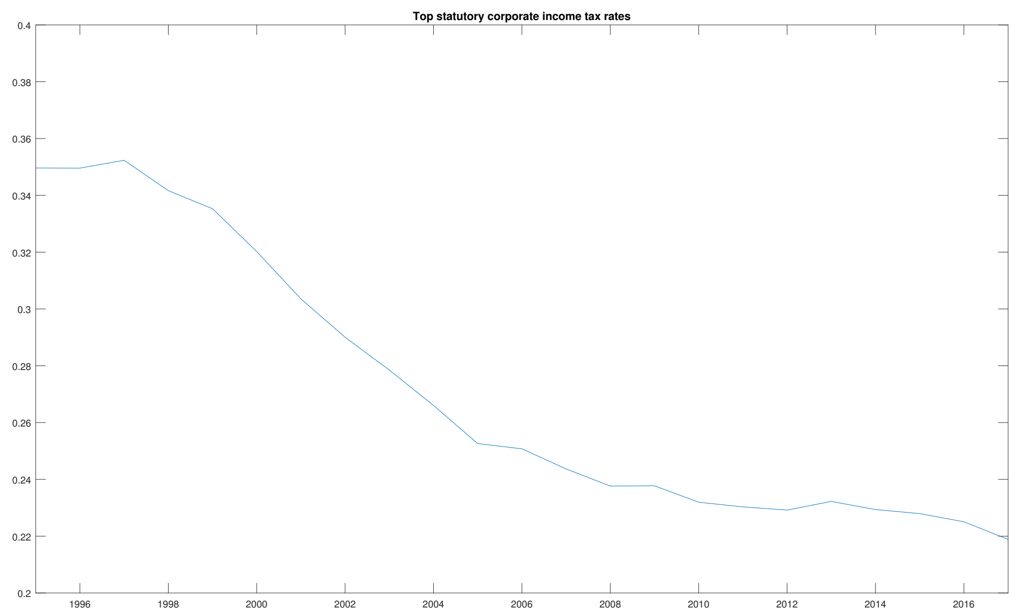

Figure 3: EU-28 average top statutory tax rates (1995-2017).

By looking at Figure 3, the same conclusion is confirmed, although for a shorter time span. Since the early days of the European Single Market, there was an effective race to bottom in capital tax rates. Although this decline seems to be sharper until the early 2000s, it must be noted that, on the one hand, the then pre-accession EU member countries had, already in 1995, an average corporate tax rate lower than the EU-15 average, at 31.4% against 38% in the EU. On the other hand, by 2004, year of the biggest EU enlargement, this gap had even further widened, with an average top statutory corporate tax rate of 21% in the thirteen new member countries against 31.4% in the EU-15. The adjustment between 2004 and 2017 was then mostly due to the EU-15 countries, which have since then slashed corporate taxes to an average of 25.5%, against 17.7% in the Eastern economies. Hence, the apparently milder decrease in corporate tax rates since the mid-2000s, rather than suggesting an appeasing downward pressure on capital taxation in the EU, point towards the opposite direction. Instead, EU-15 countries seem to have responded to the new competitive pressures, brought by the expansion of the European Single Market towards Eastern Europe, and imposed further corporate tax cuts. Quite interestingly, this was achieved in a period of high financial instability, while many EU-15 countries faced important fiscal constraints.

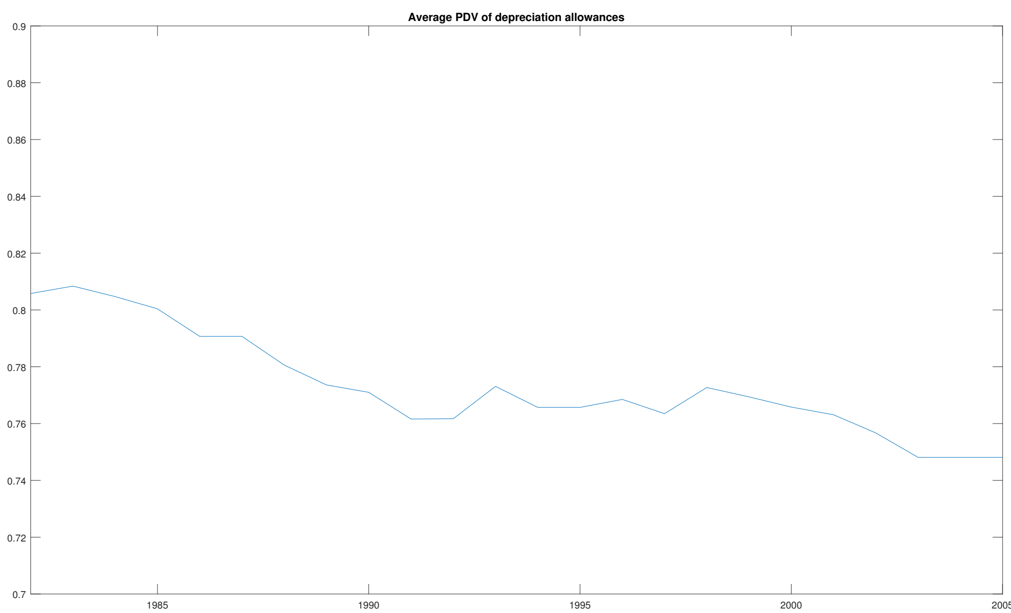

Figure 4: Average present discounted value of depreciation allowances (1982-2005).

At the same time, the corporate tax rate cuts just mentioned were accompanied by a broadening of the corporate tax base[10]. The definition of the tax base is, in this case, extremely complex[11]. We thus use a common measure of the tax base, which is based on

[10]As can be seen in Appendix A, Figures .7 and .8, effective corporate tax rates have followed the same downward trend between 1982 and 2005. The data was collected from the Institute for Fiscal Studies.

[11]The definition of the corporate tax base involves a wide range of legislation, covering namely allowances

the present discounted value (PDV) of depreciation allowances (as a percentage of the initial investment). This measure would be zero in the absence of depreciation allowances and 100% if the investment could be immediately imputed.

Figure 4 thus shows a steady broadening of the tax base from the early 1980s until the mid-2000s in the twelve EU countries identified above. It is interesting to note that, on the one hand, compared to the fall in corporate tax rates, this broadening of the tax base appears rather mild over above twenty years. On the other hand, behind this average lie somewhat different trends. Austria, Ireland and the United Kingdom, for instance, undertook large tax base broadening reforms over the years, particularly in the late 1980s in the case of the latter two. Greece, Portugal and Spain, which exhibited the largest tax bases (lower values for the PDV of allowances), tightened their tax bases over the period. Finally. in the case of Belgium and the Netherlands, on the other hand, the PDV of depreciation allowance remained unchanged over the entire period.

In sum, EU countries have engaged in extensive corporate tax cuts since the late 1980s. Albeit slightly offset by tax base enlargements, in some countries, this plunge in corporate tax rates appeared far more profound than that initially thought and even recommended, at the outset of the European Single Market. Furthermore, rather than seeming to appease after an initial transition period, it has continued far beyond the early 2000s, mostly driven by EU-15 countries facing further competition from Eastern countries.

In the next section, we present the main features of our model and its equilibrium, before we move on to look at optimal policy issues.

3. Model

A continuum of infinitely-lived individuals i ($i \in (0, 1)$) live in each of the J jurisdictions

for capital expenditures, the deductibility of pension contributions, or the valuation of assets and inventories and the extent to which different expenses can be deducted (OECD, 2007).

$(j = 1, ...J)$ of a closed economy. In an endogenous growth framework, we develop a continuous time model in the spirit of namely Barro (1990), Alesina and Rodrik (1994) and Hatfield (2015).

Each individual i of a jurisdiction j is endowed with an initial amount of capital, $k_j^i(0)$. The initial distribution of capital in each jurisdiction can be described by a distribution $F(.)$, which is assumed to be identical across jurisdictions. This represents the only source of heterogeneity between across individuals, which will then be mirrored into different income levels, as all individuals have otherwise similar endowments and characteristics, namely the same endowment of time and labour productivity. Capital can be invested, $\dot{k}_j^i(t)$, and used to produced the final good, $y_j(t)$, or used for consumption, $c_j^i(t)$. Firms producing the final good operate in perfectly competitive markets. Hence, factors are paid their marginal products and profits are zero in the whole economy. The factors of production are capital $k_j(t)$, labour $l_j(t)$ and a productive public good $g_j(t)$. In addition, there is also a publicly-provided good $h_j(t)$, which can be used for consumption only and can be seen as a merit good, or a purely (in-kind) redistributive good in nature.

In the initial period, $t = 0$, all the individuals in each jurisdiction j vote for their preferred policy set, choosing the capital tax rate, τ_j^K, the income tax rate, τ_j^L, as well as the share of total revenues to be allocated to each publicly provided good, $g_j(t)$ and $h_j(t)$, β_j and $(1 - \beta_j)$, respectively. After this set of policies $(\tau_j^K, \tau_j^L, \beta_j)$ is chosen, individuals choose their consumption and where to invest their capital. The total amount of capital invested in each jurisdiction j at time t is thus

$$k_j(t) \equiv \sum_{\{j \in J\}} \int_0^1 k_j^i \iota_{\{j = d_j^i(t)\}} di$$

and the total amount of capital in the economy is

$$k(t) \equiv \sum_{\{j \in J\}} \int_0^1 k_j^i(t) di.$$

Although the whole economy is assumed to be closed, which is reflected in the equation above (i.e. the total amount of capital in the economy equals the sum of capital holdings of all individuals), capital can move costlessly across all J jurisdictions. Individuals, endowed with one unit of labour at each time t, $l_j^i(t) = 1$, cannot move across jurisdictions[12].

3.1 Firm, government and household problems

The production function in this economy is Cobb-Douglas, with capital share α, $\alpha \in (0, 1)$, and features the three factors of production discussed above, capital, labour, and the productive public good:

$$y_j(t) = Ag_j(t)^{1-\alpha}k_j(t)^{\alpha}l_j(t)^{1-\alpha}. \tag{1}$$

Firms, operating in a perfectly competitive environment, set the wage rate, $w_j(t)$, equal to the marginal productivity of labour, and the rental rate of capital, $r_j(t)$, equal to the marginal productivity of capital. Each individual is endowed with one unit of labour, $l_j^i(t) = 1$, and labour supply in any given jurisdiction is $l_j(t) = 1$. We thus obtain the following equilibrium rental rates on capital and wage rates:

$$r_j(t) \equiv \frac{\partial y_j(t)}{\partial k_j(t)} = A\alpha g_j(t)^{1-\alpha}k_j(t)^{\alpha-1}l_j(t)^{1-\alpha} \tag{2}$$

$$w_j(t) \equiv \frac{\partial y_j(t)}{\partial l_j(t)} = A(1-\alpha)g_j(t)^{1-\alpha}k_j(t)^{\alpha}l_j(t)^{-\alpha} \tag{3}$$

The government funds the provision of the productive public good and the merit good

[12] We show in Appendix B four simpler versions of this model. The first one corresponds to the simplest Real Business Cycle model and the second one adds a merit good funded by a capital tax. The third version is similar to Alesina and Rodrik (1994) and features a capital tax used to fund a productive public good, instead. The fourth version considers both types of public good funded by a capital tax and is the closest to our model. Other extensions that can be considered in the context of this paper would include for instance the inclusion of a labour-leisure choice or the consideration of possible differences between jurisdictions. For full derivations of this model, please refer to Appendix C.

out of capital and labour income tax revenues[13]:

$$g_j(t) + h_j(t) = \tau_j^K k_j(t) + \tau_j^L w_j(t) l_j(t) \tag{4}$$

We can also rewrite this into two budget constraints, in order to identify the share of government revenues spent on the productive public good and the merit good, β_j and $1-\beta_j$, respectively:

$$g_j(t) = \beta_j \left[\tau_j^K k_j(t) + \tau_j^L w_j(t) l_j(t)\right] \tag{5}$$

$$h_j(t) = (1-\beta_j) \left[\tau_j^K k_j(t) + \tau_j^L w_j(t) l_j(t)\right] \tag{6}$$

The utility of each individual can be represented by the following CES function[14]:

$$\int_0^\infty e^{-\delta t} \log \left[\eta_c^{\frac{1}{\sigma}} c_j^i(t)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}} h_j(t)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} dt \tag{7}$$

where δ is the continuous time discount factor, η_c and η_h are preference parameters, $\eta_c + \eta_h = 1$. The parameter σ represents the elasticity of substitution between private consumption, $c_j^i(t)$, and the merit good, $h_j(t)$, provided by the government.

The budget constraint faced in any period by an individual i can thus be expressed as:

$$\dot{k}_j^i(t) = (r_{d_j^i(t)}(t) - \tau^K_{d_j^i(t)}) k_j^i(t) + (1-\tau_j^L) w_j(t) l_j^i - c_j^i(t) \tag{8}$$

[13]Another option would be to have two government budget constraints, effectively having hypothecated taxes, where possibly the merit good would be funded out of capital taxes. These budget constraints could be written as $g_j(t) = \tau_j^K k_j(t) + \tau_j^L w_j(t) l_j(t)$ and $h_j(t) = \theta_j k_j(t)$. We leave further considerations on this alternative for later. The budget constraint of individual i would in this case be $\dot{k}_j^i(t) = (r_{d_j^i(t)}(t) - \tau^K_{d_j^i(t)} - \theta_{d_j^i(t)}) k_j^i(t) + (1-\tau_j^L) w_j(t) l_j^i - c_j^i(t)$.

[14]The idea that the direct effect of government spending on private consumption and, hence, on the utility of the representative household should be accounted for in general equilibrium models dates back at least from Barro (1981). We use a CES specification to also account for the related question of the relationship between private consumption and government spending, while providing a flexible analytical framework. See for example Amano and Wirjanto (1998) for a very similar treatment of the utility function. We leave further discussion on this issue to the next sub-section.

The subscript $d_j^i(t)$ in the capital tax rate $\tau^K_{d_j^i(t)}$ highlights the possibility that different individuals in a given jurisdiction j can, in principle, obtain different net rates of return on capital, by investing in different jurisdictions. Note that households may choose, at least in principle, to invest their capital stock, $k_j^i(t)$, in different jurisdictions, with different levels of capital taxes and gross rates of return on capital. The net rate of return on labour also depends on the jurisdiction j choice of taxes and on wages - or marginal labour productivity -, but note in this case that individuals do not have the choice to relocate to neighbouring jurisdictions and, hence, the labour income tax term, τ_j^L, is indexed only by j.

As we shall see, in equilibrium there will be only one rate of return on capital, both under a single centralized governments and decentralized governments. The former case, by definition, implies one single set of policies $(\tau_j^K, \tau_j^L, \beta_j)$, to which corresponds a given rate of return on capital, $r_j(t)$. The latter case entails a Bertrand-type competition for capital between all J jurisdictions, where these will attempt to maximise the net rate of return on capital in order to attract investment. Furthermore, with no adjustment costs or any costs of moving capital across jurisdictions, a 'winner-takes-all' equilibrium is obtained, in which all jurisdictions are forced to offer the maximum rate of return on capital[15].

3.2 The role of CES preferences

The use of a CES utility function enables us to consider the cases when private consumption, $c_j^i(t)$, and the consumption of the merit good, $h_j(t)$, provided by the government are not independent of each other or, in other words, when the degree of substitutability between the two goods is different from one. Hence, we can consider the cases when private consumption and merit goods are Edgeworth-substitutes ($\sigma > 1$) or Edgeworth-complements ($\sigma < 1$). This approach will thus enable us to grasp the different optimal policies, depending on the relationship between these two aggregates. In particular, given the nature of the merit good

[15]To avoid multiple equilibria or, in other words, equilibria where some jurisdictions end up with zero capital, we use the additional assumption of a slight home bias, as in Hatfield (2015). This is equivalent to stating that individuals facing equal rates of return will choose to invest in their own jurisdiction.

delivered by the government, we will devote special attention to the case of complementarity between both goods.

The discussion around the relevance for fiscal policy of the substitutability or complementarity of public spending and private consumption has developed significantly since the early contribution of Aschauer (1985) and it is part of a wider literature on the response of economic aggregates to changes in government spending (Barro, 1981). Although the empirical evidence appears still rather inconclusive (see, for instance, Aschauer 1985, Campbell and Mankiw 1990, Graham 1993, Ni 1995, Amano and Wirjanto 1998, Okubo 2003, Fiorito and Kollintzas 2004, Bouakez and Rebei 2007, Ercolani and e Azevedo 2014; among others), two apparent features seem worth to highlight in the context of our discussion. Firstly, when the data is disaggregated into different categories of public spending, merit goods tend to be complementary to private consumption, whereas public goods, in the strict sense, tend to be substitutes to private consumption. Secondly, once we compare different periods, public spending as an aggregate appears to have become increasingly complementary to private consumption since the 1970s, namely given the general increase in welfare spending and the changing composition of general government spending (Fiorito and Kollintzas, 2004).

A similar point is made in Galí et al. (2007), in the context of a broader assessment to the relevance of the positive co-movement between government spending and private consumption in the context of business cycle models. This apparent relationship implies that standard models prove inadequate to assess the macroeconomic effects of fiscal policy. In particular, the assumption that public and private consumption are independent - or, in other words, that private consumption and the level of the merit good are separable in the utility function - seems to become rather problematic.

We thus explore a model that features two types of good provided by the government, where the merit good enters a CES utility function of the household. Although this does not bring major qualitative changes to the dynamic behaviour of economic agents, as summarised for example by the Euler equation, the equilibrium equation of our endogenous growth model.

The effective growth rate of the economy can however be slightly altered, depending on the equilibrium set of policies, $(\tau_j^K, \tau_j^L, \beta_j)$. In this context, the optimal policy may change significantly, in order to account for the relationship between the two aggregates. Namely, depending on the level of Edgeworth-substitutability or complementarity between private consumption and the merit good, it might be either increasing or decreasing in key parameters of the model.

Bearing this in mind, before we explore the equilibrium of our model more in depth, it is worth defining the merit good. Generally, this merit good can be interpreted in light of the redistributive role of the government. This may come in various forms: general education and healthcare spending, purely redistributive transfers - such as pensions, unemployment, food stamps and housing benefits -, or any social, cultural and recreational services directly provided by the government. These can be generally referred to as "Welfare State" expenditures and, together, are responsible for about two thirds of aggregate government spending in most OECD countries. These expenditures also account for most of the rise in public spending during the 1980s and the 1990s (Fiorito and Kollintzas, 2004). In order to avoid a (problematic) overlap with potential "productive" public spending categories, which enter the production function of the economy, we choose to focus in particular on those categories of public spending on the so-called merit good which can typically be considered as strictly "non-productive", such as in-kind benefits, social care or cultural and recreational services.

Recent studies generally seem to suggest these public expenditure items are strongly complementary to private consumption (Fiorito and Kollintzas 2004, Bouakez and Rebei 2007). This could be due namely to inefficiency in the public provision of the merit good, which would create a complementarity effect *within* spending categories. This is for example the case if the public social care service is of poor quality or not delivered in enough quantity to meet individual demands. In this case, this should generate an increase in demand for private healthcare provision. On the other hand, we can also have a complementarity effect *between* spending categories. This is the case when healthier and more well-educated individuals increase their demand for private consumption items, such as luxury goods.

3.3 Equilibrium

An equilibrium in this model is characterised as a set of policies for each jurisdiction j, $(\tau_j^K, \tau_j^L, \beta_j)$, corresponding to a path of consumption, capital and investment decisions for all agents, $\{c_j^i(t), k_j^i(t), d_j^i(t)\}$, and wages, rental rates, production and government expenditure decisions in each jurisdiction $\{w_j(t), r_j(t), y_j(t), g_j(t), h_j(t)\}$ such that (i) each agent maximises her utility, taking the paths of wages and rental rates of capital in each jurisdiction as given, (ii) wages and rental rates of capital are given by the marginal productivity of labour and capital in each district and (iii) agents vote on a set of policies, taking as given the policies chosen by other jurisdictions and understanding the path of the economy resulting from the set of policy choices. This latter point is particularly important in the context of our political economy equilibrium under decentralized governments and full tax competition between jurisdictions. The only difference between agents is the district where they live and their initial amount of capital $k_j^i(0)$.

Consider now the problem of a given household i, maximizing utility, (7), subject to her budget constraint (8), endowed with initial amount of capital $k_j^i(0)$:

$$\max_{[c_j^i(t),k_j^i(t)]_{t=0}^{\infty}} \int_0^{\infty} e^{-\delta t} \log\left(\left[\eta_c^{\frac{1}{\sigma}} c_j^i(t)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}} h_j(t)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}\right) dt$$

s.t.

$$\dot{k}_j^i(t) = (r_{d_j^i(t)}(t) - \tau^K_{d_j^i(t)})k_j^i(t) + (1-\tau_j^L)w_j(t)l_j^i - c_j^i(t).$$

Taking as given the set of policies $(\tau_j^K, \tau_j^L, \beta_j)$, we may rewrite the problem using the following current-value Hamiltonian (Acemoglu, 2008):

$$\hat{H}(c_j^i(t), k_j^i(t), \mu(t)) \equiv$$
$$e^{-\delta t}\Big\{ \log\left[\eta_c^{\frac{1}{\sigma}} c_j^i(t)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}} h_j(t)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} + \mu(t)\left[\gamma k_j^i(t) + (1-\tau_j^L)w_j(t)l_j^i - c_j^i(t)\right]\Big\}$$

After obtaining the first-order optimality conditions, we can write the following Euler equation for the path of consumption[16]:

$$c_j^i(t) = c_j^i(0)e^{(\psi-\delta)t} \tag{9}$$

where $\psi = r(t) - \tau_j^K$ is the net rate of return on capital. We can define the initial consumption of individual i in region j, $c_j^i(0)$, with capital holdings $k_j^i(0)$ as:

$$c_j^i(0) = \delta k_j^i(0) + (1-\tau_j^L)w_j(0)l_j^i \tag{10}$$

Hence, using (10) in (eq. (9)), we may define present consumption in each period as:

$$c_j^i(t) = \Big(\delta k_j^i(0) + (1-\tau_j^L)w_j(0)l_j^i\Big)e^{(\psi-\delta)t}.$$

The expression above denotes that, in each period, individuals will use their labour income in full plus a fraction δ of their capital stock in order to finance present consumption. Hence, those individuals in each jurisdiction j with higher capital endowments will consume more than those with lower capital endowments, given that the wage rate and the labour income tax are the same for all individuals in that jurisdiction j. It is thus foreseeable that individuals who rely relatively less on capital and more on labour income in order to finance their consumption will also tend to prefer a policy set that features higher taxes on capital (given the lower opportunity cost of capital taxation) and lower labour income taxes.

Substituting back into (8) we can also show that capital grows at the same rate as consumption and output in this economy:

$$\dot{k}_j^i(t) = \psi k_j^i(t) + (1-\tau_j^L)w_j(t)l_j^i - \Big(\delta k_j^i(0) + (1-\tau_j^L)w_j(0)l_j^i\Big)e^{(\psi-\delta)t} = (\psi-\delta)k_j^i(t)$$

given the equilibrium wage rate $w_j(t) = w_j(0)e^{(\psi-\delta)t}$.

[16]Full derivations are shown in Appendix C.

We can furthermore re-write (10) as a function of constants. This will be crucial namely when solving for the optimal policy. Hence, we can have initial consumption as a function of constants and the initial amount of capital in each jurisdiction j, $k_j(0)$, we obtain:

$$c_j^i(0) = \Big(\delta\kappa_j^i + \omega_j\Big)k_j(0) \tag{11}$$

We obtain two important ratios: the relative capital holdings of agent i in jurisdiction j, $\kappa_j^i \equiv \frac{k_j^i(0)}{k_j(0)}$, and the after-tax wage-capital ratio of economy j, $\omega_j \equiv \frac{(1-\tau_j^L)w_j(0)l_j^i}{k_j(0)}$. It can also be verified that the wage-capital ratio, ω_j, is constant with respect to time, given that the wage rate grows at the same rate as the capital stock in each jurisdiction. The relative capital of each individual, κ_j^i, is also constant, as the (net) rental rate on capital is the same for all individuals and constant over time, irrespective of their initial amount of capital, as well as the growth rate of the economy. Since capital grows at a constant rate for every agent in the economy and relative capital holdings remain constant and determined solely by the initial endowment, capital inequality persists over time. The level of consumption or income inequality, in turn, is also constant over time but depends on the policy set $(\tau_j^K, \tau_j^L, \beta_j)$ chosen by the government.

4. Optimal policy

In order to obtain the optimal policy, we first solve for the utility function with the equilibrium choices made by the an individual i, given the set of tax rates and share of public revenues devoted to the productive public good chosen by the government, $(\tau_j^K, \tau_j^L, \beta_j)$. We then reach a so-called indirect utility function expressed as a function of parameters. We can then finally obtain the optimal policies for the government.

We note that, for a policy $(\tau_j^K, \tau_j^L, \beta_j)$ to be chosen in equilibrium, at least half of the agents i in a jurisdiction j have to favour that policy over the set of all the other feasible policies. This is plainly a corollary of the median-voter theorem, which we apply in this context. We furthermore work under the assumption that governments can commit to the policies announced at time $t = 0$ and agents' preferences over policies do not change over time (since κ^i is constant for each individual). Hence there are no time-consistency issues and allowing for repeated votes on the set of policies would not alter the results.

Under this framework, we can consider both the case of the existence of a centralized government or, instead, as we assumed so far, the existence of many decentralized governments, one in each jurisdiction j, with full fiscal powers. The key difference in this context between a central government and the decentralized, or sub-central, governments lies on the fact that the central government faces no mobility of, or competition for, capital. Thus, the central government, by and large, regards capital as largely an immobile factor[17]. Sub-central governments, on the other hand, face full mobility of capital, which results into an extreme for Bertrand competition for capital. Labour is assumed to be an immobile factor throughout this exercise, as already mentioned[18].

As a preview of results, to the extent that sub-central governments face a Bertrand-like competition for capital, the latter will not be provided in the decentralized equilibrium. Let us now move towards the analysis of the equilibrium under centralization, with one single central government with full fiscal powers. We then move on to explore the equilibrium under decentralization, with J decentralized governments with full fiscal powers facing perfect capital mobility across borders. We will focus in particular on the implications of perfect capital mobility on the political economy equilibrium under decentralization.

4.1 Centralization

[17]We could drop the jurisdiction subscript in our analysis of the centralized policy, as centralization in this case is equivalent to having only one jurisdiction j, given that this would imply that all j jurisdictions would have the same set of policies $(\tau_j^K, \tau_j^L, \beta_j) = (\tau^K, \tau^L, \beta)$ and, hence, the same choices made in equilibrium by economic agents and the same growth rate of the economy, r.

[18]The assumption of *immobility* across jurisdictions is used in order to make a clear distinction between mobile and immobile factors of production. We could, however, drop the assumption of *fixed* individual supply of labour and allow for example for an explicit labour-leisure choice, as mentioned earlier. However this could lead to level effects, the equilibrium labour supply would still be invariant over time.

In order to solve for the optimal policy of the central government, under this framework, let us obtain the utility of agent i as a function of parameters and policy set $(\tau_j^K, \tau_j^L, \beta_j)$. Using (9) and (10) in (7), we obtain:

$$\int_0^\infty e^{-\delta t}\log\left(e^{\xi t}\left[\eta_c^{\frac{1}{\sigma}}(\delta k_j^i(0)+(1-\tau_j^L)w_j(0)l_j^i)^{\frac{\sigma-1}{\sigma}}+\eta_h^{\frac{1}{\sigma}}h_j(0)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}\right)dt$$

where $\xi = \psi - \delta$. Assuming that, along the balanced growth path, we must have $\frac{\dot{c}_j^i(t)}{c_j^i(t)} = \frac{\dot{h}_j(t)}{h_j(t)}$, we can express the utility function as follows:

$$\begin{aligned} V(\xi, \omega_j; \kappa_j^i) = \\ & \frac{\xi(\tau_j^K, \tau_j^L, \beta_j)}{\delta^2} \\ & + \frac{1}{\delta}\frac{\sigma}{\sigma-1}\log\left[\eta_c^{\frac{1}{\sigma}}(\delta\kappa_j^i+\omega_j)^{\frac{\sigma-1}{\sigma}}+\eta_h^{\frac{1}{\sigma}}\left((1-\beta_j)(\frac{\tau_j^L}{1-\tau_j^L}\omega_j+\tau_j^K)\right)^{\frac{\sigma-1}{\sigma}}\right] \\ & + \frac{1}{\delta}\log(k_j(0)) \end{aligned} \tag{12}$$

We recall at this point that $\kappa_j^i \equiv \frac{k_j^i(0)}{k_j(0)}$ is the parameter capturing the relative capital holdings of agent i and is invariant over time. A capital-poor agent will have a low κ_j^i and a capital-rich agent will have a high κ_j^i. Thus, κ_j^i reflects individual i economic conditions. The after-tax wage-capital ratio of economy j, $\omega(\tau_j^K, \tau_j^L, \beta_j) \equiv \frac{(1-\tau_j^L)w_j(0)}{k_j(0)}$, on the other hand, is common to every agent in a given jurisdiction j and dependent on the set of policies chosen by the government in each jurisdiction. Thus, ω_j reflects economic conditions of each jurisdiction j. Note that this ratio will also be invariant with respect to time and will not depend namely on the relative intensity of capital of each region. The after-tax wage-capital ratio could hence, in principle, be the same across many different jurisdictions, if these would have the same equilibrium set of policies $(\tau^{K'}, \tau^{L'}, \beta')$ (which is indeed the case for a centralized government). Nonetheless, as this ratio partly reflects the equilibrium set of policies chosen in each jurisdiction, which in turn is defined by the (initial) distribution of capital in each jurisdiction j, it will be most likely to vary across each of the J different jurisdictions (under decentralized governments). The intuition is simple: as more unequal jurisdictions (with a poorer median voter) would demand more redistribution, these would tend to have a higher equilibrium ω_j. More equal jurisdictions (with a richer median voter) will demand less redistribution and will thus tend to have lower after-tax wage-capital ratios. Hence, ω_j will depend on preferences and, at least in principle, on the distribution of capital in each jurisdiction. We shall return to this point when we analyse optimal policy issues.

A closer inspection of (12) reveals that the utility of each agent can thus be expressed as a function of a growth term, the initial level of utility, and a term reflecting the initial state of the economy. When choosing its policy, the government changes the first two terms. Hence, the trade-off between initial utility and long-term economic growth is clear[19]. A further interesting feature is that, similarly to Alesina and Rodrik (1994), although κ^i is not affected itself by the policy chosen by the government, it still does affect the equilibrium optimal policy (under centralization), as we shall see later, in political equilibrium. By the same token, the after-tax wage-capital ratio is increasing in the capital tax, τ_j^K, and thus a higher τ_j^K effectively implies a transfer of wealth, through an increase in (relative) wages, from those capital-rich individuals to capital-poor ones, who rely relatively more on labour, rather than capital, income. Hence, we can write the wage to capital ratio as:

$$\frac{w_j(t)}{k_j(t)} \equiv A(1-\alpha)(\frac{\tau_j^L}{1-\tau_j^L}\omega_j l_j + \tau_j^K)^{1-\alpha} l_j^{-\alpha}$$

The median-voter will typically require a high τ_j^K for redistributive purposes. Thus, the political equilibrium (under centralization) will, in general, feature a capital tax that will not maximise economic growth. We will now look at the policy choices of the central government regarding the productive public good, $g_j(t)$, and the merit good, $h_j(t)$, funded through τ_j^K and τ_j^L. We will then analyse the case of a merit good funded specifically through a capital tax, θ_j.

[19]Note again that, since wages and capital grow at the same rate, the after-tax wage-capital ratio, ω_j, is constant with respect to time, assuming no policy changes, as well as the relative capital of agent i, κ_j^i, since the rental rate of capital is constant and all individuals will, in equilibrium, earn the same rate of return on their capital stock.

For a policy set (τ^K, τ^L, β) to be chosen in political equilibrium, under centralization, at least half of the agents i in a region j have to favour that policy over the range of all the other feasible policies. The policy chosen by the central government maximises the welfare of the median-voter:

$$({\tau^K}^{\text{med}}, {\tau^L}^{\text{med}}, \beta^{\text{med}}) = \underset{(\tau^K, \tau^L, \beta)}{\arg\max} \left\{ V(\xi, \omega, \beta; \kappa^{\text{med}}) \right\} \tag{13}$$

Note that this policy will not, in general, strictly maximise economic growth. Although we will return to this point later on, it is important to stress from the outset that the median voter will typically demand more redistribution (higher capital taxes, lower labour income taxes) than optimal from the point of view of the aggregate growth rate of the economy. Namely, a centralised government will ought to respond to the median voter of the whole economy. Hence, under no capital mobility, as we assume in the centralised government case, the equilibrium policy set will be $({\tau^K}^{\text{med}}, {\tau^L}^{\text{med}}, \beta^{\text{med}})$.

4.2 Decentralization

Under decentralized fiscal powers, each of the J sub-central governments in each jurisdiction now face full capital mobility[20]. With tax competition over mobility factors, the policy response will necessarily be different. In the knowledge that, in order to attract capital to their own jurisdictions, jurisdictions have to offer the highest possible rate of return (or lowest price) on capital, governments will engage in a "race to the top" to offer the highest net rate of return on capital. As a first-mover would have the immediate benefit of attracting all the capital in the economy (leaving all the other jurisdictions with a zero amount of capital), governments are immediately driven towards this type of extreme Bertrand competition for capital. In equilibrium, all the jurisdictions will offer the same net rate of return on capi-

[20]Note that, in a world of capital controls between jurisdictions (we could in principle think of this as the EU pre-European Single Market case or, more generally, as the cases when there is limited or no capital mobility between neighbouring countries), the optimal policy would again be $({\tau_j^K}^{\text{med}}, {\tau_j}^{L^{\text{med}}}, \beta_j^{\text{med}})$, where each sub-central government would respond to the median-voter in its own jurisdiction.

tal and, with the additional assumption of a slight home-bias (whereby capital-owners, faced with similar investment opportunities, prefer to invest in their own jurisdiction), there will be no further capital movements. The policy chosen by sub-central governments thus maximises the net rate of return on capital:

$$(\tau^{K*}, \tau^{L*}, \beta^*) = \underset{(\tau_j^K, \tau_j^L, \beta_j)}{\arg\max} \left\{ A\alpha \left[\beta_j \left(\tau_j^K + \frac{\tau_j^L}{1-\tau_j^L} \omega_j \right) \right]^{1-\alpha} - \tau_j^K \right\} \tag{14}$$

This policy will, by definition, maximise economic growth. It will not however respond to median-voter preferences, as before. In other words, the median-voter, understanding the new constraints imposed by perfect capital mobility between jurisdictions, will demand that the sub-central government in her jurisdiction offers precisely the growth maximising policy $(\tau^{K*}, \tau^{L*}, \beta^*)$. Accordingly, under decentralised governments with full fiscal discretion and perfect capital mobility, although the optimal policy and governments do still respond to the median voter, the equilibrium policy set $(\tau^{K*}, \tau^{L*}, \beta^*)$ does not any longer reflect the distribution of capital in the economy. This breaks the link between economic growth and inequality found namely in Alesina and Rodrik (1994), as jurisdictions with, *a priori*, different initial distributions of capital, will necessarily offer the same growth-maximising policy set in decentralised political economy equilibrium.

Note in particular that the share β_j of government revenues spent on the productive public good will, in equilibrium, tend to unity. This implies that the merit good is not provided in decentralized political economy equilibrium. All the revenues from capital and labour taxation will be directed toward the productive public good, in order to maximise the rate of return on capital. We will now explore this point as well as the wider implications of (14) more in depth. We then move on to compare, in the next section, the decentralised political economy equilibrium with other available alternatives, namely with centralization, for which the objective function (13) was already obtained, but also with other institutional options frequently discussed in this context.

By looking at (14), we can observe that a positive capital tax rate, $\tau_j^K > 0$, could in principle be sustained as an equilibrium. Indeed, for a small enough labour income tax τ_j^L, decentralised governments will raise τ_j^K until the maximum net rate of return on capital is reached, the exact level of which depends on the capital share α (assuming throughout this theoretical exercise that $\beta_j = 1$ and $\alpha > 0$).

Yet, sub-central governments will primarily raise the net rate of return on capital through higher labour income tax rates. The rationale for this is that, on the one hand, labour income taxes do not have a (first-order) negative effect on the net rate of return on capital. On the other hand, the second-order effects of the policy set $(\tau_j^K, \tau_j^L, \beta_j)$ on the net rate of return on capital, through the wage-capital ratio, also have to be taken into account. Let us have a closer look at ω_j, before moving on to further considerations on the decentralized political economy equilibrium:

$$\omega_j \equiv \frac{(1-\tau_j^L)w_j(t)}{k_j(t)} = (1-\tau_j^L)(1-\alpha)(\frac{\tau_j^L}{1-\tau_j^L}\omega_j l_j + \tau_j^K)^{1-\alpha} l_j^{-\alpha}$$

Hence, it is clear that an increase on productive public spending, $g_j(t)$, strictly increases the wage rate. Hence, it also increases the (pre-tax) wage-capital ratio $\frac{w_j(t)}{k_j(t)}$. In terms of the effects on the after-tax wage-capital ratio, this will depend on whether this higher spending is financed out of capital or labour income taxes. The after-tax wage-capital ratio will strictly increase with higher capital taxes, whereas it will show a hump-shaped response to changes in labour-income taxes. On the whole, however, the equilibrium policy set under decentralization $(\tau^{K*}, \tau^{L*}, \beta^*)$ will bring the two tax instruments to the extreme: there will be a race to the top to tax labour, the immobile factor, driving τ^{L*} to one, and a race to the bottom in capital taxation, the mobile factor, driving τ^{K*} to zero. This is the classical result seen for example in Ramsey (1927). We shall return to this result later on, when we discuss different institutional alternatives available in this context. Hence, before moving on to the next section, let us sum up the result just obtained: perfect capital mobility together will a decentralized political setting, featuring sub-central government with full fiscal discretion, will tend to yield a political economy equilibrium with a policy set $(\tau^{K^*}, \tau^{L^*}, \beta^*) = (0, 1, 1)$.

4.3 Tax harmonization

In order to discuss tax harmonization more in depth, let us briefly outline the set of options that can be considered in this context. Firstly, we have the case of full tax harmonization. This corresponds to the case of centralization outlined above. In the context of the European Union, this would resemble to an European Commission with extensive fiscal powers, both in terms of tax setting but also in terms of public spending. Secondly, we may consider capital tax harmonization. This hypothesis is frequently discussed, namely in the context of the European Union, but more broadly in the context of globalization and global corporate tax competition issues. We assume in this case that an homogeneous capital tax rate is set by a central government and that sub-central governments are responsible for choosing the labour income tax rate, as well as the composition of public spending. Finally, we have the option of labour income tax harmonization. Although perhaps frequently overlooked, this option has markedly different implications from capital tax harmonization. We then put the three options in perspective and compare their basic qualitative properties, through the graphical illustration of a simple numerical simulation. Let's now present, one by one, the three options outlined above.

4.3.1 Full tax harmonization

As mentioned above, this corresponds to the case of a central government with full tax setting powers. If public spending powers remain at the central level too, then this corresponds to the centralization equilibrium outlined above. In the context of the European Union institutional design, this amounts to the European Commission having full fiscal discretion on tax raising and public spending issues. In other words, this would equate to the case of a full Fiscal Union, with a federal government and a large federal budget, covering essential parts of public spending categories, from healthcare and education to redistributive transfers or public infrastructure. The equilibrium obtained, is in this case, precisely the one described in section 4.1, where the central government will respond to the wishes of the median voter in the economy as a whole. Note again that, under this scenario, the policy objective will not necessarily involve maximising the rate of return on capital and, hence, the growth rate of the economy.

Another alternative - perhaps less likely to raise so many eyebrows in the European context - is to have full tax harmonization in the sense that tax rate thresholds are agreed upon between all different jurisdictions, in order to circumvent potential damaging effects of tax competition. In the European context, this would imply that countries, in the European Council, and the Commission would agree to a common taxation framework, yet leaving full (*de jure*) fiscal discretion on public spending composition. We can formalize the latter alternative in terms of a different budget constraint and objective function for sub-central governments. Hence, the budget constraint of sub-central governments would be:

$$g_j(t) + h_j(t) = \tau^K k_j(t) + \tau^L w_j(t) l_j(t) \tag{4'}$$

Which can again be rewritten as:

$$g_j(t) = \beta_j \left[\tau^K k_j(t) + \tau^L w_j(t) l_j(t) \right] \tag{5'}$$

$$h_j(t) = (1 - \beta_j) \left[\tau^K k_j(t) + \tau^L w_j(t) l_j(t) \right] \tag{6'}$$

The policy chosen by sub-central governments still has to satisfy the condition for maximising the net rate of return on capital, however. Recall that sub-central governments face perfect capital mobility and, in this context, however there will not strictly exist *tax* competition between jurisdictions, there will be a "public spending composition" competition. Hence, the race to maximise the rate of return on capital persist, but will now only feature a single policy instrument:

$$\beta^* = \arg\max_{\beta_j} \left\{ A\alpha \left[\beta_j \left(\tau^K + \frac{\tau^L}{1-\tau^L}\omega \right) \right]^{1-\alpha} - \tau^K \right\} \tag{14'}$$

Hence, it is immediately apparent that the only equilibrium is achieved for $\beta_j = 1$.

4.3.2 Capital tax harmonization

Capital tax harmonization is frequently presented as one desirable way to circumvent the adverse consequences of free movement of capital, within the European Union but also in broader contexts. This alternative is a by-product of the one analyzed before, where full tax harmonization was achieved. Here, instead, tax rate thresholds are only set on capital taxes. In the European context, this would imply common capital taxation principles and an equalization of (effective) capital tax rates, leaving full fiscal discretion on public spending composition and on labour income tax rates. We can again formalize this in terms of a different budget constraint and objective function for sub-central governments.

The budget constraint of sub-central governments would be:

$$g_j(t) + h_j(t) = \tau^K k_j(t) + \tau_j^L w_j(t) l_j(t) \tag{4''}$$

Which can again be rewritten as:

$$g_j(t) = \beta_j \left[\tau^K k_j(t) + \tau_j^L w_j(t) l_j(t) \right] \tag{5''}$$

$$h_j(t) = (1-\beta_j) \left[\tau^K k_j(t) + \tau_j^L w_j(t) l_j(t) \right] \tag{6''}$$

Once again, the policy chosen by sub-central governments has to satisfy the condition for maximising the net rate of return on capital, now with two policy instruments. With the capital tax rate fixed centrally, sub-central governments will compete to attach mobile factors through labour income tax rates and, again, the composition of public spending:

$$(\tau^{L^*}, \beta^*) = \underset{(\tau_j^L, \beta_j)}{\arg\max} \left\{ A\alpha \Big[\beta_j \Big(\tau^K + \frac{\tau_j^L}{1-\tau_j^L} \omega_j \Big) \Big]^{1-\alpha} - \tau^K \right\} \tag{14''}$$

Again, it the equilibrium is achieved for $\beta_j = 1$. Similarly to the decentralization case presented in section 4.2, the race to maximise the rate of return on capital will also entail a race to the top in labour income taxes. With the capital tax rates set centrally, sub-central governments will use their public spending powers and set $\beta_j = 1$. By the same token, labour income tax rates τ_j^L will be set to unity, taking advantage of the immobility of this factor[21]. Hence, capital tax harmonization, by not eliminating one of the main sources of tax competition - i.e. not being able to avoid that sub-central governments set $\tau_j^L = 1$ - and, similarly to full decentralization of fiscal powers, will result in a zero after-tax wage-capital ratio ($\omega_j = 0$). Before moving on to the final institutional alternative, it is important to stress that both these options - i.e. full fiscal decentralization and capital tax harmonization - entail maximum income and consumption inequality between individuals with different (initial) capital endowments.

4.3.3 Labour income tax harmonization

Labour income tax harmonization is perhaps the most unusual, or less common, alternative discussed in this context. Within the European Union, in particular, a few common labour market initiatives have certainly been put forward over the whole European economic integration process. Labour income tax systems are, however, generally perceived to be largely part of a set of issues that are bound to be national or, at least, under the discretion of national governments. This alternative can be viewed once again as a by-product of full tax harmonization. Tax rate thresholds are here set on labour income taxes, rather than

[21] Note that, with a utility function featuring a disutility of labour, this result will be qualitatively similar. The labour income tax rate would be set to the "optimal", which would be the maximum tax rate tolerated by individuals, now with a trade-off between higher tax revenues and the corresponding disincentive to work.

capital taxes. In the European context, this would imply common labour income taxation principles and an equalization of labour income tax rates, as well as labour market regulations. This would leave full fiscal discretion to sub-central (national) governments on capital taxation and, as with capital tax harmonization, on the composition of public spending.

Formalizing the problem again in terms of a government budget constraint and objective function for sub-central governments, we obtain the following budget constraint for sub-central governments:

$$g_j(t) + h_j(t) = \tau_j^K k_j(t) + \tau^L w_j(t) l_j(t) \tag{4†}$$

Which can be rewritten as:

$$g_j(t) = \beta_j \Big[\tau_j^K k_j(t) + \tau^L w_j(t) l_j(t)\Big] \tag{5†}$$

$$h_j(t) = (1-\beta_j) \Big[\tau_j^K k_j(t) + \tau^L w_j(t) l_j(t)\Big] \tag{6†}$$

The policy chosen by sub-central governments satisfies again, in equilibrium, the condition for maximising the net rate of return on capital, with two policy instruments:

$$(\tau^{K*}, \beta^*) = \underset{(\tau_j^K, \beta_j)}{\arg\max} \left\{ A\alpha \Big[\beta_j \Big(\tau_j^K + \frac{\tau^L}{1-\tau^L}\omega_j\Big)\Big]^{1-\alpha} - \tau_j^K \right\} \tag{14†}$$

Again, the equilibrium achieved features $\beta_j = 1$, implying that all tax revenues are spent on the productive public good, in any scenario with public spending powers devolved to sub-central governments. Hence, under this framework, interjurisdictional competition for mobile factors precludes merit good spending. Yet, contrary to the decentralization case presented in section 4.2 and to capital tax harmonization, the race to maximise the rate of return on capital will not entail a race to the top in labour income taxes. Instead, capital tax rates will be set by sub-central governments to compete for mobile factors. With labour income tax rates fixed, this implies $\tau_j^K \geq 0$. Labour income tax harmonization, by being effectively able to rule out the possibility that sub-central governments take advantage of the immobility of the tax base of one productive factor and set $\tau_j^L = 1$, will also prevent that a zero after-tax wage-capital ratio ($\omega_j = 0$) is reached in equilibrium. In the following simple numerical simulation, we will also devote particular attention to stress the implications of the results obtained above, from the policymaking perspective.

4.4 A numerical example

In order to better stress the main features of the various different tax environments outlined above, we will now turn to a few graphical illustrations, with a simple numerical example based on the model just outlined. The following numerical examples are based on similar parameter values chosen for the key variables, namely for the continuous-time discount factor, δ, the capital share, α, and preference parameters η_c and η_h[22].

[22]For further details on the numerical values of these parameters and the two-dimensional figures corresponding to the three-dimensional ones shown below, please refer to Appendix D.

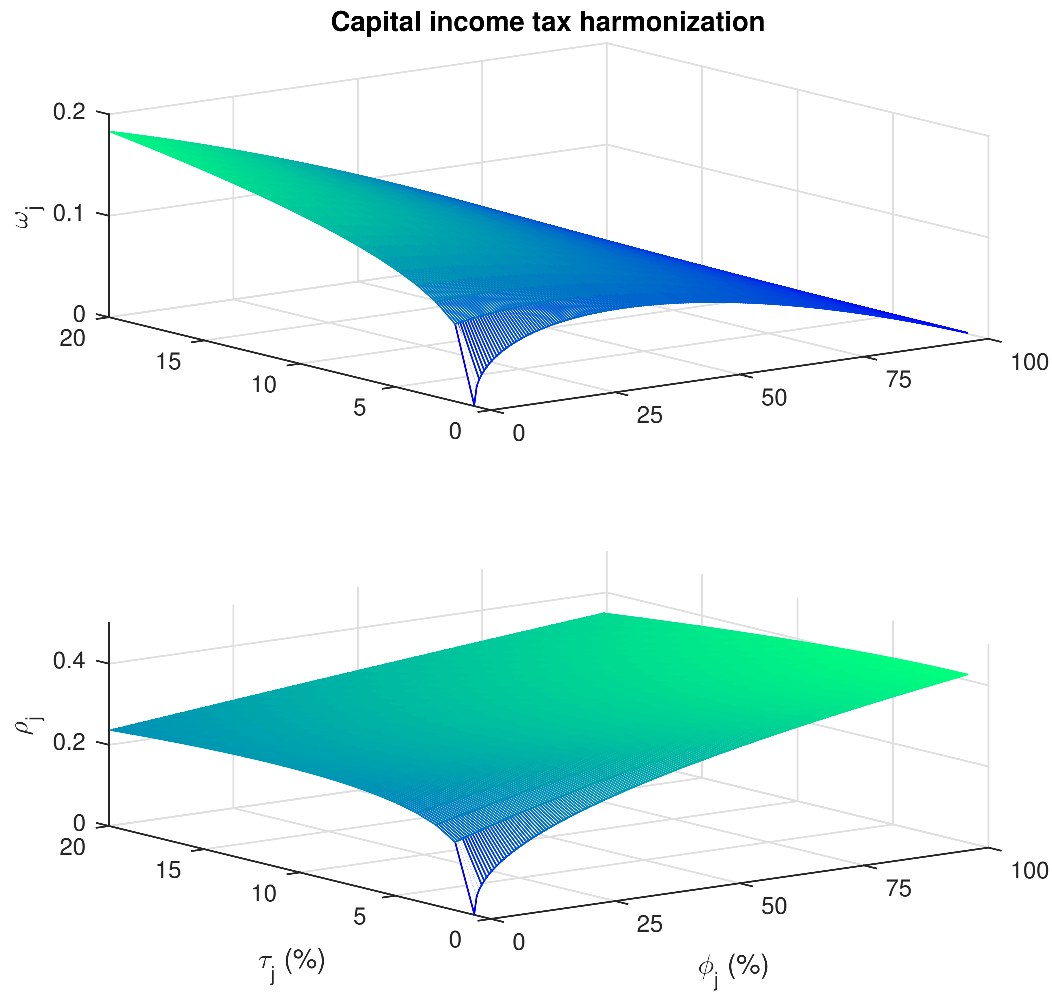

Figure 5: Capital tax harmonization (τ_j - capital tax, ϕ_j - labour income tax) - after-tax wage-capital ratio and net rate of return on capital. Numerical values for δ, α, η_c and η_h shown in Appendix D.

The results outlined in the previous section regarding capital tax harmonization are depicted in figure (5). Looking at the surface plotted in the graph, we can easily follow the two key facts outlined before. On the one hand, capital tax harmonization will lead to a race to the top in labour income taxation, in order to maximise the rate of return on capital. This can be seen by looking at the bottom graph in figure (5). By picking any level of τ_j^K, fixed by the central government or agreed upon between sub-central governments, the implication is that a race to the top in labour income taxation would immediately follow. On the other hand, the after-tax wage-capital ratio will be driven to zero, which implies an extreme form of (after-tax) income inequality. Labour income is fully taxed in order to subsidize capital owners.

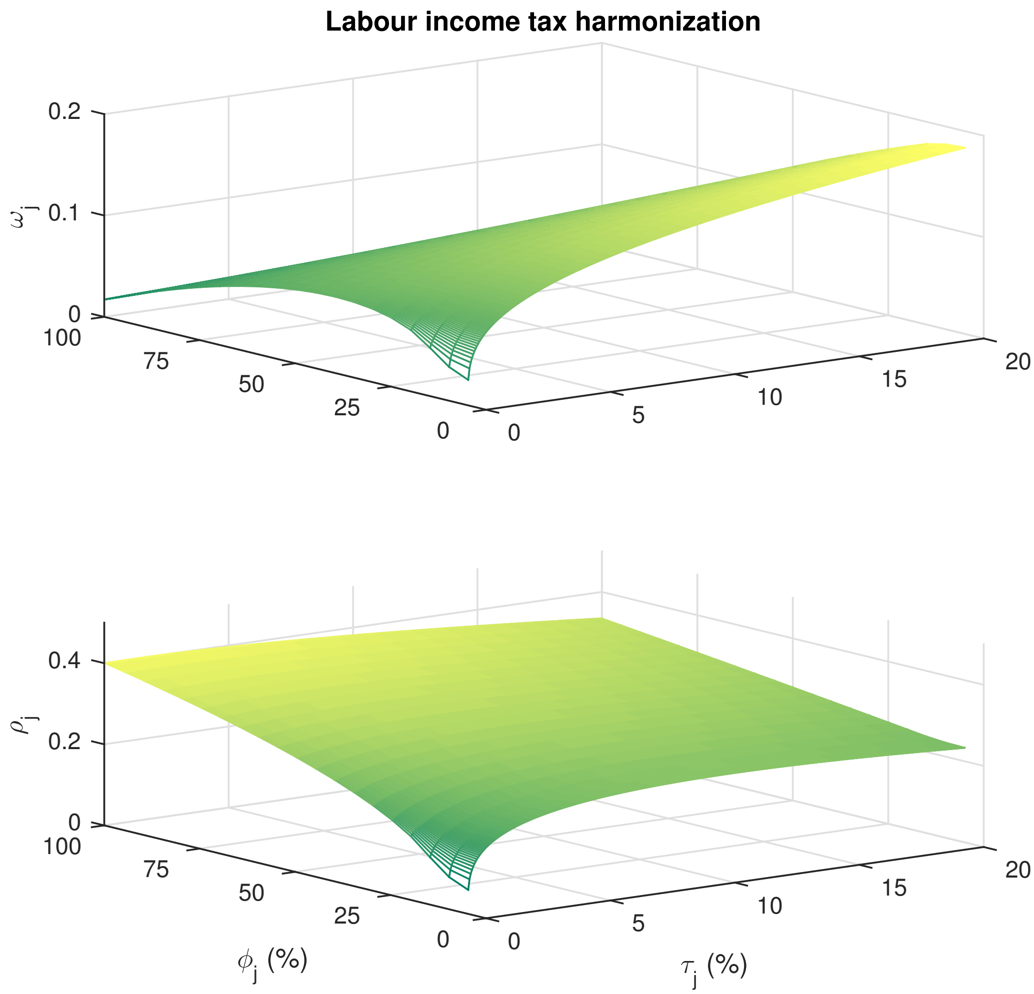

Figure 6: Labour income tax harmonization (τ_j - capital tax, ϕ_j - labour income tax) - after-tax wage-capital ratio and net rate of return on capital. Numerical values for δ, α, η_c and η_h in Appendix D.

Labour income tax harmonization, in turn, illustrated in figure (6) results in a completely different outcome. If we look again at the surface plotted in the bottom graph, we can observe that labour income tax harmonization does not necessarily result in a race to the bottom in capital taxation. Picking any level of τ_j^L, will not imply a race to the bottom in capital taxation, as for some levels of the labour income tax the growth-maximising tax is to have a positive capital tax rate, τ_j^K. The after-tax wage-capital ratio will not be driven to zero, which precludes an extreme scenario where labour income is fully taxed in order to subsidize capital income. Finally, note that the full discussion has so far resulted in a zero level of the merit good, in equilibrium, as sub-central governments (facing perfect capital mobility) are forced to set $\beta_j = 1$.

5. Conclusion

Is fiscal devolution good for growth? The forces of tax competition clearly suggest this is indeed the case. Undoubtedly, when productive factors enjoy perfect mobility, countries no longer enjoy full discretion over tax rates. In sum, economically integrated jurisdictions will have to reduce their taxation on mobile factors and increase the tax burden on relatively immobile factors of production. Rodrik (2000) famously labeled this as the Political Trilemma of the World economy. Weingast (1995), closer to the fiscal federalism tradition, defended it as a form of market-preserving federalism.

Where does the EU stand in this discussion? The trends over the past decades clearly suggest that OECD countries, and in particular EU countries, have already undertook a first wave of extensive corporate tax rate cuts. This was frequently accompanied by tax base enlargements and, perhaps more importantly, by increasing consumption and labour income taxes. In this context, the EU presents itself as a unique laboratory for exploring the effects of tax competition as the largest reductions in corporate tax rates in the past decades across OECD countries were all observed within this area (Loretz, 2008), not least because of the geographical proximity and degree of economic integration between jurisdictions. Namely, the creation of the European Single Market, with perfect mobility of goods and production factors, has given rise to a very peculiar institutional setting, under which perfectly economically integrated jurisdictions with virtually full fiscal discretion coexist. Given the limits to the broadening of tax bases and to further consumption tax increases, EU countries are thus increasingly likely to have to face the choice between raising revenue through corporate taxes or labour income taxes. Recent trends also suggest that larger EU countries, already facing substantial competition from neighbouring jurisdictions, will engage sooner or later in more aggressive tax competition. Recent corporate tax rate cuts in countries like Germany from 25 to 15 percent - at the same time as consumption taxes were being raised - certainly seem to suggest that. Moreover, further cuts are increasingly likely and have recently re-appeared in the policy agenda, namely in the United Kingdom, France and, again, Germany, not to mention the United States, as an obvious foreign competitor.

The results highlighted in this paper point towards various directions. On the one hand, the EU can let countries compete for mobile factors and let the market forces reconvene to decide on the most efficient allocation of resources. This is likely to produce the highest average growth and to exacerbate inequalities within the EU. At the other end, the EU can aim for further centralisation of fiscal, and political, powers. This would lead to a complete fiscal union, which many have argued would be the most desirable outcome, as a means to complement the existing monetary union. Yet, political feasibility and a long tradition of slow institutional change will undermine such a large shift of fiscal powers from national jurisdictions towards the European Commission. Between the present status quo, of (almost) full tax competition, and a future fiscal union, a wide array of options may be at the disposal of the EU, in trying to attenuate the harmful effects of tax competition between EU jurisdictions. Tax harmonization looks increasingly like a worthy candidate.

But which taxes should the EU harmonize? The present paper suggests various options for tax harmonization that may be on the European negotiating table. Full tax harmonization would amount to a complete fiscal union within the EU or, at least, to a case where all tax rates would be decided centrally and sub-central governments would be left with (*de jure*) discretion over the composition of public spending. This will not however correspond a *de facto* discretion over public spending choices, as the spending on so-called merit goods, at least those with the clearest redistributive character, would be limited, at the very least, as a result of the persistent competition to attract mobile factors. Capital tax harmonization, a recurrently debated option in this context, would in turn lead to a race to the top in labour income taxation and not be able, on its own, to avoid a result under which the immobile tax base is taxed to subsidize capital. Finally, labour income tax harmonization provides a framework under which such race to the top can be prevented. With fully integrated labour and capital markets, a common labour taxation framework with common labour regulations seems to provide the only alternative able to hinder a *de facto* subsidy to capital owners, through heavier labour taxation and lighter labour market regulations. Any choices made in the EU on tax harmonization will thus depend on the ultimate policy objectives of governments and voters. One issue is clear however from this analysis: the trade-off between economic growth and redistribution is inevitable and interjurisdictional tax competition, or capital mobility more in general, brings further constraints to this difficult puzzle.

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Appendix A

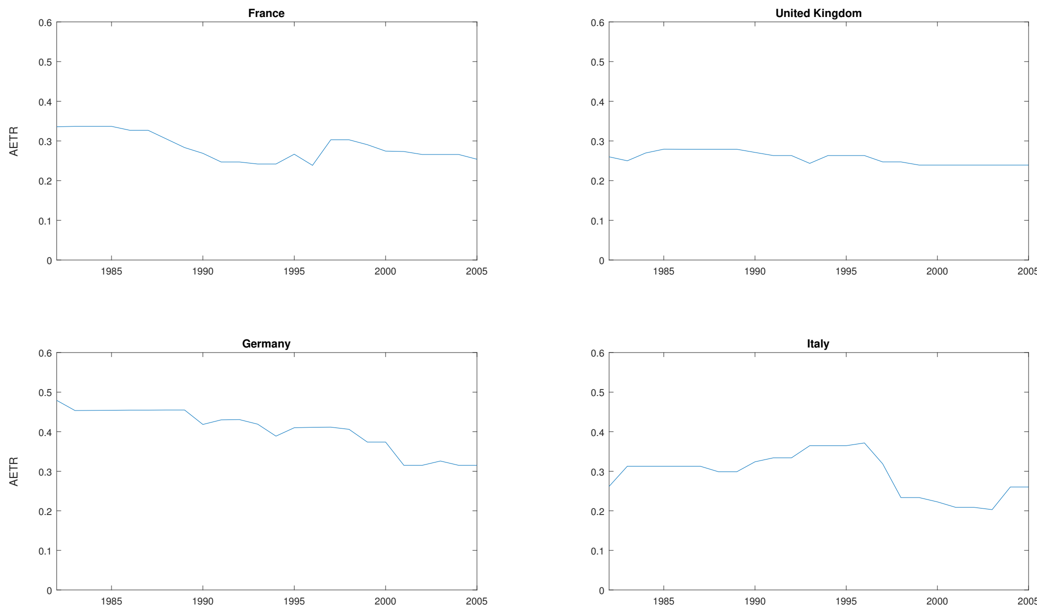

Figure .7: Average effective tax rates of 4 large EU countries (1982-2005).

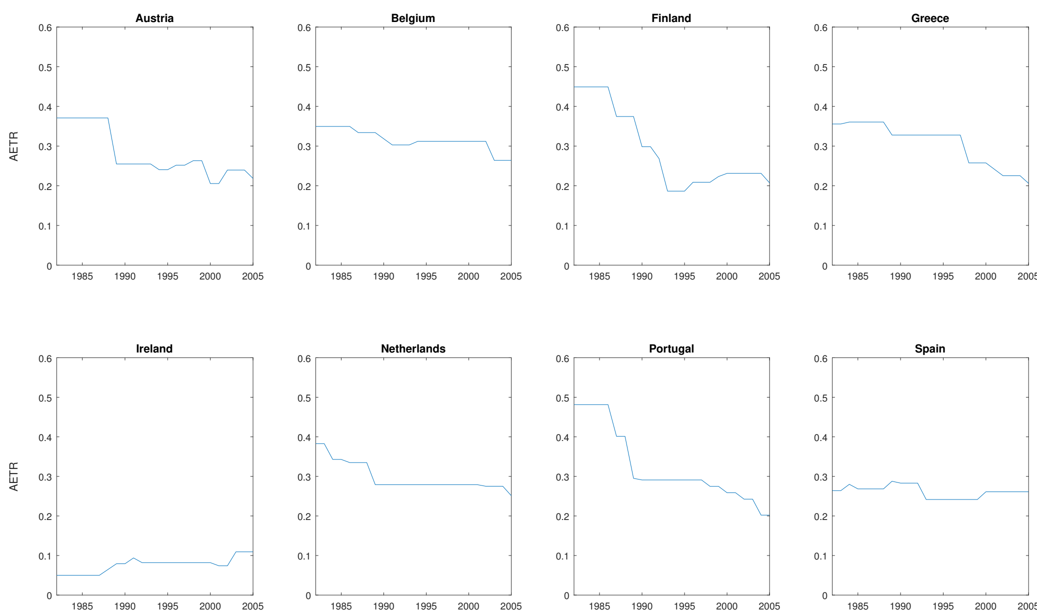

Figure .8: Average effective tax rates of 8 small EU countries (1982-2005).

Appendix B

The standard Real Business Cycle (RBC) model:

We can represent utility of the representative household and the production function of the economy as follows:

$$\int_0^\infty e^{-\delta t} \log\left[c_j^i(t)\right] dt \tag{.1}$$

$$y_j(t) = Ak_j(t)^\alpha l_j(t)^{1-\alpha} \tag{.2}$$

Assuming a perfectly competitive environment in the economy, profit-maximization yields the following returns to the productive factors:

$$r_j(t) \equiv \frac{\partial y_j(t)}{\partial k_j(t)} = A\alpha k_j(t)^{\alpha-1} l_j(t)^{1-\alpha} \tag{.3}$$

$$w_j(t) \equiv \frac{\partial y_j(t)}{\partial l_j(t)} = A(1-\alpha)k_j(t)^\alpha l_j(t)^{-\alpha} \tag{.4}$$

Agents face the following budget constraint:

$$\dot{k}_j^i(t) = r_{d_j^i(t)}(t)k_j^i(t) + w_j(t)l_j^i - c_j^i(t) \tag{.5}$$

We can write the following Hamiltonian:

$$\hat{H}(c_j^i(t), k_j^i(t), \mu(t)) \equiv e^{-\delta t}\Big\{ \log\left[c_j^i(t)\right] + \mu(t)\Big[r_{d_j^i(t)}(t)k_j^i(t) + w_j(t)l_j^i - c_j^i(t)\Big]\Big\}$$

and, after combining the first-order optimization conditions, obtain the following Euler equation:

$$c_j^i(t) = c_j^i(0)e^{(r_j(t)-\delta)t} \tag{.6}$$

After re-arranging the terms, consumption can be expressed as:

$$c_j^i(t) = \Big(\delta k_j^i(0) + w_j(0)l_j^i\Big)e^{(r_j(t)-\delta)t}.$$

Substituting back into the budget constraint we can show:

$$\dot{k}^i_j(t) = (r_j(t) - \delta)k^i_j(t)$$

given that $w_j(t) = w_j(0)e^{(r_j(t)-\delta)t}$.

We can finally write the following utility function, as function of parameters ϱ, κ^i and ω_j:

$$V(\varrho, \omega_j; \kappa^i) = \tfrac{\varrho}{\delta^2} + \tfrac{1}{\delta}\log\left(\delta\kappa^i + \omega_j\right) + \tfrac{1}{\delta}\log(k(0))$$

where $\varrho = r_j(t) - \delta$ is rate of growth of the economy, $\kappa^i = \frac{k^i_j(0)}{k_j(0)}$ is the relative capital intensity of agent i and $\omega_j = \frac{w_j(0)}{k_j(0)}$ is the wage-capital ratio in the economy. Thus, there is no role for policy in the standard RBC model.

RBC model with capital taxes and a *merit* good:

We can represent utility of the representative household and the production function of the economy as follows:

$$\int_0^\infty e^{-\delta t}\log\left[\eta_c^{\frac{1}{\sigma}} c^i_j(t)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}} h_j(t)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} dt \tag{.7}$$

Given that the production function and the competitive conditions of the economy are similar, profit-maximization will result in the same equilibrium wage rate $w_j(t)$ and rate of return on capital $r_j(t)$.

Agents face the following budget constraint:

$$\dot{k}^i_j(t) = (r_{d^i_j(t)}(t) - \theta_j)k^i_j(t) + w_j(t)l^i_j - c^i_j(t) \tag{.8}$$

Given that now, in order to fund the merit good, the government charges the tax rate θ_j on capital:

$$h_j(t) = \theta_j k_j(t). \tag{.9}$$

We can thus write the following Hamiltonian:

$$\hat{H}(c_j^i(t), k_j^i(t), \mu(t)) \equiv$$
$$e^{-\delta t}\Big\{ \log\Big(\Big[\eta_c^{\frac{1}{\sigma}} c_j^i(t)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}} h_j(t)^{\frac{\sigma-1}{\sigma}}\Big]^{\frac{\sigma}{\sigma-1}}\Big) + \mu(t)\Big[\Big(r_{d_j^i(t)}(t) - \theta_j\Big)k_j^i(t) + w_j(t)l_j^i - c_j^i(t)\Big]\Big\}$$

and obtain the following Euler equation:

$$c_j^i(t) = c_j^i(0)e^{(r_j(t)-\theta_j-\delta)t} \tag{.10}$$

Consumption can be expressed as:

$$c_j^i(t) = \Big(\delta k_j^i(0) + w_j(0)l_j^i\Big)e^{(r_j(t)-\theta_j-\delta)t}.$$

Finally, substituting back into the budget constraint, we show:

$$\dot{k}_j^i(t) = (r_j(t) - \theta_j - \delta)k_j^i(t)$$

given that $w_j(t) = w_j(0)e^{(r_j(t)-\theta_j-\delta)t}$.

In this model with capital taxes and a merit good, we have a role for government as provider of the public good. To fund this publicly delivered good, the government raises capital taxes. It is clear from the utility of the representative household that agents will prefer a non-negative amount of this good delivered in equilibrium. We can find this by writing the utility function as a function of parameters:

$$V(\Phi, \omega_j, \theta_j; \kappa^i) = \frac{\Phi(\theta_j)}{\delta^2} + \frac{1}{\delta}\frac{\sigma}{\sigma-1}\log\Big[\eta_c^{\frac{1}{\sigma}}(\delta\kappa^i + \omega_j)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}}\theta_j^{\frac{\sigma-1}{\sigma}}\Big] + \frac{1}{\delta}\log(k(0)) \tag{.11}$$

where $\Phi = r_j(t) - \theta_j - \delta$ is rate of growth of the economy, κ^i is the again relative capital intensity of agent i and $\omega_j = \frac{w_j(0)}{k_j(0)}$ is now the *after-tax* wage-capital ratio in the economy.

The policy most favoured by the median voter is the policy θ^{med} chosen in equilibrium by the benevolent central government. This policy can be defined by maximizing $V(\Phi, \omega, \theta_j; \kappa_i)$ with respect to the policy parameter θ_j:

$$\left(\frac{\eta_c}{\eta_h}\right)^{\frac{1}{\sigma}}[\delta\kappa^i + \omega_j]^{\frac{\sigma-1}{\sigma}}\theta^{\frac{1}{\sigma}} + \theta_j = \delta \tag{.12}$$

Thus, the optimal policy for the capital tax to fund the merit good is similar to the one presented in the more comprehensive model we present in our paper. We leave further interpretations to the section on optimal policy, but not without mentioning that the equilibrium under decentralization will entail a race to bottom in θ_j and the policy will diverge from the optimal policy.

RBC model with capital taxes and a *productive* public good:

We can represent utility of the representative household similarly to (.1) but the production function of the economy is now as follows:

$$y_j(t) = Ag_j(t)^{1-\alpha}k_j(t)^{\alpha}l_j(t)^{1-\alpha} \tag{.13}$$

Assuming a perfectly competitive environment in the economy, profit-maximization yields the following private rate of return on capital and wage rate:

$$r_j(t) \equiv \frac{\partial y_j(t)}{\partial k_j(t)} = A\alpha g_j(t)^{1-\alpha}k_j(t)^{\alpha-1}l_j(t)^{1-\alpha} \tag{.14}$$

$$w_j(t) \equiv \frac{\partial y_j(t)}{\partial l_j(t)} = A(1-\alpha)g_j(t)^{1-\alpha}k_j(t)^{\alpha}l_j(t)^{-\alpha} \tag{.15}$$

Agents face the following budget constraint:

$$\dot{k}_j^i(t) = (r_{d_j^i(t)}(t) - \tau_j)k_j^i(t) + w_j(t)l_j^i - c_j^i(t) \tag{.16}$$

Given that now, in order to fund the merit good, the government charges the tax rate τ_j on capital:

$$g_j(t) = \tau_j k_j(t). \tag{.17}$$

We can thus write the following Hamiltonian:

$$\hat{H}(c_j^i(t), k_j^i(t), \mu(t)) \equiv e^{-\delta t}\Big\{ \log\left[c_j^i(t)\right] + \mu(t)\Big[\big(r_{d_j^i(t)}(t) - \tau_j\big)k_j^i(t) + w_j(t)l_j^i - c_j^i(t)\Big]\Big\}$$

and obtain the following Euler equation:

$$c_j^i(t) = c_j^i(0)e^{(r_j(t)-\tau_j-\delta)t} \tag{.18}$$

We can again represent consumption and the equilibrium growth rate of capital in a similar fashion. In this model with capital taxes and a productive public good, we have a somehow different role for government, which now provides a good that is fundamental for the production of output. So it is clear that now there cannot be a 'full' race to bottom in the decentralized case. To fund this publicly delivered productive input, the government raises capital taxes. It is again clear that agents in this economy will prefer a non-negative amount of this good delivered in equilibrium, as it affects the first term of the utility function as a function of parameters:

$$V(\gamma, \omega_j, \theta_j; \kappa^i) = \frac{\gamma(\tau_j)}{\delta^2} + \frac{1}{\delta}\log\left[\delta\kappa^i + \omega_j(\tau_j)\right] + \frac{1}{\delta}\log(k(0)) \tag{.19}$$

where $\gamma = r_j(t) - \tau_j - \delta$ is rate of growth of the economy and κ^i and ω_j are again the relative capital intensity of agent i and the after-tax wage-capital ratio in the economy, respectively.

The policy most favoured by the median voter is the policy τ^{med} chosen in equilibrium by the benevolent central government. This policy can be defined by maximizing $V(\gamma, \omega, \theta_j; \kappa_i)$ with respect to the policy parameter τ_j. Now τ_j will only affect the first term of the utility function. Still, we can observe that it will have an optimal level. Furthermore, given that the chosen tax rate τ_j affects the return to productive factors, it also affects the equilibrium after-tax wage-capital ratio of the economy, ω_j.

Notice that a poorer agent will generally prefer a higher wage-capital ratio, given the growth rate. We can alternatively express this as follows:

$$\frac{\partial V(\gamma,\omega_j,\theta_j;\kappa^i)}{\partial\gamma} = \frac{1}{\delta^2}$$

$$\frac{\partial V(\gamma,\omega_j,\theta_j;\kappa^i)}{\partial \omega_j} = \frac{1}{\delta}\frac{1}{\delta\kappa^i+\omega_j}$$
$$\frac{\frac{\partial V(\gamma,\omega_j,\theta_j;\kappa^i)}{\partial \gamma}}{\frac{\partial V(\gamma,\omega_j,\theta_j;\kappa^i)}{\partial \omega_j}} = \frac{\delta\kappa^i+\omega_j}{\delta}$$

This result is similar to Hatfield (2015). It is thus clear that the rate at which an agent i is willing to substitute between the growth rate of the economy and the after-tax wage-capital ratio is increasing in its relative capital intensity, κ^i. Hence, a poorer median voter will tend to prefer a higher after-tax wage-capital ratio, even if this means a lower equilibrium growth rate.

Notice, on the other hand, that under decentralization the policy will again differ from the optimal, as governments of different jurisdictions will have a different objective function. Decentralized governments will choose in equilibrium to maximise the private rate of return on capital, $\rho = r_j(t) - \tau_j$. This model is the closest one to Alesina and Rodrik (1994), where it is discussed that, without tax competition and with only a capital tax as policy instrument, there will be a level of provision of the (productive) public good that is not growth-maximizing.

RBC model with capital taxes and both types of public good:

We can represent utility of the representative household similarly to (.7) and the production function of the economy is similar to (.13). Profit-maximization will thus result in the same rate of return on capital $r_j(t)$ and equilibrium wage rate $w_j(t)$, as expressed in (.14) and (.15), respectively.

Agents face the following budget constraint:

$$\dot{k}^i_j(t) = (r_{d^i_j(t)}(t) - \theta_j - \tau_j)k^i_j(t) + w_j(t)l^i_j - c^i_j(t) \tag{.20}$$

Given that now, in order to fund both the merit and the productive public good, the government charges two different tax rates on capital, (.9) and (.17).

We can write the current-value Hamiltonian:

$$\hat{H}(c_j^i(t), k_j^i(t), \mu(t)) \equiv$$
$$e^{-\delta t}\Big\{ \log\Big(\Big[\eta_c^{\frac{1}{\sigma}} c_j^i(t)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}} h_j(t)^{\frac{\sigma-1}{\sigma}}\Big]^{\frac{\sigma}{\sigma-1}}\Big) + \mu(t)\Big[\big(r_{d_j^i(t)}(t) - \theta_j - \tau_j\big)k_j^i(t) + w_j(t)l_j^i - c_j^i(t)\Big]\Big\}$$

and obtain the following Euler equation:

$$c_j^i(t) = c_j^i(0)e^{(r_j(t)-\theta_j-\tau_j-\delta)t} \tag{.21}$$

Consumption can be expressed as:

$$c_j^i(t) = \Big(\delta k_j^i(0) + w_j(0)l_j^i\Big)e^{(r_j(t)-\theta_j-\tau_j-\delta)t}.$$

Finally, substituting back into the budget constraint, we can show:

$$\dot{k}_j^i(t) = (r_j(t) - \theta_j - \tau_j - \delta)k_j^i(t)$$

given that $w_j(t) = w_j(0)e^{(r_j(t)-\theta_j-\tau_j-\delta)t}$.

Agents in the economy will prefer a non-negative amount of both publicly delivered goods, in equilibrium. We can write the utility function as a function of parameters:

$$V(\xi, \omega_j, \theta_j; \kappa^i) = \frac{\xi(\theta_j, \tau_j)}{\delta^2} + \frac{1}{\delta}\frac{\sigma}{\sigma-1}\log\Big[\eta_c^{\frac{1}{\sigma}}(\delta\kappa^i + \omega_j(\tau_j))^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}}\theta_j^{\frac{\sigma-1}{\sigma}}\Big] + \frac{1}{\delta}\log(k(0)) \tag{.22}$$

where $\xi = r_j(t) - \theta_j - \tau_j - \delta$ is rate of growth of the economy and κ^i and ω_j are, respectively, the relative capital intensity of agent i and the after-tax wage-capital ratio in the economy.

The same reasoning follows from the analysis above, as the optimal policies will be similar to the ones already discussed. Agents will prefer a non-negative value of the merit good in equilibrium, as this directly affects their current utility level (second term of the utility function). However, as this is funded through a capital tax, which effectively reduces the private rate of return on capital, this good will not be provided in decentralized equilibrium, due to tax competition among jurisdictions. This generates a deviation from optimal policy and welfare losses. Regarding the productive public good, poorer agents will again tend to prefer a higher after-tax wage-capital ratio, given the growth rate of the economy. Whereas the government will aim to maximise the utility of the median voter in a centralized setting, in the presence of tax competition the governments of different jurisdictions will have instead the objective of maximizing the private rate of return on capital. A more detailed discussion of the implications of this model are left to the main text.

Appendix C

Necessary conditions:

$$\cdot\, \hat{H}_c(c_j^i(t), k_j^i(t), \mu(t)) \equiv u'(c_j^i(t)) - \mu(t) = 0 \Rightarrow \left(\frac{\eta_c}{c_j^i(t)}\right)^{\frac{1}{\sigma}} \frac{1}{C_j^i(t)} - \mu(t) = 0$$

$$C_j^i(t) = \eta_c^{\frac{1}{\sigma}} c_j^i(t)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}} h_j(t)^{\frac{\sigma-1}{\sigma}}$$

$$\frac{\partial \log \left[\eta_c^{\frac{1}{\sigma}} c_j^i(t)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}} h_j(t)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}}{\partial c_j^i(t)} = \frac{\sigma}{\sigma-1}\left\{\frac{1}{\eta_c^{\frac{1}{\sigma}} c_j^i(t)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}} h_j(t)^{\frac{\sigma-1}{\sigma}}} \frac{\sigma-1}{\sigma} \eta_c^{\frac{1}{\sigma}} c_j^i(t)^{-\frac{1}{\sigma}}\right\}$$

$$= \left(\frac{\eta_c}{c_j^i(t)}\right)^{\frac{1}{\sigma}} \frac{1}{\eta_c^{\frac{1}{\sigma}} c_j^i(t)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}} h_j(t)^{\frac{\sigma-1}{\sigma}}}$$

or...

$$\cdot\, \hat{H}_c(c_j^i(t), k_j^i(t), \mu(t)) \equiv u'(c_j^i(t)) - \mu(t) = 0 \Rightarrow \frac{1}{[C_j^i(t)]^{\frac{\sigma}{\sigma-1}}} \left(\frac{\eta_c C_j^i(t)^{\frac{\sigma}{\sigma-1}}}{c_j^i(t)}\right)^{\frac{1}{\sigma}} - \mu(t) = 0$$

$$\frac{\partial \log \left[C_j^i(t)\right]^{\frac{\sigma}{\sigma-1}}}{\partial c_j^i(t)} = \frac{1}{[C_j^i(t)]^{\frac{\sigma}{\sigma-1}}} \frac{\sigma}{\sigma-1} \left[C_j^i(t)\right]^{\frac{\sigma}{\sigma-1}-1(=\frac{1}{\sigma-1})} \frac{\sigma-1}{\sigma} \eta^{\frac{1}{\sigma}} c_j^i(t)^{-\frac{1}{\sigma}} \ ,\ C_j^i(t)^{\frac{1}{\sigma-1}} = [C_j^i(t)^{\frac{\sigma}{\sigma-1}}]^{\frac{1}{\sigma}}\ ,$$

$$\frac{C_j^i(t)^{\frac{1}{\sigma-1}}}{C_j^i(t)^{\frac{\sigma}{\sigma-1}}} = \frac{1}{C_j^i(t)}$$

$$\cdot\, \hat{H}_k(c_j^i(t), k_j^i(t), \mu(t)) \equiv \mu(t)(r_{d_j^i(t)}(t) - \tau_{d_j^i(t)} - \theta_{d_j^i(t)}) = \delta\mu(t) - \dot{\mu}(t)$$

$$\Rightarrow -\dot{\left[\left(\frac{\eta_c}{c_j^i(t)}\right)^{\frac{1}{\sigma}} \frac{1}{C_j^i(t)}\right]} = \left(\frac{\eta_c}{c_j^i(t)}\right)^{\frac{1}{\sigma}} \frac{1}{C_j^i(t)} (r_{d_j^i(t)}(t) - \tau_{d_j^i(t)} - \theta_{d_j^i(t)} - \delta)$$

$$\left[\left(\frac{\eta_c}{c_j^i(t)}\right)^{\frac{1}{\sigma}} \frac{1}{C_j^i(t)}\right] dt :$$

Let us consider:

$$\dot{\mu}(t) = \frac{d}{dt}\left[\left(\frac{\eta_c}{c_j^i(t)}\right)^{\frac{1}{\sigma}}\right] \frac{1}{C_j^i(t)} + \frac{d}{dt}\left[\frac{1}{C_j^i(t)}\right] \left(\frac{\eta_c}{c_j^i(t)}\right)^{\frac{1}{\sigma}}$$

$$\frac{d}{dt}\left[\frac{1}{C_j^i(t)}\right] = \frac{d\left[C_j^i(t)^{-1}\right]}{dC_j^i(t)} \frac{dC_j^i(t)}{dt}$$

$$\frac{dC_j^i(t)}{dt} = \frac{dC_j^i(t)}{dc_j^i(t)} \dot{c}_j^i(t) + \frac{dC_j^i(t)}{dh_j(t)} \dot{h}_j(t)$$

$$\Rightarrow -\dot{\mu}(t) = \frac{1}{\sigma}\left(\frac{\eta_c}{c_j^i(t)}\right)^{\frac{1}{\sigma}} \frac{\dot{c}_j^i(t)}{c_j^i(t)} . \frac{1}{C_j^i(t)} + \left[\frac{1}{C_j^i(t)}\right]^2 \left(\eta_c^{\frac{1}{\sigma}} . \frac{\sigma-1}{\sigma} c_j^i(t)^{\frac{\sigma-1}{\sigma}} \frac{\dot{c}_j^i(t)}{c_j^i(t)} + \eta_h^{\frac{1}{\sigma}} . \frac{\sigma-1}{\sigma} h_j(t)^{\frac{\sigma-1}{\sigma}} \frac{\dot{h}_j(t)}{h_j(t)}\right) . \left(\frac{\eta_c}{c_j^i(t)}\right)^{\frac{1}{\sigma}}$$

$$\Rightarrow -\dot{\mu}(t) = \frac{1}{\sigma} \mu(t) \frac{\dot{c}_j^i(t)}{c_j^i(t)} + \frac{\sigma-1}{\sigma} \mu(t) \frac{1}{C_j^i(t)} \left(\eta_c^{\frac{1}{\sigma}} . c_j^i(t)^{\frac{\sigma-1}{\sigma}} \frac{\dot{c}_j^i(t)}{c_j^i(t)} + \eta_h^{\frac{1}{\sigma}} . h_j(t)^{\frac{\sigma-1}{\sigma}} \frac{\dot{h}_j(t)}{h_j(t)}\right)$$

$$\Rightarrow -\dot{\mu}(t) = \frac{1}{\sigma}\mu(t)\frac{\dot{c}_j^i(t)}{c_j^i(t)} + \frac{\sigma-1}{\sigma}\mu(t)\frac{1}{C_j^i(t)}\left(\eta_c^{\frac{1}{\sigma}}.c_j^i(t)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}}.h_j(t)^{\frac{\sigma-1}{\sigma}}\right)\frac{\dot{c}_j^i(t)}{c_j^i(t)}\ ,\ \text{if}\ \frac{\dot{c}_j^i(t)}{c_j^i(t)} = \frac{\dot{h}_j(t)}{h_j(t)}$$

$$\Rightarrow -\dot{\mu}(t) = \left(\frac{1}{\sigma} + \frac{\sigma-1}{\sigma}\right)\mu(t)\frac{\dot{c}_j^i(t)}{c_j^i(t)} = \mu(t)\frac{\dot{c}_j^i(t)}{c_j^i(t)}$$

$$\Rightarrow -\frac{\dot{\mu}(t)}{\mu(t)} = (r_{d_j^i(t)}(t) - \tau_{d_j^i(t)} - \theta_{d_j^i(t)} - \delta)$$

$$\Rightarrow \frac{\dot{c}_j^i(t)}{c_j^i(t)} = (\psi - \delta)\ ,\ \psi = r_{d_j^i(t)}(t) - \tau_{d_j^i(t)} - \theta_{d_j^i(t)}$$

$$\Rightarrow c_j^i(t) = c_j^i(0)e^{(\psi-\delta)t}$$

or...

$$\cdot\ \hat{H}_k(c_j^i(t), k_j^i(t), \mu(t)) \equiv \mu(t)(r_{d_j^i(t)}(t) - \tau_{d_j^i(t)} - \theta_{d_j^i(t)}) = \delta\mu(t) - \dot{\mu}(t)$$

$$\Rightarrow -\dot{\left[\frac{1}{[C_j^i(t)]^{\frac{\sigma}{\sigma-1}}}\left(\frac{\eta_c C_j^i(t)^{\frac{\sigma}{\sigma-1}}}{c_j^i(t)}\right)^{\frac{1}{\sigma}}\right]} = \frac{1}{[C_j^i(t)]^{\frac{\sigma}{\sigma-1}}}\left(\frac{\eta_c C_j^i(t)^{\frac{\sigma}{\sigma-1}}}{c_j^i(t)}\right)^{\frac{1}{\sigma}}(r_{d_j^i(t)}(t) - \tau_{d_j^i(t)} - \theta_{d_j^i(t)} - \delta)$$

$$\left[\frac{1}{[C_j^i(t)]^{\frac{\sigma}{\sigma-1}}}\left(\frac{\eta_c C_j^i(t)^{\frac{\sigma}{\sigma-1}}}{c_j^i(t)}\right)^{\frac{1}{\sigma}}\right]dt :$$

Let us consider:

$$\dot{\mu}(t) = \frac{d}{dt}\left[\frac{1}{[C_j^i(t)]^{\frac{\sigma}{\sigma-1}}}\right]\left(\frac{\eta_c C_j^i(t)^{\frac{\sigma}{\sigma-1}}}{c_j^i(t)}\right)^{\frac{1}{\sigma}}\ \text{if}\ \frac{c_j^i(t)}{C_j^i(t)^{\frac{\sigma}{\sigma-1}}}\ \text{constant over the BGP}$$

$$\frac{d}{dt}\left[\frac{1}{C_j^i(t)^{\frac{\sigma}{\sigma-1}}}\right] = \frac{d\left[C_j^i(t)^{-\frac{\sigma}{\sigma-1}}\right]}{dC_j^i(t)}\frac{dC_j^i(t)}{dt}$$

$$\frac{dC_j^i(t)}{dt} = \frac{dC_j^i(t)}{dc_j^i(t)}\dot{c}_j^i(t) + \frac{dC_j^i(t)}{dh_j(t)}\dot{h}_j(t)$$

$$\Rightarrow -\dot{\mu}(t) = \left\{\frac{\sigma}{\sigma-1}\frac{1}{[C_j^i(t)]^{\frac{\sigma}{\sigma-1}}}\frac{1}{C_j^i(t)}\left(\eta_c^{\frac{1}{\sigma}}.\frac{\sigma-1}{\sigma}c_j^i(t)^{\frac{\sigma-1}{\sigma}}\frac{\dot{c}_j^i(t)}{c_j^i(t)} + \eta_h^{\frac{1}{\sigma}}.\frac{\sigma-1}{\sigma}h_j(t)^{\frac{\sigma-1}{\sigma}}\frac{\dot{h}_j(t)}{h_j(t)}\right)\right\}.\left(\frac{\eta_c C_j^i(t)^{\frac{\sigma}{\sigma-1}}}{c_j^i(t)}\right)^{\frac{1}{\sigma}}$$

$$\Rightarrow -\dot{\mu}(t) = \frac{1}{[C_j^i(t)]^{\frac{\sigma}{\sigma-1}}}\frac{1}{C_j^i(t)}\left(\eta_c^{\frac{1}{\sigma}}c_j^i(t)^{\frac{\sigma-1}{\sigma}}\frac{\dot{c}_j^i(t)}{c_j^i(t)} + \eta_h^{\frac{1}{\sigma}}h_j(t)^{\frac{\sigma-1}{\sigma}}\frac{\dot{h}_j(t)}{h_j(t)}\right).\left(\frac{\eta_c C_j^i(t)^{\frac{\sigma}{\sigma-1}}}{c_j^i(t)}\right)^{\frac{1}{\sigma}}$$

$$\Rightarrow -\dot{\mu}(t) = \mu(t)\frac{1}{C_j^i(t)}\left(\eta_c^{\frac{1}{\sigma}}c_j^i(t)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}}h_j(t)^{\frac{\sigma-1}{\sigma}}\right)\frac{\dot{c}_j^i(t)}{c_j^i(t)}\ ,\ \text{if}\ \frac{\dot{c}_j^i(t)}{c_j^i(t)} = \frac{\dot{h}_j(t)}{h_j(t)}$$

$$\Rightarrow -\dot{\mu}(t) = \mu(t)\frac{\dot{c}_j^i(t)}{c_j^i(t)}$$

$$\Rightarrow \frac{\dot{c}_j^i(t)}{c_j^i(t)} = (\psi - \delta)$$

$$\Rightarrow c_j^i(t) = c_j^i(0)e^{(\psi-\delta)t}$$

In order to obtain the utility as a function of parameters, we plug-in our optimality conditions into the original form of the utility function:

$$\int_0^\infty e^{-\delta t} \log\left(e^{\xi t}\left[\eta_c^{\frac{1}{\sigma}}(\delta k_j^i(0) + (1-\phi_j)w_j(0)l_j^i)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}} h_j(0)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}\right)dt$$

where $\xi = \psi - \delta$ and assuming that, along the balanced growth path, we must have $\frac{\dot{c}_j^i(t)}{c_j^i(t)} = \frac{\dot{h}_j(t)}{h_j(t)}$. Since labour supply $l_j^i(t)$ is constant, we can simplify this expression to:

$$\begin{aligned}\int_0^\infty \xi t e^{-\delta t} dt + \int_0^\infty \log\left(\left[\eta_c^{\frac{1}{\sigma}}(\delta k_j^i(0) + (1-\phi_j)w_j(0)l_j^i)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}} h_j(0)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}\right)e^{-\delta t}dt \\ = \frac{\xi}{\delta^2} + \frac{1}{\delta}\frac{\sigma}{\sigma-1}\left(\log\left[\eta_c^{\frac{1}{\sigma}}(\delta k_j^i(0) + (1-\phi_j)w_j(0)l_j^i)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}} h_j(0)^{\frac{\sigma-1}{\sigma}}\right]\right).\end{aligned}$$

Dividing and multiplying the second term by $[\log k_j(0)]^{\frac{\sigma-1}{\sigma}}$:

$$= \frac{\xi}{\delta^2} + \frac{1}{\delta}\frac{\sigma}{\sigma-1}\left\{\log\left[\eta_c^{\frac{1}{\sigma}}(\delta\kappa^i + \omega_j)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}}\left(\frac{h_j(0)}{k_j(0)}\right)^{\frac{\sigma-1}{\sigma}}\right] + \frac{\sigma-1}{\sigma}\log(k_j(0))\right\}$$

We thus reach our final form:

$$V(\xi,\omega;\kappa_i) = \frac{\xi(\phi_j,\tau_j,\theta_j)}{\delta^2} + \frac{1}{\delta}\frac{\sigma}{\sigma-1}\log\left[\eta_c^{\frac{1}{\sigma}}(\delta\kappa^i + \omega_j(\phi_j,\tau_j))^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}}\theta_j^{\frac{\sigma-1}{\sigma}}\right] + \frac{1}{\delta}\log(k(0))$$

Appendix D

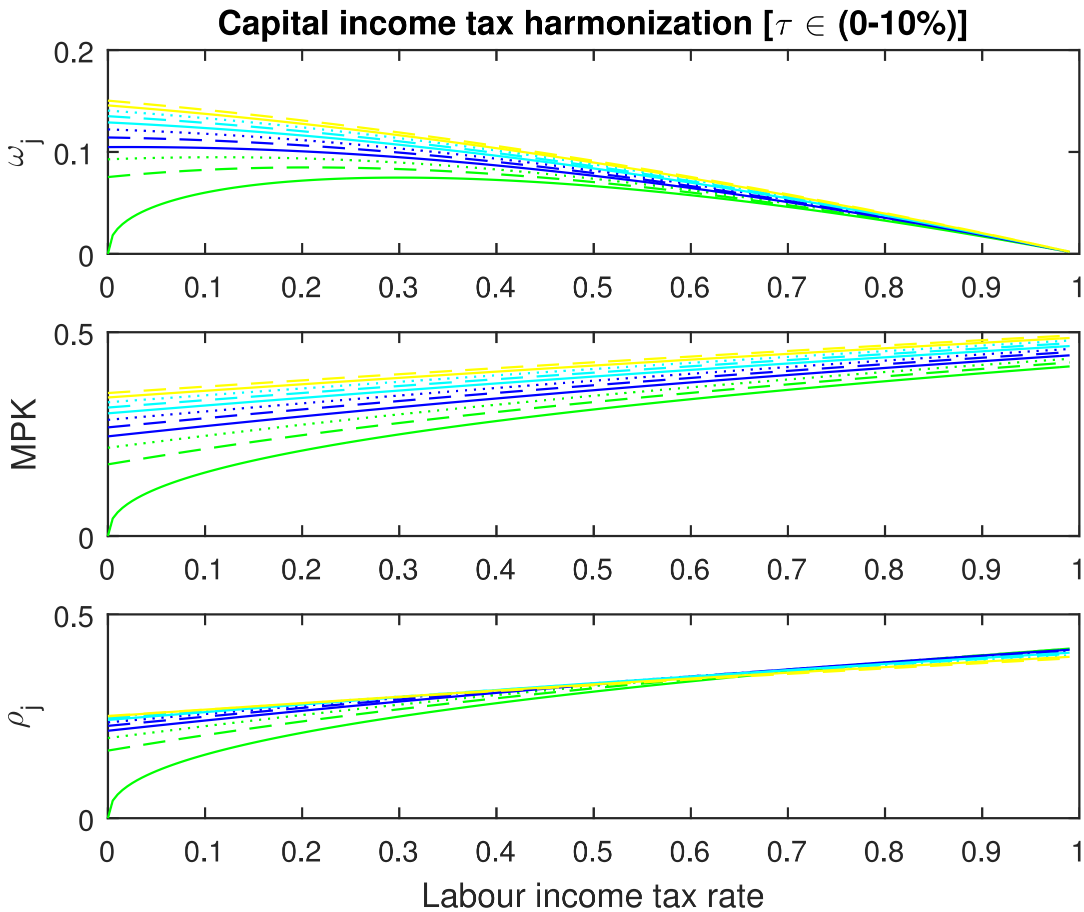

Figure .9: Capital tax harmonization (τ_j - capital tax, ϕ_j - labour income tax)

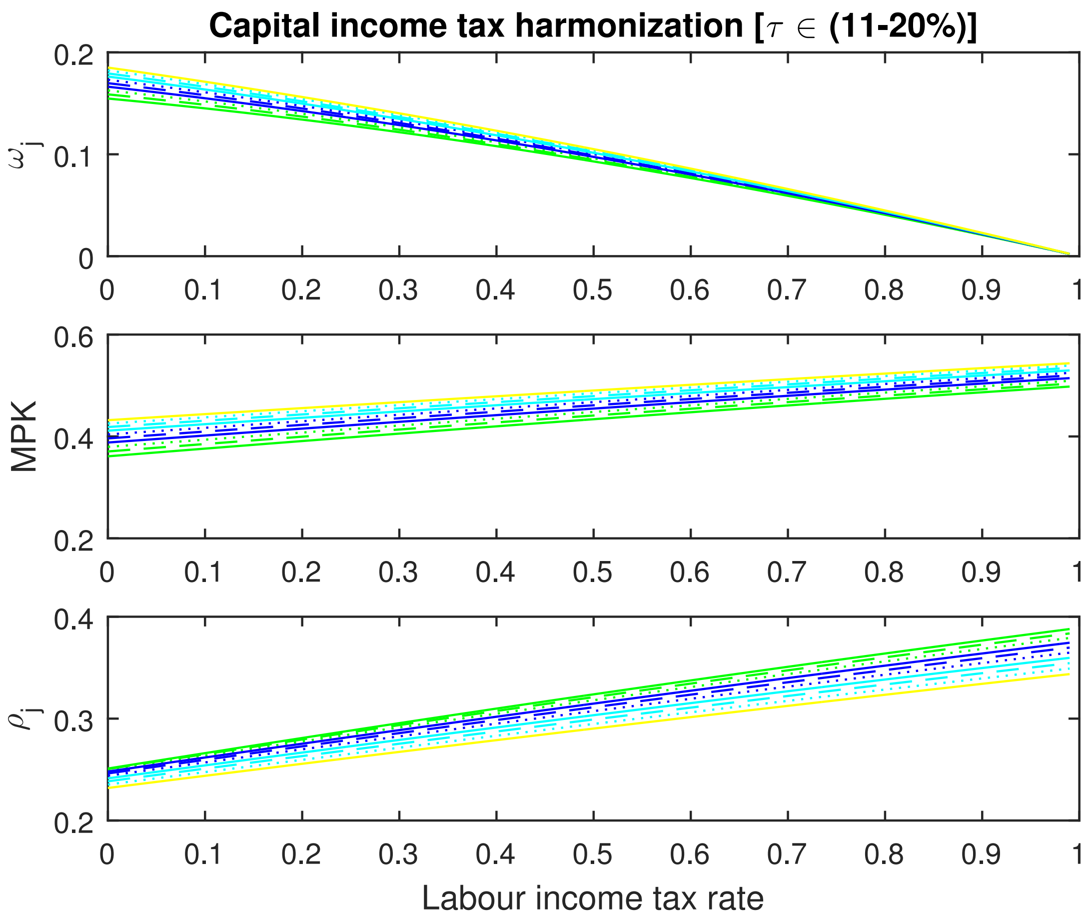

Figure .10: Capital tax harmonization (τ_j - capital tax, ϕ_j - labour income tax)

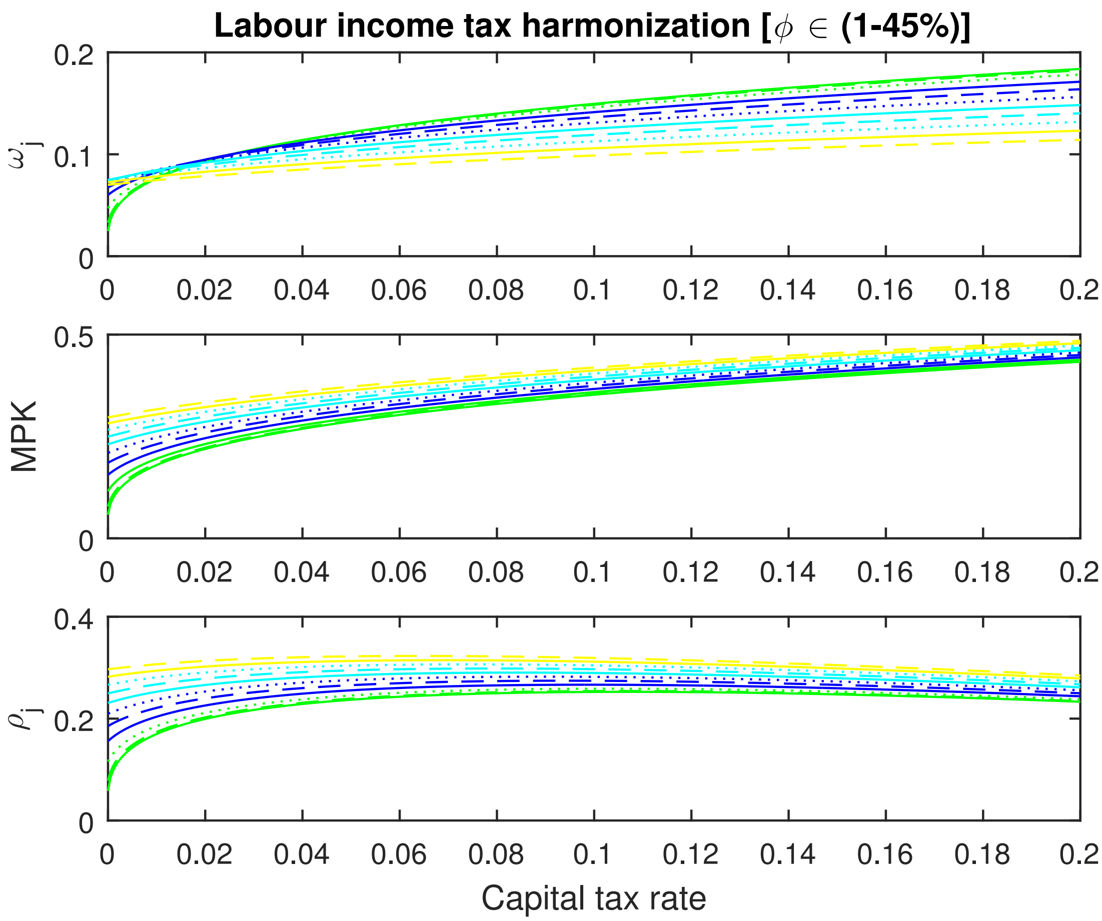

Figure .11: Labour income tax harmonization (τ_j - capital tax, ϕ_j - labour income tax)

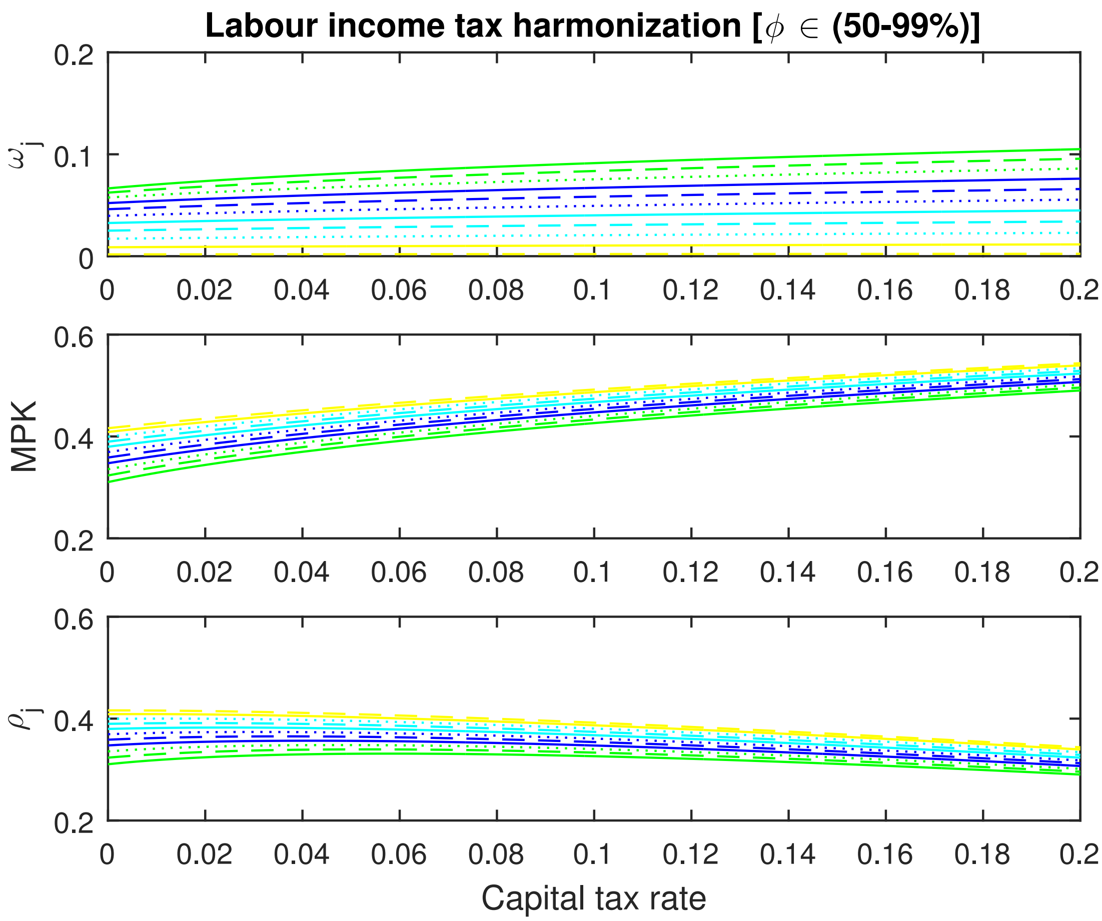

Figure .12: Labour income tax harmonization (τ_j - capital tax, ϕ_j - labour income tax)