Essays on Fiscal Federalism

by

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"If we want true international economic integration, we have to go either with the nation-state, in which case the domain of national politics will have to be significantly restricted, or else with mass politics, in which case we will have to give up the nation-state in favor of global federalism."

Dani Rodrik (2000)

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Abstract

This thesis investigates the effects of pressures brought by increasing capital mobility and interjurisdictional fiscal competition to fiscal policy, focusing particularly on the European Union and the analysis of policy reforms that can be adopted in such contexts. Firstly, the relationship between tax competition and economic growth is re-assessed. In a race to attract mobile capital, jurisdictions compete to offer the highest after-tax rates of return. Governments are driven into the provision of higher levels of productive public goods, and shift their tax structures, towards the taxation of the least mobile factors or least distortive tax bases. In an environment of fixed labour supply, this implies a race to the bottom in capital taxes and a race to the top in the taxes falling on labour. Taking into account the potential effects of fiscal competition on fiscal policy, the consequences of different tax harmonization scenarios are also analyzed. The harmonization of capital taxes leads to a race to the top in taxes on immobile factors. Once tax rates on mobile factors are fixed, tax competition shifts towards immobile factors. This implies that the tax burden falls again disproportionately on labour. Only the harmonization of labour income taxes can avoid this outcome, while leaving room for positive capital income taxes.

Secondly, extending this argument within a more detailed model of labour supply calibrated to the EU economy, more detailed policy proposals for a European-wide fiscal harmonization agreement are studied. Labour income and consumption tax harmonization yield potentially better results than capital tax harmonization, as the main fiscal competition-driven government investment distortion, resulting in the over-investment on productive public goods at the expense of merit goods, is minimized. In particular, policy simulation results suggest that indirect taxes, such as value-added taxes, should become a priority instrument for European-wide fiscal reforms. Expenditure side reforms are also necessary, in order to address the race to bottom in the provision of merit goods. Even limited reforms that do not require large increases in the EU budget, such as the introduction of a common European unemployment insurance system, can yield interesting results in a context of interjurisdictional fiscal competition.

Thirdly, the cyclical behaviour of fiscal policies across OECD countries is investigated. In

so doing, a more complete picture of fiscal policy can be obtained, by identifying both the short term behaviour of discretionary fiscal policies and long term structural fiscal policy trends. Fiscal policy has become pro-cyclical over recent decades, particularly within the European Monetary Union. The average level of structural fiscal balances and the responsiveness of fiscal policy to the level of debt are found persistently weaker beyond the 70 percent debt-to-GDP threshold, pointing to the relevance of fiscal fatigue episodes. Average fiscal balances and a stronger responsiveness to debt conditions are also found higher at higher levels of the potential level of debt service. This is accompanied by a more pro-cyclical response of the fiscal stance. Finally, the role of fiscal decentralization is also assessed. Two issues remain clear. On the one hand, fiscal decentralization does not appear to directly affect fiscal performance. On the other hand, large intergovernmental transfer systems show a persistent negative relationship with the fiscal stance. Considering the level of sub-national fiscal autonomy also uncovers that this negative effect becomes stronger when sub-national governments have a wide policy scope. These results are found particularly worrying as many OECD countries maintain highly decentralized systems of government, under which large intergovernmental grant systems are kept in parallel with a significant policy scope at the regional and local level.

The lessons from this thesis have wide implications for the current discussion on the fiscal architecture of the European Union and for the future design of fiscal reforms. Any future fiscal reforms that involve only a partial harmonization of corporate taxes, or the mere consolidation of tax bases such as in current proposals, are unlikely to produce significant results in terms of limiting the potentially damaging effects of fiscal competition. Instead, these are likely to generate more regressive income tax structures and produce a heavier reliance on indirect forms of taxation. Value-added taxes appear as a leading candidate for future European-wide tax harmonization reforms, given the relative importance in terms of government revenue and their effectiveness in restraining fiscal competition incentives. Such an instrument can not only equip member countries with a tax system that is able to limit fiscal competition pressures, but also provides a fiscal capacity able to finance a larger EU budget. Any fiscal reforms must also learn from the past. Besides the desirability of ruling out permanent transfers between member countries, these also need to be able to overcome other potential issues. Namely, European-wide fiscal reforms ought to ensure that the quality of fiscal policies over the business cycle

is improved, particularly in countries with larger debt burdens. The fiscal architecture of the European Union, can also learn from individual country fiscal decentralization experiences. As both revenue and expenditure side reforms can lead to extensive fiscal transfer systems, both of cyclical and permanent nature, these ought to be carefully designed so as to ensure fiscal discretion at the national level is preserved and an alignment of fiscal incentives of different member countries across the European Union.

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Table of Contents

I Introduction **2**

1.1 Main findings . . . 3

1.2 Thesis contribution within the wider literature . . . 5

1.3 Motivation behind *Essays of Fiscal Federalism* . . . 7

1.4 A brief revision of endogenous growth . . . 10

II Fiscal Federalism and Tax Competition: a Double-Edged Sword? **18**

2.1 Introduction . . . 18

2.2 Trends in corporate taxation in the EU . . . 23

2.3 Model . . . 29

2.3.1 Firm, government and household problems . . . 30

2.3.2 The role of CES preferences . . . 32

2.3.3 Equilibrium . . . 35

2.4 Optimal policy . . . 37

2.4.1 Centralization . . . 39

2.4.2 Decentralization . . . 41

2.5 Tax harmonization . . . 44

2.5.1 Full tax harmonization . . . 45

2.5.2 Capital tax harmonization . . . 47

2.5.3 Labour income tax harmonization . . . 49

2.5.4 Simulation of tax harmonization policies . . . 51

2.6 Conclusions . . . 54

III On the Design of a European Fiscal Harmonization Agreement **59**

3.1 Introduction . . . 59
3.2 Data and motivation . . . 64
3.3 Model . . . 73
3.3.1 Environment . . . 74
3.3.2 Equilibrium . . . 77
3.3.3 Qualitative effects of fiscal shocks . . . 81
3.4 Optimal policy . . . 90
3.4.1 Optimal fiscal policy . . . 91
3.4.2 Calibration and model simulations . . . 94
3.4.3 Tax competition . . . 102
3.5 Fiscal harmonization . . . 105
3.5.1 Capital income tax harmonization . . . 106
3.5.2 Labour income tax harmonization . . . 107
3.5.3 Consumption tax harmonization . . . 110
3.5.4 Tax harmonization: a summary . . . 113
3.5.5 Federal budget: towards a new EU Cohesion Policy? . . . 117
3.6 Concluding remarks . . . 122

IV Fiscal Decentralization and Debt Limits in OECD Countries 127

4.1 Introduction . . . 127
4.2 Literature review and motivation . . . 133
4.2.1 Fiscal reaction functions: theoretical frameowork . . . 133
4.2.2 Fiscal reaction functions: empirical specification . . . 136
4.2.3 Fiscal reaction functions: main results . . . 139
4.2.4 Fiscal federalism . . . 144
4.2.5 Motivation . . . 146
4.3 Data and methodology . . . 148
4.3.1 Data . . . 148

4.3.2 Methodology . . . 155
4.4 Results . . . 164
4.4.1 Dynamic panel regression estimates: baseline results . . . 166
4.4.2 Robustness checks . . . 185
4.5 Concluding remarks . . . 196

V Conclusion 202

5.1 Lessons from *Essays on Fiscal Federalism* . . . 203
5.2 Policy proposals and future work . . . 207
5.3 Closing remark . . . 210

VI Bibliography and Data Sources 214

VII Appendices 231

A Figures (Chapter II) 231

B Mathematical Appendix (Chapter II) 234

C Figures and Mathematical Appendix (Chapter III) 244

D Tables (Chapter III) 260

E Figures (Chapter IV) 262

F Tables (Chapter IV) 265

List of Figures

1 Top statutory corporate income tax rates in 4 large EU economies (1982-2017) . 25

2 Top statutory corporate income tax rates in 8 small EU economies (1982-2017) . 26

3 EU-28 average top statutory tax rates (1995-2017) 27

4 EU-28 average present discounted value of depreciation allowances (1982-2005) . 28

5 Capital tax harmonization 52

6 Labour income tax harmonization 53

7 Average and standard deviation of top statutory corporate income tax (CIT) rates in EU countries (1982-2017) 66

8 Top statutory corporate income tax (CIT) rates in the EU-28 (1995-2017) 67

9 Average and standard deviation of top statutory personal income tax (PIT) rates in EU-28 countries (1995-2017) 69

10 Top statutory personal income tax (PIT) rates in the EU-28 (1995-2017) 70

11 Average and standard deviation of top value added tax (VAT) rates in EU-28 countries (2000-2017) 71

12 Top value added tax (VAT) rates in the EU-28 (2000-2017) 72

13 Fiscal shocks: changes in tax rates 83

14 Fiscal shocks: changes in government expenditure shares 85

15 Composite fiscal shocks: compensated changes in government expenditure shares 88

16 Composite fiscal shocks: compensated changes in government expenditure shares and tax rates 89

17 Cyclically-adjusted primary balances (CAPB) and underlying primary balances (UPB) of 25 OECD countries (1995-2016). Fiscal balances can be separated into a cyclical and a non-cyclical component. Cyclical influences are associated with variations of the actual output around its potential level (the output gap). Non-cyclical changes can be seen as a "cause", rather than an effect, of output fluctuations and may be interpreted as indicative of *discretionary* policy adjustments. The CAPB refers to general government cyclically-adjusted balances and exclude net interest payments. UPB eliminate the impact of so called one-off transactions from the CAPB. One-offs transactions include deviations from trend in net capital transfers and special one-offs not related to capital transfers. 149
18 Debt-to-GDP ratios and (potential) debt service of 25 OECD countries (1995-2016) 151
19 Underlying primary balances (UPB) and output gap of 25 OECD countries (1995-2016) 153
20 Share of sub-national expenditures and own revenues, as percentage of total general government expenditure and revenue of 25 OECD countries (1995-2016) . . 154
21 Fiscal policy sustainability across OECD countries (1995-2016) 166
22 Fiscal policy cyclicality across OECD countries (1995-2016) 167
A.1 Average effective tax rates of 4 large EU countries (1982-2005). 231
A.2 Average effective tax rates of 8 small EU countries (1982-2005). 231
A.3 Capital tax harmonization 232
A.4 Capital tax harmonization 232
A.5 Labour income tax harmonization 233
A.6 Labour income tax harmonization 233
C.1 Top statutory corporate income tax (CIT) rates in the EU-28 (1982-2017) 1 . . . 244
C.2 Top statutory corporate income tax (CIT) rates in the EU-28 (1982-2017) 2 . . . 245
C.3 Top statutory corporate income tax (CIT) rates in the EU-28 (1982-2017) 3 . . . 246
C.4 Top statutory corporate income tax (CIT) rates in the EU-28 (1995-2017) 1 . . . 247
C.5 Top statutory corporate income tax (CIT) rates in the EU-28 (1995-2017) 2 . . . 247
C.6 Top statutory corporate income tax (CIT) rates in the EU-28 (1995-2017) 3 . . . 248
C.7 Top statutory corporate income tax (CIT) rates in the EU-28 (1995-2017) 4 . . . 248
C.8 Top statutory corporate income tax (CIT) rates in the EU-28 (1995-2017) 5 . . . 249

C.9 Top statutory corporate income tax (CIT) rates in the EU-28 (1995-2017) 6 . . . 249
C.10 Top statutory personal income tax (PIT) rates in the EU-28 (1995-2017) 1 . . . 250
C.11 Top statutory personal income tax (PIT) rates in the EU-28 (1995-2017) 2 . . . 250
C.12 Top statutory personal income tax (PIT) rates in the EU-28 (1995-2017) 3 . . . 251
C.13 Top statutory personal income tax (PIT) rates in the EU-28 (1995-2017) 4 . . . 251
C.14 Top statutory personal income tax (PIT) rates in the EU-28 (1995-2017) 5 . . . 252
C.15 Top statutory personal income tax (PIT) rates in the EU-28 (1995-2017) 6 . . . 252
C.16 Value-added tax (VAT) rates in the EU-28 (2000-2017) 1 253
C.17 Value-added tax (VAT) rates in the EU-28 (2000-2017) 2 253
C.18 Value-added tax (VAT) rates in the EU-28 (2000-2017) 3 254
C.19 Value-added tax (VAT) rates in the EU-28 (2000-2017) 4 254
C.20 Value-added tax (VAT) rates in the EU-28 (2000-2017) 5 255
C.21 Value-added tax (VAT) rates in the EU-28 (2000-2017) 6 255
E.1 Value-added tax (VAT) and top statutory personal income tax (PIT) rates in 21 OECD countries (1995-2016) 262
E.2 Top statutory corporate income tax (CIT) rates in 21 OECD countries (1995-2016) 263
E.3 Local autonomy index (1995-2016) 264

List of Tables

1 Average EU-28 tax rates (1982-2017) . . . 73
2 Benchmark model calibration . . . 95
3 Optimal policy . . . 100
4 Tax competition . . . 104
5 Capital income tax harmonization . . . 108
6 Labour income tax harmonization . . . 109
7 Consumption tax harmonization . . . 111
8 Tax harmonization: summary . . . 114
9 Joint tax harmonization: summary . . . 117
10 EU budget . . . 121
11 Limited EU budget . . . 122
12 Fiscal reaction functions of 25 OECD countries (1995-2016): baseline results . . . 172
13 Fiscal reaction functions of 25 OECD countries (1995-2016): debt thresholds . . . 175
14 Fiscal reaction functions of 25 OECD countries (1995-2016): fiscal rules . . . 178
15 Fiscal reaction functions of 21 OECD countries (1995-2016): tax rates . . . 183
16 Fiscal reaction functions of 21 OECD countries (1995-2016): tax rates 2 . . . 184
17 Fiscal reaction functions of 25 OECD countries (1995-2016): alternative debt thresholds . . . 188
18 Fiscal reaction functions of 25 OECD countries (1995-2016): US output gap . . . 190
19 Fiscal reaction functions of 13 EMU countries (1995-2016): baseline results . . . 194
20 Fiscal reaction functions of 13 EMU countries (1995-2016): debt thresholds . . . 195
D.1 Federal spending . . . 260
D.2 Federal spending . . . 260
D.3 Limited EU budget with common consumption vs. capital income taxes . . . 261
F.1 Fiscal reaction functions of 25 OECD countries (1995-2016): baseline results . . . 265
F.2 Fiscal reaction functions of 25 OECD countries (1995-2016): potential debt service thresholds . . . 266
F.3 Fiscal reaction functions of 24 OECD countries (1995-2016): baseline results . . . 267

F.4 Fiscal reaction functions of 24 OECD countries (1995-2016): debt thresholds . . 268
F.5 Fiscal reaction functions of 25 OECD countries (1995-2016): sub-national autonomy 269

I

Introduction

I Introduction

This thesis investigates the effects of pressures brought by increasing capital mobility and interjurisdictional fiscal competition to fiscal policy, focusing particularly on countries in the European Union. The term *interjurisdictional fiscal competition* refers to the behaviour of different countries, regions or municipalities in a context of economic integration. On the one hand, governments ought to respond to their electorate. On the other hand, the pressure brought by the increasing mobility of productive factors brings important constraints to the classical trade-off between efficiency and equity. This thesis studies how these processes affect fiscal policies at the national level, in particular across the European Union, and focuses on the analysis of policy proposals that can be adopted in such contexts.

The thesis is divided into five chapters. The current chapter provides an introduction and aims to provide a short overview to unify the work presented in the following chapters. It also aims to briefly outline the motivation behind the thesis and highlight the role of different historical and institutional paths in shaping the concept of fiscal federalism. Chapter Two develops a simple political economy model that explains the main intuition behind some of the key results in this thesis. Chapter Three extends this argument and develops a more detailed model, with endogenous labour supply, calibrated to the EU economy. It also develops more detailed policy proposals that can form the basis of European-wide fiscal harmonization agreement. Chapter Four assesses empirically the evolution of fiscal policy across OECD countries over the last decades, aiming to build further evidence and draw lessons from recent experience. Chapter Five analyzes the main findings of this thesis, focusing particularly on their policy implications, and proposes future extensions and developments to the current work.

1.1 Main findings

Building on the classical literature on fiscal federalism, Chapter Two re-assesses the relationship between tax competition and economic growth. In a race to attract mobile factors of production, such as capital, jurisdictions attempt to offer the highest after-tax rate of return. Governments are driven into the provision of progressively higher levels of productive public goods, and this leads to large shifts in tax revenues, from the taxation of mobile factors towards the taxation of the least mobile and distortive tax bases. In an environment of fixed labour supply, this implies a race to the bottom in capital taxes and a race to the top in labour income taxes. This is a fully efficient phenomenon that yields the highest growth rate of the economy, which occurs irrespective of the initial distribution of capital in the economy. Hence, the classical link in the political economy literature between inequality and economic growth is broken. Acknowledging the constraints brought by tax competition to fiscal policy, Chapter Two also provides a first analysis of the consequences of potential tax harmonization scenarios. One result that clearly emerges from this theoretical exercise is that the harmonization of capital taxes may in fact lead to a race to the top in taxes on immobile factors. Once tax rates on mobile factors are fixed, tax competition shifts towards immobile factors, with the aim to achieve the highest rate of return on capital. This implies that the tax burden once again falls disproportionately on labour. Only the harmonization of taxes on the immobile factor, labour, can avoid this outcome, while leaving room for positive capital income taxes.

Building on this intuition, Chapter Three develops an endogenous growth model with flexible labour supply, calibrated to the EU economy. The main results of the policy simulations performed in this context yield the three key

results. Capital income tax harmonization results in a race to the top in consumption taxes, as the least distortive tax base. Labour income and consumption tax harmonization yield potentially better results, as the main distortion, resulting from the overinvestment on productive public goods, is minimized. In particular, indirect taxes, such as VAT, should become a priority instrument for fiscal reforms proposals across the European Union. Expenditure side reforms are also necessary, as a race to bottom in the provision of public goods with a welfaristic character, or merit goods, also emerges, simultaneously with a higher provision of productive public goods. Even reforms that do not require large increases in the EU budget, such as the introduction of a common European unemployment insurance system, can exhibit interesting properties in a context of interjurisdictional fiscal competition, deterring the potentially significant welfare losses resulting from large shifts in the composition of government spending.

Finally, Chapter Four investigates the cyclical behaviour of fiscal policies across OECD countries, both in terms of its response to short-term business cycle fluctuations and fiscal sustainability concerns. In so doing, the short term behaviour of discretionary fiscal policies can be assessed against the long term structural fiscal policy trends. Fiscal policy has become pro-cyclical over recent decades, particularly within the European Monetary Union. The average level of structural fiscal balances and the responsiveness of fiscal policy to the level of debt are found in this chapter to be persistently weaker beyond the 70 percent debt-to-GDP threshold, pointing to endogenous debt limits and the relevance of fiscal fatigue phenomena. However, higher average fiscal balances, as well as a stronger response to indebtedness conditions, are found at higher levels of the potential level of debt service. This is also accompanied by a more pro-cyclical response

to the business cycle, suggesting that fiscal fatigue episodes in countries under greater fiscal stress may lead to strong constraints on the pursuit of fiscal policy during economic downturns. The role of fiscal decentralization is also assessed. Despite the measurement problems associated with fiscal decentralization, due to the heterogeneity in national political and legal frameworks, two issues remain clear. Fiscal decentralization does not appear to affect fiscal performance. Instead, large intergovernmental transfer systems, show a persistent negative relationship with the fiscal stance, found stronger when sub-national governments are involved in the provision of a wide array of public services. This result is particularly worrying given that, in many OECD countries with relatively high levels of expenditure decentralization, sub-national governments have kept a large dependence on intergovernmental grants together with a significant policy scope.

1.2 Thesis contribution within the wider literature

The classical theory on fiscal federalism, initially developed as a branch of the public finance literature, was pioneered namely by Tiebout (1956) and Oates (1993). It was extended by several contributions from public choice and political economy theory to account for the incentives of governments, elected officials and bureaucrats. Namely, Weingast (1995) introduced the idea of market-preserving federalism, which would promote efficiency through the competition between different jurisdictions. In Chapter Two, this thesis explores this argument in a context where jurisdictions have full discretion over capital and labour income tax rates and the composition of government spending, with a fixed supply of labour. In the context of a closed economy where households own an heterogeneous stock of capital, this should lead to the classical political economy result obtained in

Alesina and Rodrik (1994): higher inequality in capital ownership would result in more redistributive policies benefiting the labour factor, and this would lead to a lower equilibrium growth rate. Yet, relaxing the assumption of a closed economy and introducing perfect mobility of capital, breaks this link. Chapter Two focuses on the consequences of capital mobility for fiscal policy and for potential international tax harmonization agreements.

In Chapter Three, this thesis looks further into potential tax harmonization agreements, dropping the assumption of a fixed labour supply. This modelling choice, together with the introduction of consumption taxes, allows for a more detailed characterization of optimal fiscal policy and for a meaningful calibration of the model to the average EU economy. This chapter thus examines in greater detail the scope for future fiscal harmonization agreements and contributes to the large literature on tax harmonization and the fiscal architecture of the European Union. Unlike the literature on capital tax harmonization (Sørensen 2000, 2004, Conconi et al. 2008, Bettendorf et al. 2010, and Haufler and Lülfesmann 2015), it analyses this option in a wider context, where capital is fully mobile but also when other tax rates are allowed to vary. The resulting policy proposals are also dramatically different from the literature. Capital income tax harmonization is no panacea and is indeed likely to do more harm than good, in the medium to long term. It also contributes to the recent blossoming literature on designing a fiscal capacity for the European Monetary Union (Bargain et al. 2013, Farhi and Werning 2017, Abraham et al. 2018b, Abraham et al. 2018a, Dolls et al. 2018), by focusing on the long-term equilibrium properties of both expenditure and revenue-side fiscal reforms.

Chapter Four contributes to the literature on fiscal reaction functions, pio-

neered namely by Bohn (1998), by providing a novel characterization of the cyclical behaviour of fiscal policy across OECD countries over the past two decades. It focuses in particular on the existence of endogenous debt limits, confirming some of the results from the fiscal fatigue and debt overhang literature (Ghosh et al. 2013, Checherita-Westphal and Žďárek 2017), and on the relationship between fiscal decentralization and fiscal performance (Schaltegger and Feld 2009, Baskaran 2010, Asatryan et al. 2015), by profiting from a novel dataset on sub-national fiscal autonomy.

1.3 Motivation behind *Essays of Fiscal Federalism*

How far will international economic integration go? This is the question asked by Dani Rodrik in the wake of the twenty-first century, giving title to a paper where the Political Trilemma of the World Economy is proposed (Rodrik, 2000). It is presented as an impossibility theorem between democratic political regimes, national sovereignty and global economic integration. In short, like in the well-known impossible trinity of monetary policy (Obstfeld and Taylor, 1997), two of the three, but never have all three in full, can be achieved simultaneously. Three options emerge at the extremes. The first is to maintain full national sovereignty together with perfect economic integration, making national policies only responsive to the global forces of the international economy. This would correspond to a scenario where nation-states would pursue global economic integration at the expense of any other domestic objectives, which is interpreted as a constraint on democracy. The convertibility experiment in Argentina during the 1990s provides a useful illustration of the potential incompatibility of national sovereignty and full economic integration with a well-functioning democracy. The second option

is to limit the global integration of national economies, by setting clear boundaries on what it can and should achieve. This corresponds to a limited version of globalization, more similar to the Bretton Woods regime in the postwar period, with capital controls and limits to free trade. The third option is a form of "global federalism", where the scope of democratic regimes is aligned with that of global integrated markets, in the sense that common agreements would aim to deliver better policies, otherwise unachievable due to the lack of coordination. Yet, taken to an extreme, this would imply a difficult - and perhaps politically strenuous - downgrade in the role of nation-states, which would have to relinquish an important part of their sovereignty to supra-national institutions. However challenging, this has been already partially attained within the European Union. As experience demonstrates, however, the road is tumultuous.

Having achieved unprecedented levels of economic integration, and despite some recent protectionist and totalitarian waves, the road towards globalization seems to be one-way. As Rodrik (2000) suggests, if the aim is to preserve economic integration, future policy reforms must face the trade-off between democracy and national sovereignty. The common trade rules under the World Trade Organization are perhaps the best example of this trade-off; nations have agreed to constrain their sovereignty, subjecting themselves to a supranational institution and agreed rules. They made this choice in order to deter competition between countries, in the form of trade wars, which would potentially generate large welfare losses for them. This can be understood in the present context as a victory for democracy (or "mass politics", in the terminology used in (Rodrik, 2000), assuming democracy can bring about "optimum", or at least more welfare-enhancing, policies from the point of view of a representative economic agent or median voter)

and economic integration. Exactly in the same fashion, tax competition can degenerate into a "fiscal war" for attracting mobile tax bases. The case of tax or fiscal harmonization is thus similar: even restricting national sovereignty, such tax agreements can pay off and potentially deliver better policies in the long run. In other words, similarly to existing trade institutions, tax harmonization agreements can be the best way to solve a Prisoner's Dilemma for countries facing perfect economic integration. After more than sixty years of European integration, although several cornerstones have been achieved, lessons remain to be learnt. Also aiming to learn from the past, this thesis is thus an exploration of how different fiscal reforms can shape the EU economy in the future. Policy proposals, rather than recommendations, are necessarily given with a word of caution.

The European federalist experience must also necessarily be different from the American or individual country decentralization processes. First and foremost, the beginning of the American process of fiscal federalism relies historically on a "bottom-up" approach, started immediately after the Revolutionary War against the British, while the European process can be seen as a "top-down" process, started in the aftermath of World War II, when sovereign countries aimed to cooperate economically. This is confirmed by the two founding treaties, the Articles of Confederation and the Treaty of Rome. While both initially granted very limited powers to the federal government, the former, ratified in 1781 by the thirteen founding states, immediately assigned the US federal government with the tasks of the resolution of bilateral state disputes, diplomatic affairs and defense. The Treaty of Rome, signed in 1957, remained less ambitious, focusing on the deepening the economic relations between the six founding European member-states, after the Treaty of Paris had established the European Coal and Steel Community.

The origin of the terms "fiscal federalism" and "fiscal devolution" or decentralization also reflects this historical process. While in America this process has been analyzed from the lenses of a process of political integration between states, under the common umbrella of a federal government and well-established judicial powers, in Europe the words devolution and decentralization have prevailed, as the process has been studied as a result of individual country experiences, decentralizing their administrations to state, regional, provincial, municipal or local governments.

1.4 A brief revision of endogenous growth

The development of models featuring steady-state growth, specifically modelling the process through which growth can be generated within an economy as a result of agents and governments economic decisions, arose as a response to the limitations of the classical workhorse of modern growth theory, the Solow model (Solow, 1956), then also further developed famously in the contributions of Cass (1965) and Koopmans (1965).

Indeed, endogenous growth models have been a further attempt to deliver answers to essential questions with which economists have been dealing with for centuries and for which standard neoclassical growth theory provides little or no guidance. Why has in the past decades average *per capita* income growth been so much higher in several developed countries than in developing countries? Why was average *per capita* income growth so much higher in the late twentieth century than in the early eighteenth century? The answers typically found in the Solow model for these questions relate to differences in Total Factor Productivity (TFP) across countries and time periods. However, why was TFP different? In other

words, how were the innovation processes driven and why was the access to or propagation of these innovations different? The answers to these questions need to bring the process by which innovations themselves are generated to the heart of the problem, as a direct result (or at least as a by-product) of economic decisions, with marginal cost and benefits, made by optimizing agents. To put it another way, in order to fully grasp the long-run growth process of the economy one cannot simply assume there are so many young Isaac Newtons sitting in a garden just below a falling apple.

An easily tractable neoclassical growth model, yet with interesting dynamic features, provides a useful bridge between the Solow model and endogenous growth theory, pioneered, among others, by Romer (1986) and Lucas (1988). The neoclassical version of the AK model, even not specifically modelling technological change as an endogenous phenomenon, provides a useful illustration of how neoclassical models can feature sustained economic growth. One unattractive feature of this model is that, with a production technology linear in capital, the share of national income accruing to capital tends to unity, putting it at odds with the well-established Kaldor facts on the stability of the factor-income distribution. As an attempt to address this issue, early contributions extended this model to include physical and human capital, both with linear accumulation functions, and two-sector models with different factor intensities, such as Rebelo (1991). One common feature of these and later endogenous growth models is the linearity that ensures sustained economic growth. It is the underlying process by which (asymptotic) linearity - as a necessary condition to ensure perpetual or steady-state growth - is generated that represents the main difference between AK-type and endogenous growth models. While the latter focus most of the attention on the (endogenous)

process through which technology develops, the former models do not feature sustained technological progress and economic growth then arises as a result of capital deepening, in the broad sense, or the accumulation of productive factors. This does not imply in itself an inconsistency with the data, particularly taking into account the recent trends in capital-output ratios and tax policy observed across developed economies (Alvaredo et al. 2013, Piketty and Zucman 2014, Auerbach and Hassett 2015, Piketty 2015).

In order to focus on the issue of the effects of fiscal policy on the equilibrium growth rate and welfare, we thus restrict the analysis to a set of neo-classical models featuring a balanced growth path, convex production sets, well-behaved household preferences and competitive market structures (Jones and Manuelli, 2005). Moving away from the world of stationary or pure exogenous growth neo-classical models, *à la* Solow (1956), thus requires to drop one crucial assumption: that the marginal product of capital is low. With an economy in equilibria with long-run growth, i.e. in which the marginal product of capital and thereby the real interest rate remain bounded away from zero, this will depend on a variety of factors, from preference parameters to fiscal policy.

Bearing this in mind, one can start by gaining some further insight into the key mechanisms of this class of models by explicitly looking at the social planner's problem in a basic one-sector growth model, with preferences given by

$$\max_{c_t} \sum_{t=0}^{\infty} \beta^t u(c_t)$$

subject to

$$c_t + i_t \leq F(k_t, l_t)$$

$$k_{t+1} \leq (1-\delta)k_t + i_t$$

where c_t is consumption, k_t is the stock of capital, i_t is the flow of investment and l_t is employment, all in *per capita* terms, at point t. Assuming a fixed supply of labour, the Euler equation for such problem can be written as

$$u'(c_t) = \beta u'(c_{t+1})[1 - \delta + r_{t+1}]$$

With $f(k) = F(k, 1)$, in a competitive economy, it follows that, if $\lim_{k\to\infty} \beta[1 - \delta + f(k)] > 1$, then $\limsup_t c_t = \infty$, implying that this type of model can feature long-run sustained growth. Extending this model to multiple types of capital, the above constraints change to

$$c_t + \sum_{i=1}^{I} i_{it} \leq F(k_{1t}, ..., k_{It})$$

$$k_{i,t+1} \leq (1-\delta_i)k_{it} + i_{it}$$

Thus, the analogue to the assumption that the marginal product of capital is sufficiently bounded away from zero is that there is a homogeneous function of degree one - i.e. a linear function - in the stocks of capital representing the lower bound for the production function. This does not in itself rule out the existence of decreasing returns to scale and this class of models is thus not readily distinguishable from Solow-Cass-Koopmans type of models. The main difference can be found on the tail behaviour of the relevant variables and not necessarily on the nature of the equilibrium path (Jones and Manuelli, 2005).

In order to switch to a model able to account for the effects of fiscal policy on

the path of the economy, one can assume a utility function of the form $u(c, 1-l) = (c\upsilon(l))^{1-\theta}/(1-\theta)$ and look at the problem faced by a representative agent in the context of a one-sector model with capital taxation:

$$\max \sum_{t=0}^{\infty} \beta^t u(c_t, 1 - l_t)$$

subject to

$$c_t + (1 + \tau^i)p_t i_t \leq w_t l_t + (1 - \tau^k)r_t k_t + T_t + \Pi_t$$

$$F^k = Ak + \hat{F}(k)$$

where $\hat{F}(k)$ is a strictly concave function (with $\lim_{k\to\infty} \hat{F}'(k) = 0$) and it is assumed for simplicity that labour is supplied inelastically and that lump-sum transfers are used to clear the government budget constraint. The equilibrium growth rate along the balanced growth path satisfies

$$\gamma^\theta = \beta\Big[1 - \delta + \frac{1 - \tau^k}{1 + \tau^i}A\Big]$$

An increase in the effective tax rate on capital, $1 - \tau^k/1 + \tau^i$, will thus unambiguously decrease the equilibrium growth rate. This model thus provides an elementary illustration of how changes in tax rates may affect the long run growth rate of the economy and how the intertemporal elasticity of substitution, $1/\theta$, affects the magnitude of such effects. Thus, even in this simple example, the importance of the values of the relevant preference and technology parameters to determine the quantitative predictions of these models can readily be observed[1].

[1] Jones et al. (1993), for instance, analyzing the optimal choice of distortionary taxes in the context of endogenous growth models, find that the growth effects of switching to an optimal taxation schedule could yield

In order to fully being able to characterize the effects of fiscal policy on the long-run equilibrium growth rate of the economy, another underlying implicit assumption made so far needs to be dropped: that additional revenues from tax increases are solely used to finance lump-sum transfers to households. In this context, a seminal contribution is attributed to Barro (1990), which provides an explicit role for government spending. With a technology given by

$$y_{it} \leq A k_{it}^{\alpha_1} h_{it}^{\alpha_2} G_t^{1-\alpha_1-\alpha_2}$$

where k_{it} and h_{it} are the amounts of physical and human capital, respectively, and G_t is the measure of productive goods, taken as given by firms. The government budget constraint is assumed balanced at all times, with taxes on physical capital, τ^k, and human capital, τ^h. The equilibrium growth rate can be expressed as

$$\gamma^{\theta} = \beta\Big[1 - \delta_k + \alpha(1-\tau^k)\mathcal{A}\Big]$$

where $\mathcal{A} \equiv A^{1/(\alpha_1+\alpha_2)}(\alpha_1\tau^k + \alpha_2\tau^h)^{(1-\alpha_1-\alpha_2)/(\alpha_1+\alpha_2)}\kappa^{-\alpha_2/(\alpha_1+\alpha_2)}$ and κ represents the (constant) physical-human capital ratio in the economy. It can thus be shown that the growth rate of the economy is not a linear function of tax rates. Namely, intermediate values of tax rates will yield positive growth rates and tax rate increases do not necessarily entail a lower equilibrium growth rate, if they are accompanied by increases in (productive) government spending. These features of the model seem to be important to fit the model to the available evidence on the US economy, namely given the large increase in government spending in the

substantial growth effects in the US economy, between 1.5% and 3% per year, depending on the version of the model used, one-sector versus with physical and human capital, fixed versus flexible labour supply or without versus with endogenous determination of government consumption. Stokey and Rebelo (1995), on the other hand, in a broad review of growth models with fiscal policy, conclude that changes in tax rates cannot have such large effects in order to be consistent with the growth patterns observed across the twentieth century. Please refer to Jones and Manuelli (2005) or Acemoglu (2008) for a more detailed discussion of the workings of endogenous growth models of fiscal policy with physical and human capital.

postwar period, from 5 to about 20% of income, excluding defense expenditures. Hence, as mentioned in Jones and Manuelli (2005), even if not all forms of government expenditure are productive, if the trend in the productive component follows the general trend in government spending, ignoring these changes would result in biased estimates of the general equilibrium effects of fiscal policy. While the models like the one seen in Barro (1990) have nothing to say about the reasons why this the ratio of government spending would necessarily increase, they provide a useful benchmark for looking at the steady-state effects of more complex fiscal policy changes[2]

The models used in the context of Chapter Two and Three will borrow several elements from this brief discussion and namely from the Barro (1990) background. The fundamental idea is to have a theoretical framework able to grasp the interconnections between fiscal policy and the long-run equilibrium of an economy, where the process of technological change is reflected by the secular process of *capital* accumulation, in the broad sense. Hence, rather than aiming to retrieve the most detailed image of the underlying mechanics of the process of technological change, the models used will crucially allow to understand how fiscal policy may affect these processes, while keeping a tractable format, and enable a meaningful characterization of the effects of different policy environments, namely in the context of an interconnected global economy where sovereign governments compete to attract mobile resources to their own jurisdictions and seek to promote the long-run prosperity of national, regional and local economies.

[2]In addition, this has served as a motivation behind other fiscal policy models of growth which have later addressed the issues of tax progressivity or transitional effects (Li and Sarte, 2001). In a similar fashion, Aghion and Howitt (1998) or Boldrin and Levine (2008) later went on to further develop the technology side and model it as a purely endogenous phenomenon, bringing further richness to the standard endogenous growth models and to the analysis of fiscal policy in the context of a growing economy.

II

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

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

Abstract

Fiscal decentralization, devolution or federalism creates the possibility for tax competition between jurisdictions. In an endogenous growth model with capital and labour taxation where governments provide both productive goods and merit goods, we show that tax competition brings growth-maximizing policies. Yet, this translates into a 'race to bottom' for the taxation of the mobile factor, capital, together with a 'race to the top' for the taxation of immobile factor, labour. 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 where member states are decentralized jurisdictions. Capital tax harmonization avoids a race to the bottom in capital taxation but implies a race to the top in labour taxation. Only labour income tax harmonization can avoid the latter, while leaving room for a positive capital tax.

2.1 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 and political 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. Yet, by and large, fiscal policy has been left decentralized and member states have kept virtually full discretion over their tax and spending decisions. A

large body of literature has developed on the wider implications of the removal of barriers to the mobility of productive factors across the European Union (EU) on fiscal policy (Persson and Tabellini 1992, 1996, Ottaviano and Van Ypersele 2005, Wilson and Janeba 2005). In this context, the desirability - or otherwise - of fiscal policy harmonization and coordination in the EU, triggered famously by the Delors report, has since become the focus of vivid academic discussions and was recently brought again to the centre stage of the political debate.

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 devolution or decentralization. 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[3]. Another strand of the literature emphasizes the so-called market-preserving role of tax competition between jurisdictions with devolved fiscal powers (Weingast, 1995) to reach a similar conclusion. Put simply, fiscal federalism was regarded by this first generation of the literature as an institutionally optimal solution which would eventually promote economic development, on the grounds of increased efficiency and political accountability[4]. Here we focus

[3]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).

[4]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 (Martinez-Vazquez and McNab, 2003).

in particular on the mechanism of interjurisdictional tax competition. This allows us at the same time to highlight the scope for potential efficiency-enhancing reforms and focus on the main trade-offs faced by policymakers attempting to design an appropriate fiscal architecture in federations of countries or regions.

Different jurisdictions - both cities, regions, states, and countries - may compete to offer the best possible business environment for firms to invest and set profitable businesses. An important part of this is to grant adequate infrastructure and competitive tax regimes. Recent data reveals that the average tax-to-GDP ratio amongst OECD countries reached 34.3% in 2016, the highest level ever recorded. Yet, the sources of tax revenues have been dramatically changing over the past decades. The share of personal income taxes, social security contributions and value-added taxes are now also at their highest point, at around a quarter of GDP on average. Namely, VAT revenues reached a peak of 6.8% of GDP, or about a fifth of total tax revenues, on average (OECD, 2016)[5]. On a diverging path, the share of corporate taxes to total revenue in 2014 was 8.8%, down from 11.2% only in 2007.

A substantial fall in statutory corporation tax rates observed across OECD countries, particularly since the early 1980s, has been documented and focus substantial research (Devereux et al. 2002, Devereux et al. 2008, Overesch and Rincke 2011). Between 1982 and 2007, statutory tax rates across OECD countries are documented to have fallen from an average of 47 to 27.5 percent. Virtually all OECD countries have reduced their statutory corporate tax rates during this pe-

[5]The collection of government revenue data series starts in 1965. Despite some clear common patterns - as for example ten OECD countries had in 2015 a standard VAT rate above 22%, against only four in 2008 -, individual countries have also shown recently some different trends. For instance, between 2007 and 2015, Norway experienced a fall of around 4 percentage points of the total tax burden. In the same period, 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.

riod (Loretz, 2008). Globalization and technical progress are frequently pointed as the main drivers 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[6]. Furthermore, this competition over corporate tax rates does not seem to be slowing down over time or to become less fierce within an economic block like the EU. A recent report shows further evidence of increasing tax competition (OECD, 2017). In 2016 only, eight countries - most of which EU member states - implemented or legislated corporate tax cuts and others announced further reductions[7]. Lastly, the recent corporate tax reforms in the United States seem nothing but to reinforce these trends.

In this paper, we explore the effects of tax competition on economic growth and redistribution. In order to do so, we attempt to integrate the insights offered by the fiscal federalism literature with the ongoing debate on international tax competition and harmonization. We focus our discussion in particular on the EU case, as an emerging federal structure. In this context, the EU as a whole can be viewed as a very particular federation of countries, consisting of a group of decentralized jurisdictions with perfect capital mobility and frictionless trade between each other but preserving nearly full fiscal and political discretion. The federal or central government can be considered to have negligible fiscal capacity. We

[6]Existing empirical evidence shows, however, significant volatility with respect to measures and datasets used (Adam et al., 2013). Furthermore, the downward trend observed in personal income tax rates until recently suggests this decline in corporate tax rates cannot be explained solely by the forces of globalization and capital mobility. At the same time, the path of corporate tax revenues relative to GDP does 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. Yet, the above does not necessarily imply that governments do not engage in tax competition or that firms do not engage in strategic tax planning. 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).

[7]Most notably, Hungary, with a sudden cut from near 20% to only 9%, making it the country with the lowest statutory corporate tax rate within the EU, after decades during which Ireland had a notorious 'lead', keeping a 12.5% statutory corporate tax rate. Other EU countries which legislated or announced further cuts are Luxembourg, the United Kingdom, Slovak Republic, Italy, Spain, France and Germany.

start by reconsidering the main trends in taxation across the EU since the early 1980s. The main aim of this paper is to assess the current institutional setting, in an environment of declining corporate tax rates and fully decentralized fiscal policy, against other possible options, such as partial or full tax harmonization. The effects of such options are considered in the context of a parsimonious endogenous growth model with government spending, 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 merit good enters a Constant Elasticity of Substitution (CES) utility function, while the productive public good is a labour-augmenting factor of production[8] Focusing on the optimal policy choices for governments brings us to the core of the trade-off between economic growth and inequality. The spirit of our paper is thus closest to Alesina and Rodrik (1994). We explore in particular the consequences of tax competition between jurisdictions induced by capital mobility.

The contribution of this paper is twofold. Firstly, we show that a world of perfect capital mobility and full fiscal powers for decentralized governments maximizes 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. Governments of decentralized jurisdictions are induced to favour pro-growth policies and the scope for redis-

[8]One can think of the productive public good as being, by and large, any "pro-growth" government expenditure, which contributes directly towards increasing the productive potential of the economy. Items in this category - which can also be interpreted broadly as public capital - can range from direct investments on R&D activities, financial support for high-tech SMEs or provision of productive infrastructure and investments in human capital. Merit goods can in turn be understood as goods or services which may also be privately provided but whose characteristics are usually perceived as essential. For this reason, merit goods are frequently associated with the idea of universal or unconditional provision. Alternatively, we can refer to this category as referring to government expenditure with a purely "redistributive" character. Items such as in-kind benefits, family allowances, social care, social housing, or recreational and cultural services can fit into this category (Fiorito and Kollintzas, 2004).

tributive policies becomes highly constrained. Secondly, we bring forward several tax harmonization scenarios under this framework, worth considering namely in the EU context. Most of the current debate focuses on the desirability, or otherwise, of having a common fiscal capacity that potentially allows EU member countries to better respond to asymmetric shocks (viz. Abraham et al. 2018a). The present paper focuses instead on the potential international tax agreements, across the EU or more broadly, that would allow countries to respond to the new challenges brought by capital mobility and international tax competition. The options outlined here can be seen as the main paths ahead that can be considered by European policymakers.

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

2.2 Trends in corporate taxation in the EU

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[9]. By the beginning of the twenty-first century, one

[9] 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

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[10] 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[11]. 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%.

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 conclude that corporate tax cuts were not exclusive to smaller EU economies (the absolute decrease was actually slightly larger for the four largest economies).

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.

[10]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.

[11]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 subgroups of large and small economies for illustrative purposes and analytical convenience.

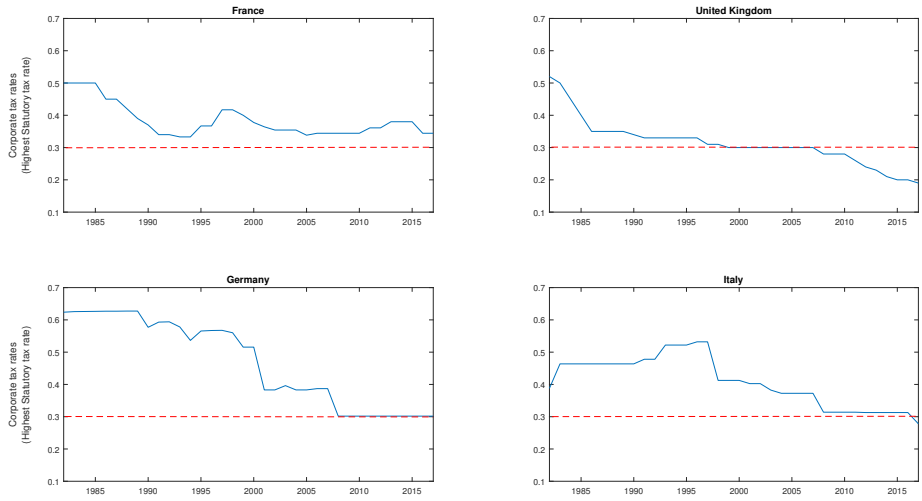

Figure 1: Top statutory corporate income tax rates in 4 large EU economies (1982-2017). The blue line tracks the evolution of top statutory corporate income tax rates in EU countries. Country coverage: France, United Kingdom, Germany and Italy. The dashed red line highlights the 30% minimum threshold initially put forward by the Ruding Committee, at the launch of the European Single Market. The figure depicts a downward trend in corporate taxation across the EU, with a first wave of corporate income tax cuts in the late 1980s, in France and in the United Kingdom, and a second wave in the late 1990s and early 2000s, most pronounced in Germany and Italy.

Moreover, since 1992, when the European Single Market was launched, all the EU economies reduced corporate income tax rates, with the exception of France and Ireland, which remained fairly stable over the period.

After inspecting Figure 3, the same conclusion is confirmed, although over a shorter time span. Since the early days of the European Single Market, there was effectively a significant 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

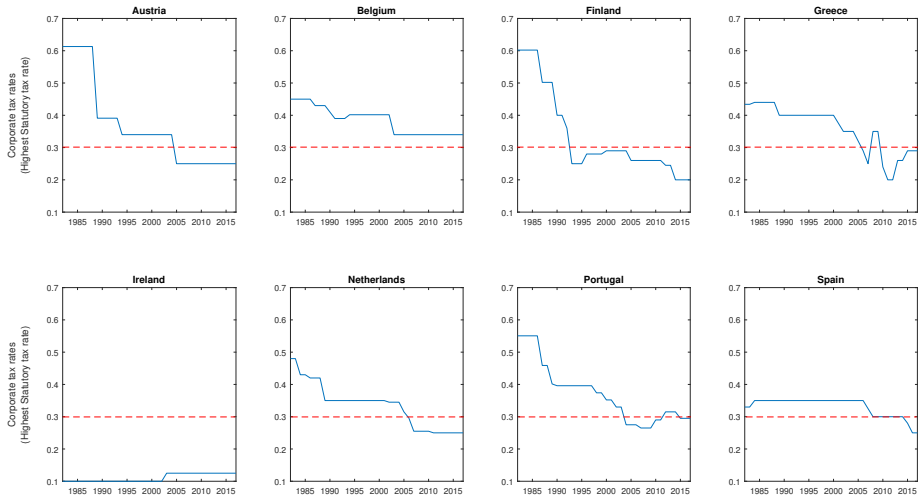

Figure 2: Top statutory corporate income tax rates in 8 small EU economies (1982-2017). The blue line tracks the evolution of top statutory corporate income tax rates in EU countries. Country coverage: Austria, Belgium, Finland, Greece, Ireland, Netherlands, Portugal, Spain. The dashed red line highlights the 30% minimum threshold initially put forward by the Ruding Committee, at the launch of the European Single Market. The figure depicts a generalized downward trend in corporate taxation across the EU, with most countries now under the 30% barrier.

adjustment between 2004 and 2017 was then mostly due to EU-15 countries, which have since then slashed corporate taxes to an average of 25.5%, against 17.7% in 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.

At the same time, the corporate tax rate cuts just mentioned were accompanied

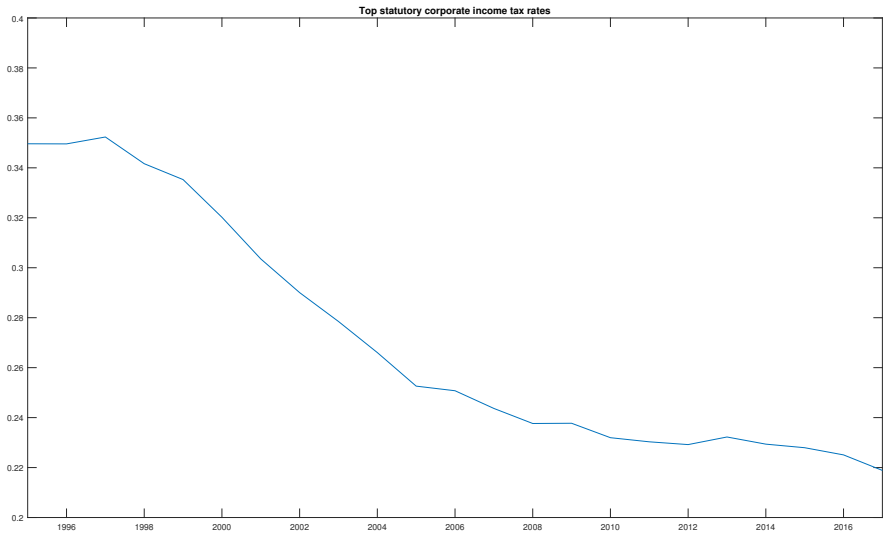

Figure 3: EU-28 average top statutory corporate income tax rates (1995-2017). Country coverage: all EU-28 countries. The figure depicts a markedly downward trend in corporate taxation across the EU, which appears stronger in the late 1990s and early 2000s, with smoother path after the mid-2000s.

by a broadening of the corporate tax base[12]. The definition of the tax base is, however, extremely complex in this case[13]. We use a common proxy for the tax base, based on 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 one if investments could be immediately deducted.

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 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

[12]As can be seen in Appendix A, Figures A.1 and A.2, effective corporate tax rates have followed the same downward trend between 1982 and 2005. The data was collected from the Institute for Fiscal Studies.

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

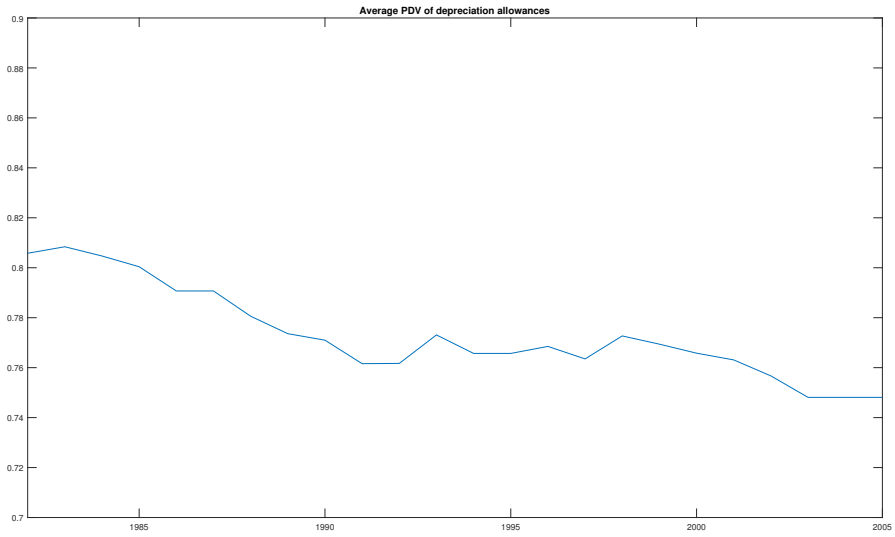

Figure 4: EU-28 average present discounted value of depreciation allowances (1982-2005). The definition of the corporate tax base involves a wide range of legislation, covering namely the extent of depreciation allowances for capital expenditures and the deductibility of different expenditure categories. This measure equals zero without any depreciation allowances and one if all investments could be immediately deducted.

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 diminish after an initial transition period, it has continued far beyond the early 2000s, mostly driven by EU-15 countries facing further competition from Eastern European economies.

2.3 Model

Each individual i in 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 may vary across different jurisdictions. This heterogeneity between agents' capital endowments also represents thus a source of heterogeneity between jurisdictions. Different initial endowments of capital will be mirrored into different consumption and income levels between individuals, as all other endowments and characteristics are assumed to be otherwise equal. Namely, they will have namely the same endowment of time and labour productivity. A continuum of infinitely-lived individuals ($i \in (0,1)$) live in each of the J jurisdictions ($j = 1, ...J$) of a closed economy. In an endogenous growth framework, we develop a continuous time model in the spirit of Barro (1990), Alesina and Rodrik (1994) and Hatfield (2015). 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

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

The subscript $d_j^i(t)$ highlights the possibility that different individuals in a given jurisdiction j can invest in different jurisdictions and thereby obtain different rates of return on their capital holdings. Although the whole economy is assumed to be closed, which is reflected in the second identity above (i.e. the total amount of capital in the whole economy equals the sum of capital holdings of all individuals), capital can move costlessly across all J jurisdictions. Individuals cannot move across jurisdictions.

2.3.1 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:

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

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, $l_j^i(t) = 1$. The government funds the provision of the productive public good and the merit good out of capital and labour income tax

revenues[14]:

$$g_j(t) + h_j(t) = \tau_j^K k_j(t) + \tau_j^L w_j(t) l_j(t) \tag{2}$$

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 $1 - \beta_j$:

$$g_j(t) = \beta_j \Big[\tau_j^K k_j(t) + \tau_j^L w_j(t) l_j(t)\Big] \tag{2'}$$

$$h_j(t) = (1 - \beta_j) \Big[\tau_j^K k_j(t) + \tau_j^L w_j(t) l_j(t)\Big] \tag{2"}$$

The utility of each individual can be represented by the following CES function[15]:

$$\int_0^\infty e^{-\delta t} \log \left[\eta_c^{\frac{1}{\sigma}} c_j^i(t)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}} h_j(t)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} dt \tag{3}$$

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:

$$\dot{k}_j^i(t) = (r_{d_j^i(t)}(t) - \tau_{d_j^i(t)}^K) k_j^i(t) + (1 - \tau_j^L) w_j(t) l_j^i - c_j^i(t) \tag{4}$$

[14] 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 $h_j(t) = \theta_j k_j(t)$.

[15] 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.

Note again that individuals may choose, at least in principle, to have their capital stock, $k_j^i(t)$, invested across many different jurisdictions, with different levels of capital taxes and gross rates of return on capital. Thus $r_{d_j^i(t)}(t)$ and $\tau^K_{d_j^i(t)}$ correspond to the average gross return and tax rate on the stock of capital of an individual, obtained across all J jurisdictions. The net rate of return on labour also depends on the jurisdiction j choice of taxes and on wages, 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 net rate of return on capital, both under a single centralized government and decentralized governments. The former case, by definition, implies one single set of policies $(\tau_j^K, \tau_j^L, \beta_j)$, to which also corresponds a single gross 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 maximize 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[16].

2.3.2 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-

[16]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.

substitutes ($\sigma > 1$) or 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 delivered by the government, we will devote special attention to the case of complementarity between both goods[17]. We thus explore a model that features two types of good provided by the government. Although this does not bring major qualitative changes to the dynamic behaviour of individuals, 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: redistributive transfers - such as subsistence income, food stamps or housing benefits -, or any social, cultural and recreational services directly provided by the government. In addition, education and healthcare - although also with a clear productive role - are also typically understood as merit goods, given the widespread perception of the desirability of their universal provision. Items that fit into this category are also be generally referred to as welfare expenditures and account for up to two thirds of aggregate government spending in most OECD

[17]Note that this complementarity can be seen both *between* and *within* categories. For instance, a healthier individual may want to increase her demand for a wide array of consumption categories. On the other hand, a lack of quality or quantity in the provision of some merit goods - for instance, social care or free school lunch programmes - may increase the private consumption of these items.

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 an overlap with potential "productive" public spending categories, we can focus in particular on those categories of public spending which can be considered as strictly "non-productive", such as in-kind benefits, social care or cultural and recreational services.

Recent studies generally suggest these public expenditure items are strongly complementary to private consumption (Fiorito and Kollintzas 2004, Bouakez and Rebei 2007). 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 over time, given the general increase in welfare spending and the changing composition of general government spending[18].

[18] A similar point is made by Galí et al. (2007), in the context of an assessment of 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 macroeconomics models would prove unfit to assess the effects

2.3.3 Equilibrium

An equilibrium in this model is defined 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 individuals, $\{c_j^i(t), k_j^i(t), d_j^i(t)\}$, 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 individual maximizes 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 jurisdiction 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 jurisdiction j where they live and their initial level of wealth $k_j^i(0)$.

Consider now the problem of an individual i endowed with an initial amount of capital $k_j^i(0)$, maximizing utility, (15), subject to the budget constraint, (16):

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

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 $(\tau_j^K, \tau_j^L, \beta_j)$ and corresponding net rate of return on capital $\psi_j = r_j(t) - \tau_j^K$, we may rewrite the problem using the following current-value Hamiltonian (Acemoglu, 2008):

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.

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

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

$$c_j^i(t) = c_j^i(0) e^{(\psi_j - \delta)t} \tag{5}$$

Furthermore, we can define the initial consumption of individual i in region j, $c_j^i(0)$, with capital holdings $k_j^i(0)$ as:

$$c_j^i(0) = \delta k_j^i(0) + (1-\tau_j^L) w_j(0) l_j^i \tag{6}$$

Hence, combining (21) and (6), we obtain the consumption level for each individual i in each period t:

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

Individuals will thus use their labour income plus a fraction δ of their capital stock in order to finance their consumption in each period. Those with higher initial capital endowments will thus 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 each jurisdiction. 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 (16) we can also show that capital grows at the same rate as wages, consumption and output in each economy:

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

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

We can furthermore re-write our (6) as a function of constants, which will be important when solving for the optimal policy:

$$c_j^i(0) = \Big(\delta \kappa_j^i + \omega_j\Big) k_j(0) \tag{7}$$

Hence, we obtain that initial consumption is a function of parameters of the model and the initial amount of capital in each jurisdiction j, $k_j(0)$. We obtain here 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 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 holdings of each individual are also constant, as the (net) rate of return on capital is the same for all individuals in equilibrium and constant over time, irrespective of their initial amount of capital. Since capital grows at a constant rate for every agent and relative capital holdings are determined solely by the initial endowment, capital inequality persists over time in this economy. The level of income and consumption inequality also remains constant over time, given the policy set $(\tau_j^K, \tau_j^L, \beta_j)$.

2.4 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 policy set chosen by the government, $(\tau_j^K, \tau_j^L, \beta_j)$. We then reach an indirect utility form,

where we have the present value of an individual's utility expressed as a function of parameters. Finally, we can obtain the optimal policies for the government. 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 a corollary of the median-voter theorem, which we apply in this context. The preferences of individuals over policy sets do not change over time (since κ^i is constant) and we work under the assumption that governments can commit to the policies announced at time $t = 0$. 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 either the case of the existence of a centralized government or, instead, 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 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[19]. sub-central governments, on the other hand, face full mobility of capital, which results in an extreme Bertrand competition for capital. Labour is assumed to be an immobile factor throughout this exercise[20]. 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

[19]We can drop the jurisdiction subscript in our analysis of the centralized government policy, as centralization in this case is equivalent to having only one jurisdiction j. We can also think that all j jurisdictions have the same set of policies (τ^K, τ^L, β) and, hence, same choices made by individuals and growth rate, $\psi - \delta$.

[20]The assumption of *immobility* across jurisdictions is used in order to make a clear distinction between mobile and immobile factors of production. It is possible, however, to drop the assumption of a *fixed* individual supply of labour and allow for an explicit labour-leisure choice. The next chapter considers a more complete model of endogenous growth with flexible labour supply.

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.

2.4.1 Centralization

In order to solve for the optimal policy of the central government, let us obtain the utility of agent i as a function of parameters and policy set $(\tau_j^K, \tau_j^L, \beta_j)$. Hence, defining the equilibrium growth rate of the economy as $\xi = \psi - \delta$ and combining (15), (21) and (6)[21]:

$$
\begin{aligned}
V(\xi, \omega_j; \kappa_j^i) = & \\
& \frac{\xi(\tau_j^K, \tau_j^L, \beta_j)}{\delta^2} \\
& + \frac{1}{\delta}\frac{\sigma}{\sigma - 1}\log\left[\eta_c^{\frac{1}{\sigma}}(\delta\kappa_j^i + \omega_j)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}}\left((1-\beta_j)(\frac{\tau_j^L}{1-\tau_j^L}\omega_j + \tau_j^K)\right)^{\frac{\sigma-1}{\sigma}}\right] \\
& + \frac{1}{\delta}\log(k_j(0))
\end{aligned}
\tag{8}
$$

We recall at this point that κ_j^i 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. The after-tax wage-capital ratio of economy j, 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, $\omega(\tau_j^K, \tau_j^L, \beta_j)$ reflects economic conditions of each jurisdiction j. This ratio will also be invariant with respect to time and will not depend on the relative abundance of capital in each region. The after-tax wage-capital ratio could hence, in principle, be the same across many different jurisdictions, if these would have

[21] We assume that, along the balanced growth path, we must have $\frac{\dot{c}_j^i(t)}{c_j^i(t)} = \frac{\dot{h}_j(t)}{h_j(t)}$.

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: jurisdictions with more unequal capital distributions will have a poorer median voter, who demands more redistribution. Hence, more unequal jurisdictions will tend to have a higher equilibrium after-tax wage-capital ratios. Jurisdictions with less unequal capital distributions (with a richer median voter) will tend to have a less redistributive policy set and will thus tend to have lower after-tax wage-capital ratios. In this context, ω_j will thus depend on individual preferences and on the distribution of capital in each jurisdiction. We shall return to this point when we analyse optimal policy issues under decentralization.

A closer inspection of (8) reveals that the utility of each agent can 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 the policy set, a government changes the first two terms. The trade-off between present consumption and long-term economic growth is thus clear. A further interesting feature is that, similarly to Alesina and Rodrik (1994), although κ_j^i is not affected itself by the policy chosen by the government, it affects the equilibrium optimal policy (under centralization), as we shall see later, in a political economy 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 capital-rich to capital-poor individuals, 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. The political economy equilibrium (under centralization) will, in general, feature a capital tax that will not maximize economic growth. 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 maximizes the welfare of the median-voter[22]:

$$(\tau^{K^{\text{med}}}, \tau^{L^{\text{med}}}, \beta^{\text{med}}) = \underset{(\tau^K, \tau^L, \beta)}{\arg\max} \left\{ V(\xi, \omega, \beta; \kappa^{\text{med}}) \right\} \tag{9}$$

Note that this policy will not, in general, strictly maximize economic growth. It is important to stress at this point 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. Hence, under no capital mobility, a centralized government will respond to the median voter and set the equilibrium policy $(\tau^{K^{\text{med}}}, \tau^{L^{\text{med}}}, \beta^{\text{med}})$[23].

2.4.2 Decentralization

Under decentralized fiscal powers, each of the J sub-central governments in each jurisdiction now face full capital mobility. With tax competition over mobile factors, the policy response will necessarily be different. In the knowledge that, in order to attract capital to their own jurisdiction, governments have to offer the

[22] Further details on this result (Proposition 1) and detailed model derivations are presented in Appendix B.

[23] 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.

highest possible net rate of return on capital, these will engage in a "race to the top" involving the highest possible rates of return on capital and lowest capital taxation. A first-mover would have, in this context, the immediate benefit of attracting all the capital in the economy (leaving all the other jurisdictions with a zero amount of capital). Hence, governments are immediately driven towards an environment of extreme Bertrand competition for capital. In equilibrium, every jurisdiction will offer the same net rate of return on capital and the assumption of a slight home-bias will imply no further capital movements will take place. The policy chosen by sub-central governments thus maximizes the net rate of return on capital[24]:

$$(\tau^{K*}, \tau^{L*}, \beta^*) = \underset{(\tau_j^K, \tau_j^L, \beta_j)}{\arg\max} \left\{ A\alpha \left[\beta_j \left(\tau_j^K + \frac{\tau_j^L}{1-\tau_j^L} \omega_j \right) \right]^{1-\alpha} - \tau_j^K \right\} \tag{10}$$

This policy will, by definition, maximize economic growth. It will not however respond to median-voter redistributive preferences, as before. In other words, median-voters of different jurisdictions, understanding the new constraints imposed by capital mobility between jurisdictions, will demand that the sub-central governments choose the growth maximising policy set, $(\tau^{K*}, \tau^{L*}, \beta^*)$. Accordingly, with perfect capital mobility, full fiscal discretion for sub-central governments implies that equilibrium policy sets do no longer reflect the distribution of capital in different jurisdictions. 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 decentralized political economy equilibrium. Note in particular that the share β_j of government revenues spent on the productive pub-

[24]Further details on this result (Propositions 2 and 3) are presented in Appendix B.

lic good will, in equilibrium, tend to unity. This implies that the merit good is not provided under decentralization. All the revenues from capital and labour taxation will be directed towards the productive public good, in order to achieve the objective of maximizing the rate of return on capital. We will now explore this point as well as the wider implications of (10) more in depth. We then move on to compare, in the next section, the decentralized political economy equilibrium with other possible scenarios, namely under which some or all tax rates are harmonized across jurisdictions.

By looking at (10), 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, decentralized governments with full fiscal discretion will choose to raise τ_j^K until the maximum net rate of return on capital is reached, the exact level of which depends namely on the capital share α. 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 the after-tax wage-capital ratio, before moving on to further considerations on the decentralized political economy equilibrium:

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

An increase on productive public spending, $g_j(t)$, strictly increases the wage rate. This also increases the (pre-tax) wage-capital ratio. In terms of the effects on the after-tax wage-capital ratio, ω_j, 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 result is similar to the classical optimal taxation literature (Ramsey, 1927). We shall return to this result later on, when we discuss different institutional alternatives available in this context. Before moving on to the next section, we can summarize the results just obtained: in an environment of perfect capital mobility, full fiscal decentralization, featuring sub-central governments with complete tax and spending discretion, yields a political economy equilibrium with policy set $(\tau^{K^*}, \tau^{L^*}, \beta^*) = (0, 1, 1)$.

2.5 Tax harmonization

In order to discuss tax harmonization more in depth, let us briefly outline and explore the set of options that can be considered in this context. We will look at three benchmark scenarios in this context: full tax harmonization, capital tax harmonization and labour income tax harmonization. Any tax harmonization initiatives that can be undertaken in the future at the EU level can be thought to belong to any of these categories. Firstly, let us look at the case of full tax harmonization. In the context of the European Union, this would resemble to a multilateral tax agreement between all member countries, with the tax rates to be negotiated and set periodically by the European Council. Alternatively, one could also think of a pure form of centralization of fiscal powers, whereby

the European Commission would gain full tax setting discretion but with public spending remaining largely at the discretion of EU member countries. This type of more ambitious tax agreement can furthermore be understood as a step short of a full EU Fiscal Union, under which a federal government would be given significant spending powers. 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 international 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 setting labour income tax rates, as well as retaining full discretion over the composition of public spending. Finally, we have the scenario under which only labour income taxes are harmonized. Although perhaps frequently overlooked, this option has markedly different implications from capital tax harmonization. We finally compare the three options, by analyzing their basic qualitative properties.

2.5.1 Full tax harmonization

The case of full tax harmonization corresponds to a scenario under which a central or federal government has full tax setting powers. Let us first clearly highlight the differences between this case and one of full centralization of fiscal powers. If the central government would also retain public spending powers, then the equilibrium obtained here would be equivalent to the centralization equilibrium outlined above. In the context of the EU institutional design, this amounts to having the European Commission with full fiscal discretion over tax setting and public spending issues. In other words, this would correspond to the concept of a complete monetary and fiscal union at the EU level, with a large federal budget, covering essential parts of public spending categories, from unemployment insurance, defense

and infrastructure investment to healthcare and education spending. The equilibrium obtained, similarly to the centralized case discussed before, would imply that the central or federal government would respond to the policy preferences of an "EU median voter". 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.

The alternative we discuss here - perhaps less likely to raise eyebrows, namely in the European context - is to have full tax harmonization. In this case, common tax rates or tax rate thresholds are agreed upon between different jurisdictions, with the objective of mitigating potential damaging effects of aggressive tax competition. In the European context, this would imply that EU member countries and the European Commission would agree to a common taxation framework, yet leaving full (*de jure*) fiscal discretion over the composition of public spending at the national level. We can formalize this scenario in terms of a different budget constraint and objective function for sub-central governments. Hence, the budget constraint of sub-central governments would be:

$$g_j(t) + h_j(t) = \tau^K k_j(t) + \tau^L w_j(t) l_j(t) \tag{2a}$$

This (consolidated) budget constraint can again be rewritten as:

$$g_j(t) = \beta_j \Big[\tau^K k_j(t) + \tau^L w_j(t) l_j(t)\Big] \tag{2a'}$$

$$h_j(t) = (1 - \beta_j) \Big[\tau^K k_j(t) + \tau^L w_j(t) l_j(t)\Big] \tag{2a"}$$

Note that the policy chosen by sub-central governments still has to satisfy in this case the condition for maximising the net rate of return on capital. 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 maximize the rate of return on capital persist, but will now only feature a single policy instrument:

$$\beta^* = \arg\max_{\beta_j} \left\{ A\alpha \left[\beta_j \left(\tau^K + \frac{\tau^L}{1-\tau^L}\omega \right) \right]^{1-\alpha} - \tau^K \right\} \tag{10a}$$

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

2.5.2 Capital tax harmonization

Capital tax harmonization is often presented as one option that would be able to undermine international tax competition and, thereby, mitigate the adverse consequences of free movement of capital, within the EU but also in broader contexts. This option can also be seen as a more modest version of the one analyzed before, where full tax harmonization was achieved. Here, instead, tax rates or (minimum) 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, with EU member states keeping full discretion over labour income taxation and public spending. 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:

$$g_j(t) + h_j(t) = \tau^K k_j(t) + \tau_j^L w_j(t) l_j(t) \tag{2b}$$

Which can again be rewritten as:

$$g_j(t) = \beta_j \Big[\tau^K k_j(t) + \tau_j^L w_j(t) l_j(t)\Big] \tag{2b'}$$

$$h_j(t) = (1-\beta_j) \Big[\tau^K k_j(t) + \tau_j^L w_j(t) l_j(t)\Big] \tag{2b"}$$

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, sub-central governments will compete to attach mobile factors through labour income tax rates and, again, through the composition of public spending:

$$(\tau^{L^*}, \beta^*) = \underset{(\tau_j^L, \beta_j)}{\arg\max} \left\{ A\alpha \Big[\beta_j \Big(\tau^K + \frac{\tau_j^L}{1-\tau_j^L}\omega_j\Big)\Big]^{1-\alpha} - \tau^K \right\} \tag{10b}$$

Again, the only equilibrium for the composition of public spending is achieved for $\beta_j = 1$. Furthermore, similarly to the decentralization case presented above, the race to maximize the rate of return on capital will 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 $\tau_j^L, \beta_j = 1$[25]. Hence, capital tax harmonization, by not eliminating one critical source of tax competition - or, in other words, by not being able to prevent that sub-central governments engage in a competition for capital using labour income taxation and set the highest possible tax rates on this factor ($\tau_j^L = 1$) -, will result in the lowest after-tax wage-capital ratio ($\omega_j = 0$). This result is thus similar to case of full fiscal decentralization. Before moving on to the final tax harmonization option, it is important to stress again that both full fiscal decentralization and capital tax harmonization will

[25]To avoid this result, we could have a utility function featuring a disutility of labour supply. The key result would, however, remain qualitatively similar. Labour income taxes would again be set to the maximize the rate of return on capital, which would be the maximum tax rate tolerated by individuals, now with a trade-off between higher tax revenues and the disincentive to work.

entail maximum income and consumption inequality between individuals with different initial capital endowments.

2.5.3 Labour income tax harmonization

Labour income tax harmonization is perhaps a less commonly discussed option in this context. Within the EU, in particular, a few modest common labour market initiatives have certainly been put forward over the whole European economic integration process. The recent discussions on a common European unemployment insurance mechanism (e.g. Abraham et al. 2018a) can also be interpreted as a form of labour market integration. Labour income tax systems are, however, generally perceived to be largely part of a set of issues that are bound to be under the discretion of national governments. Similarly, in federal countries, regions or states are often left with significant discretion over labour income tax rates and regulations. This scenario can be viewed once again as a by-product of full tax harmonization. Common tax rates or tax thresholds are instead set only over labour income, rather than capital. In the European context, this would imply common labour income taxation principles and an equalization of EU labour income tax rates, as well as labour market regulations. This would leave full discretion to EU member countries on capital taxation and, as before, over public spending. If we formalize again the problem in terms of the budget constraints and objective function for sub-central governments, we obtain the following:

$$g_j(t) + h_j(t) = \tau_j^K k_j(t) + \tau^L w_j(t) l_j(t) \tag{2c}$$

The (consolidated) budget constraint can again be divided into two different budget constraints:

$$g_j(t) = \beta_j \Big[\tau_j^K k_j(t) + \tau^L w_j(t) l_j(t)\Big] \tag{2c'}$$

$$h_j(t) = (1-\beta_j) \Big[\tau_j^K k_j(t) + \tau^L w_j(t) l_j(t)\Big] \tag{2c"}$$

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:

$$(\tau^{K*}, \beta^*) = \underset{(\tau_j^K, \beta_j)}{\arg\max} \left\{ A\alpha \left[\beta_j \left(\tau_j^K + \frac{\tau^L}{1-\tau^L}\omega_j\right)\right]^{1-\alpha} - \tau_j^K \right\} \tag{10c}$$

Again, the equilibrium achieved features $\beta_j = 1$. Hence, any scenario with public spending powers devolved to sub-central governments will imply that all tax revenues are spent exclusively on productive public goods. Under this framework, interjurisdictional competition for capital precludes spending on merit goods. Yet, contrary to full fiscal decentralization and to capital tax harmonization, the race to maximize the rate of return on capital does not also entail any longer a race to the top in labour income taxation. 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 labour tax base 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 numerical simulations, we will compare the above results and devote particular attention to their implications from an EU policymaking perspective.

2.5.4 Simulation of tax harmonization policies

In order to highlight the main qualitative features of the various different tax harmonization environments just described, we will now turn to the graphical illustration of a numerical simulation of our model. 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[26].

The capital tax harmonization case, outlined in the previous section, is depicted in Figure (5). Looking at the two surfaces plotted in the graph, we can identify two key facts. On the one hand, capital tax harmonization leads to a race to the top in labour income taxation, in order to maximize the rate of return on capital. This happens irrespectively of the level at which capital tax rates are harmonized. 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. This suggests that a scenario under which only capital taxation is harmonized, both at the rate and the base level, is likely to amplify the competition for capital over labour income tax rates.

The scenario of labour income tax harmonization is in turn illustrated in Figure (6). Looking again at the two surfaces, we can observe that this leads to a

[26] 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 B.

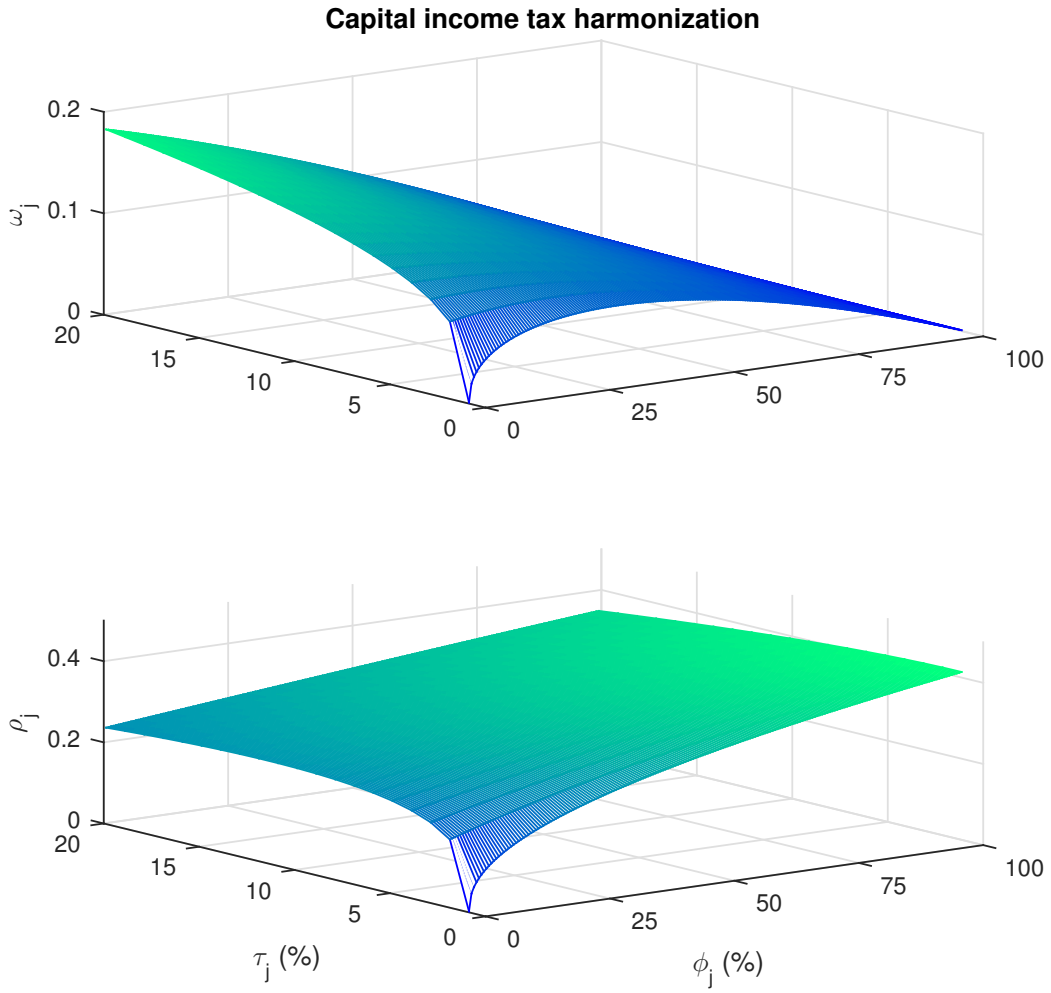

Figure 5: Capital tax harmonization (τ_j - capital tax, ϕ_j - labour income tax) - after-tax wage-capital ratio (ω_j) and net rate of return on capital (ρ_j). The level of the (after-tax) wage-capital ratio (top graph) and the net rate of return on capital (bottom graph) are plotted for different values of the labour income tax rate and the capital tax rate. With capital tax harmonization, i.e. holding τ_j constant, it can be observed that there is a "race to the top" in ϕ_j so to maximize the net rate of return on capital (bottom graph), leading to a progressive decrease in the (after-tax) wage-capital ratio.

markedly different outcome. On the one hand, labour income tax harmonization does not necessarily result in a race to the bottom in capital taxation. One can observe instead, by considering different levels of labour income taxation along the axis, that sub-central jurisdictions do no longer have the incentive to engage

in a race to the bottom in capital taxation. Instead, for most levels of the labour income tax the growth-maximising policy set implies a positive capital tax rate in equilibrium, $\tau_j^K > 0$.

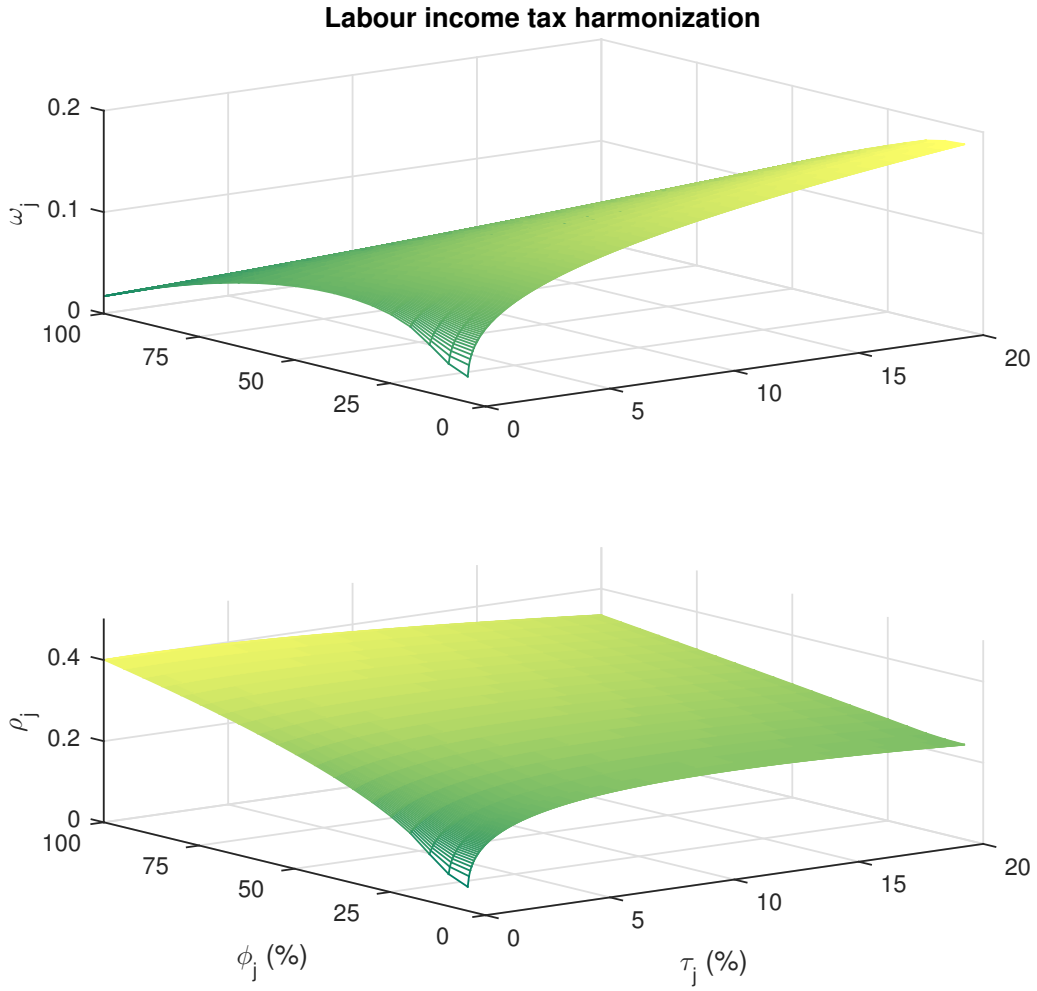

Figure 6: Labour tax harmonization (τ_j - capital tax, ϕ_j - labour income tax) - after-tax wage-capital ratio (ω_j) and net rate of return on capital (ρ_j). The level of the (after-tax) wage-capital ratio (top graph) and the net rate of return on capital (bottom graph) are plotted for different values of the labour income tax rate and the capital tax rate. With labour income tax harmonization, i.e. holding ϕ_j constant, it can be observed that there might be a non-zero capital tax rate, τ_j, that maximizes the net rate of return on capital (bottom graph), for small enough levels of labour income taxation. Holding ϕ_j constant also implies that the (after-tax) wage-capital ratio does not follow a decreasing path with the (constrained) maximization of the net rate of return on capital.

On the other hand, the after-tax wage-capital ratio is not driven to zero, which precludes the extreme result observed in the previous scenarios, under which 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 $\beta_j = 1$.

2.6 Conclusions

Is fiscal decentralization good for economic growth? The forces of tax competition suggest this is indeed the case. When some productive factors enjoy free mobility, government can use their tax and spending powers to attract these factors to their own jurisdictions. This also implies that the fiscal discretion of jurisdictions becomes constrained by the free mobility of mobile factors across borders. Economically integrated jurisdictions will thus tend to reduce the tax burden on mobile factors and increase the tax burden on immobile factors of production. The choice over public expenditures also becomes constrained. Jurisdictions facing full capital mobility will be driven to implement pro-growth over redistributive policies. Hence, fiscal decentralization in a world of perfect capital mobility is growth-maximizing. This was labeled as the Political Trilemma of the World Economy (Rodrik, 2000). Closer to the public finance tradition, this is the primary driving force at the heart of the idea of market-preserving federalism (Weingast, 1995).

Where does the EU stand in this discussion? The trends over the past decades clearly indicate that EU countries have already undertaken a first wave of large-scale corporate tax rate cuts. This was frequently accompanied by tax base en-

largements and, perhaps more importantly, by an expansion towards other tax revenue sources, for instance to consumption and labour income taxation. The largest reductions in corporate tax rates in the past decades across OECD countries were indeed observed within this area, not least because of the degree of geographical, regulatory and economics proximity between jurisdictions. In this context, the EU presents itself as a unique laboratory for exploring the effects of tax competition, The creation of the European Single Market, with perfect mobility of goods and factors of production, 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 taxes on capital or through taxes falling on labour. Existing data suggests that larger countries, facing substantial competition from neighbouring jurisdictions, are already engaging in more aggressive tax setting behaviour. Furthermore, the tax reforms in the United States, as a distinct foreign competitor, are likely to trigger a EU response. The re-appearance of this issue in the policy agenda of many EU countries suggests that these trends are unlikely to be toned-down in the foreseeable future.

This paper points towards various directions. The current status quo, with countries enjoying full fiscal discretion to compete for capital, is likely to produce the highest aggregate growth, while exacerbating economic inequalities. At the other end, jurisdictions can aim for further centralization of fiscal powers. In the EU, this could eventually lead to a fiscal union, which many have argued would be the most desirable way to complement the existing monetary union. Yet,

political feasibility and a long tradition of gradual institutional change is likely to hinder such a large shift of fiscal powers from national jurisdictions towards a federal level. Nonetheless, between the current institutional setting of nearly full national fiscal discretion and a complete fiscal union, a wide array of options is at the disposal of policymakers. The arduous task of trying to mitigate the harmful effects of aggressive tax competition between jurisdictions, while leaving room for sufficient fiscal discretion at the national level, seems to bring forward tax harmonization as an increasingly worthy candidate, at the EU level but also more broadly.

But which taxes should be harmonized? The present paper explores various available options. Full tax harmonization - which would likely prove difficult to achieve even between economically integrated jurisdictions like the EU - would be equivalent to a partial fiscal union. In this scenario, all tax rates would be set centrally or agreed upon in multilateral tax agreements between jurisdictions and national governments would keep (*de jure*) discretion over the composition of public spending. As we have shown, this does not correspond to a *de facto* discretion over public spending, as the public provision of merit goods would be severely constrained 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 immobile tax bases are effectively taxed away to subsidize capital. With fully integrated capital markets, the harmonization of labour income taxes and regulations provides the only option able to prevent in practice a subsidy to capital owners, through heavier labour taxation and looser labour market regulations. In the EU, but also elsewhere, any

decisions on tax harmonization will thus necessarily depend on the ultimate policy objectives of governments and voters. The policy options presented in this paper have been kept simple to ensure model tractability. In order to assess the wider welfare implications of each of these tax harmonization options, a richer model is no doubt needed. Moreover, within each of different scenarios proposed here, several options may be at the disposal of policymakers and worth exploring in this context. One issue is clear however from our analysis: growing interjurisdictional capital mobility and tax competition bring important constraints to the difficult trade-off between economic growth and redistribution.

III

On the Design of a European Fiscal Harmonization Agreement

III On the Design of a European Fiscal Harmonization Agreement

Abstract

Fiscal competition can bring large welfare losses and imply significant shifts in tax and spending structures of developed economies. Some form of fiscal coordination is thus commonly advocated in order to prevent such type of non-cooperative Nash equilibria. But how should policymakers design a fiscal harmonization agreement in the European Union? Recent tax harmonization proposals have focused on corporate income tax harmonization. This paper proposes a different approach. Several policy scenarios are examined within an endogenous growth model with flexible labour supply calibrated for the EU economy. Two main messages emerge from the policy simulations. Firstly, capital income tax harmonization is no panacea. Indirect taxes, such as VAT, should become priority targets of fiscal reforms proposals. Secondly, expenditure side reforms are also needed. Even limited EU budget increases, such as the introduction of common welfare programmes like a European-wide unemployment insurance system, can go a long way in preventing significant welfare losses from fiscal competition.

3.1 Introduction

Deepening economic integration in an environment of nearly perfect capital mobility brings new challenges for policymakers. Governments may be tempted in this context to compete with each other for mobile resources and tax bases, trying to offer the highest rate of return or lowest price on these factors, namely by providing investment subsidies or productivity-enhancing public investments, and undercutting each other's capital income taxes. The downward trend in corporate tax rates in the past decades, seen namely across the European Union (EU) as the rules of the Single Market entered into force and removed any lasting capital controls, certainly seems to confirm the latter incentive. Aggressive tax

competition may generate adverse effects for all countries and imply large welfare losses. Furthermore, becoming the main driver of national fiscal policies, it may culminate in significant shifts in the tax and spending structures of different governments. Against this background, several tax harmonization initiatives have been proposed and debated by European policymakers. While these contributions have taken several forms over the years and the discussion has evolved since the early Tinbergen Report in 1953[27] or the proposals put forward by the Ruding Committee (Ruding, 1992), one common denominator can readily be identified: all the tax harmonization proposals have mostly focused on capital income taxation.

Either of the form of tax base harmonization (Bettendorf et al., 2010), the aim of the so-called CCCTB project, or through more ambitious tax rate harmonization proposals (Sørensen 2000, 2004, Zodrow 2003, Mendoza and Tesar 2005, Conconi et al. 2008, Haufler and Lülfesmann 2015), the literature can be said to reach a common ground: in principle, tax harmonization can deliver non-negligible welfare gains, particularly at the bottom of the income distribution (Sørensen, 2000). In practice, however, it may prove politically very challenging to achieve a common European agreement on the matter. The recent hesitant movements towards tax base harmonization certainly seem to confirm this issue. At the EU level, the recent sovereign debt crisis has also relaunched the debate on fiscal reform (Van Rompuy et al. 2012, Juncker et al. 2015, European Commission 2017a, 2017c, Bénassy-Quéré et al. 2018) and several proposals for completing the Economic and Monetary Union have recently been put forward (Allard et al. 2013,

[27] Written in the wake of the Treaty of Paris, in 1951, which established the European Coal and Steel Community, this report is formally known as the "Report on the Problems Raised by the Different Turnover Tax Systems Applied Within the Common Market", and was chaired by the Dutch economist and Nobel-prize winner Jan Tinbergen.

Bargain et al. 2013), focusing mostly on the macroeconomic stabilization properties of such reforms (Farhi and Werning 2017, Abraham et al. 2018b), and in particular on the optimal design of a common European unemployment insurance system (Beblavý and Maselli 2014, Abraham et al. 2018a, Dolls et al. 2018).

This paper studies the scope for tax harmonization in the EU and, in particular, the consequences of different tax harmonization scenarios are investigated. From the lenses of an endogenous growth model with flexible labour supply, government fiscal policies are obtained as a product of government expenditure composition and choices of consumption, capital and labour income tax rates. The endogeneity of labour supply is an essential ingredient to obtain real effects of government consumption expenditure (Turnovsky, 2000)[28].

Our analysis of fiscal policy focuses on three main issues. First, we characterize optimal fiscal policy in steady state and we calibrate our growth model for the average EU economy. Consumption and leisure should be taxed uniformly at the optimum. Furthermore, with government expenditures set at their optimal levels, capital should not be taxed. We show that moving from the current benchmark to optimal fiscal policy would generate significant welfare gains. This would also imply significant shifts in the tax structures of EU economies, namely in labour income tax structures and consumption tax rates. It would also lead to large changes in revenue sources, from a system predominantly reliant on income tax revenues towards an indirect tax system, heavily reliant on consumption taxes.

Secondly, we focus on the role of tax competition between EU countries. In a context where capital is fully mobile, households will aim to invest their capital

[28] We consider two main types of expenditure. Government *consumption* expenditure can be thought as government expenditure with a welfaristic nature, on merit goods and income maintenance. Government *production* expenditure has a productive character and can include public infrastructure, as well as R&D expenditure or targeted training programmes.

in those jurisdictions that offer the highest (after-tax) rates of return. Hence, jurisdictions compete with each other to attract mobile factors. Without any form of tax coordination, jurisdictions are driven into a form of non-cooperative Nash equilibrium, where governments shift their tax and spending structures to benefit (mobile) production factors, at the expense of income distribution and of expenditure on public goods that directly benefit (immobile) households. As economies converge to this equilibrium, we observe that this implies a large subsidization of capital, either through direct subsidies or, alternatively, through higher-than-optimal productive public expenditure, working effectively as a form of indirect capital subsidization. This tax competition equilibrium also implies very high taxes on consumption and a "race to the bottom" in government consumption expenditure, which lead to potentially substantial welfare losses.

Finally, we analyse several different scenarios of fiscal harmonization and how these might restrain competitive pressures at the country level and help to prevent the large welfare losses implied by unfettered fiscal competition between EU countries. The results from our "theory with numbers" exercise point towards several directions. Capital income tax harmonization, implying a common tax rate (or a minimum tax threshold) on capital income for all EU countries necessarily avoids a race to bottom in capital taxation. Yet, it implies a shift of fiscal competition towards immobile tax bases and towards *de facto* subsidies to capital, through an over-investment in productive public goods. Other options studied in this context are the harmonization of labour income tax and of consumption tax rates. Both lead to qualitatively similar effects, as these can be seen as implicit taxes on consumers. On their own, the harmonization of consumption or labour income tax rates can lead to smaller welfare losses than capital tax harmonization.

This can be explained by the fact that a race to the top in taxes on consumption and leisure is avoided. The harmonization of consumption taxes, in particular, dramatically restrains the scope for over-investment on productive public goods and thereby minimizes potential welfare losses from fiscal competition.

The above tax harmonization scenarios fail to tackle another important distortion introduced by interjurisdictional fiscal competition: the race to the bottom in government consumption expenditure. In this vein, expenditure-side fiscal reforms are also considered. Even a fairly limited increase in the EU budget, with consumption-targeted expenditures, delivers interesting welfaristic properties, particularly when coupled with consumption tax harmonization. The optimal fiscal harmonization scenario implies a significant increase in the EU budget, with consequently a greater need for expanding EU own resources, for instance via the centralization of consumption tax revenues. In this case, EU countries, with full discretion over income taxes and government expenditures, are also induced to set taxes and government production expenditures optimally.

Having shed light on the implications of potential tax harmonization and expenditure-side fiscal reforms - which could, in principle, be implemented in a federation of countries like the EU -, the question of income inequality and redistribution still remains. Optimal fiscal harmonization in the EU may imply consumption rather than capital or labour income tax harmonization and a larger federal budget. Yet, this scenario also implies zero capital income taxes, in equilibrium. The current model is silent on the distributional effects of these fiscal reforms. However, acknowledging that the harmonization of consumption taxes may imply very large shifts in VAT structures across the EU, one possible avenue to explore is to consider the introduction of progressive consumption tax-

ation in the EU context[29]. This might not only be more feasible at the federal rather than at the country level, but it has the benefit of financing both the EU and national budgets through a tax scheme that, absent lump-sum, discriminatory or extensive time-consistent wealth taxation, potentially implies the least distortive properties. Another possible avenue for further fiscal reforms brings us to the realm of wealth taxation (Diamond and Saez, 2011). This paper somehow complements this literature, particularly in the context of fiscal competition, by shedding light on the potentially malign implications of focusing solely on capital income tax harmonization at the EU level.

In the next section, the recent taxation trends in the EU are re-assessed. In the third section, the model is presented and the main mechanisms through which fiscal policy works are examined. In the fourth section, the issue of optimal fiscal policy is addressed. The framework for the model simulations is also set, as the benchmark calibration is discussed. The equilibria under the benchmark scenario, optimal policy and tax competition are then explored. In the fifth section, we discuss different fiscal harmonization scenarios and explore their implications in detail, before offering some concluding remarks, in the final section.

3.2 Data and motivation

Corporate income tax (CIT) rates have been steadily declining in the European Union since the early 1980s. The average EU-28 statutory CIT rate is 21.9% in 2017, down from 34.7% in 1995. Going further back, the average statutory CIT rate in the EU was above 50% in 1982[30].

[29]This goes along the recent discussion on progressive taxation and proposals by Auerbach and Hassett (2015), Mankiw (2015), Piketty (2015), or Fullerton et al. (1983).

[30]The reported averages going back to the period prior to 1995, reflect the available data gathered by the Institute for Fiscal Studies for Austria, Belgium, Finland, France, Germany, Greece, Italy, Netherlands, Portugal,

As can be seen from Figure 7, EU CIT rates have been steadily declining over the period. Furthermore, a convergence of CIT rates can also be observed, particularly since the mid-1990s. Looking at individual country paths uncovers another characteristic of this downward trend in CIT rates. With the exception of France, the general downward trend in CIT rates appears more volatile in 'peripheral' than in 'core' EU economies (Figures C.1, C.2 and C.3 in Appendix). Four out of the five EU core economies saw their CIT rates gradually decrease over the 35-year period, with little or no temporary spikes. In addition, while the three largest economies - France, Germany and the United Kingdom - had started the period with CIT rates above 50%, these were all below 40% by the late 1990s (2001, in the case of Germany), converging with the CIT rates in 'peripheral' economies. The latter had CIT rates around 40% already in the early 1980s (with exception of Portugal) and saw this gap close significantly until the late 1990s. Together, these factors can explain the fast convergence of EU CIT rates in the late 1990s, shown in Figure 7.

The case of Italy is perhaps the more peculiar, with an increase in the top statutory CIT rate from below 40% in 1982 to above 50% until 1997. On the other hand, Finland and Sweden more than halved their top statutory CIT rates during that period, coinciding with the pre-accession to the EU and the Single Market. A similar, but less pronounced, path can also be observed in Austria. By the early 2000s, all the twelve EU countries had CIT rates below 40%. Ten out of the twelve countries had CIT at or below 30% in 2017. The exceptions are Belgium and France, which stand out as the two EU countries with highest CIT rates.

Spain, Sweden, United Kingdom, and Norway. For comparison purposes, the US statutory CIT rate was 49.6% in 1982, falling to 38.4% in 1987 and remained broadly constant until 2017.

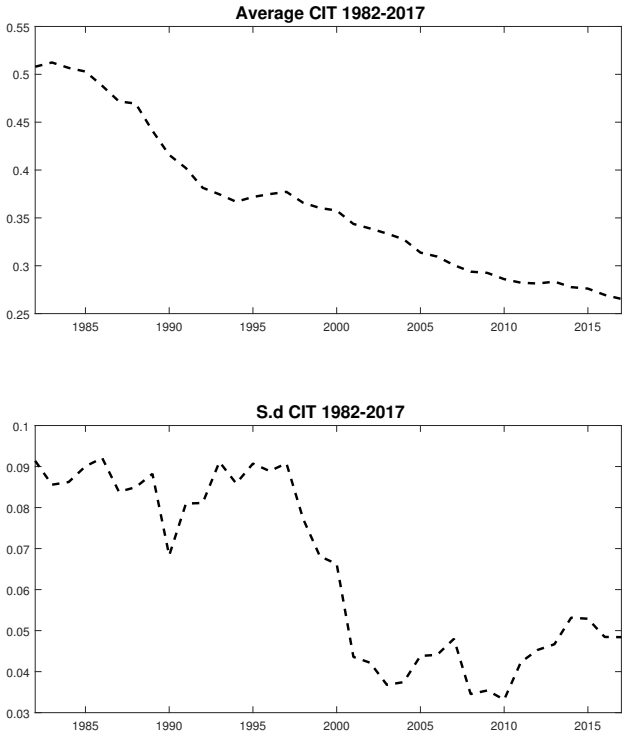

Figure 7: Average and standard deviation of top statutory corporate income tax (CIT) rates in EU countries (1982-2017). Country coverage: Austria, Belgium, Finland, France, Germany, Greece, Italy, Netherlands, Portugal, Spain, Sweden and the United Kingdom. The figure depicts a global downward trend in corporate taxation across the EU, which is accompanied by a period of marked convergence of top statutory CIT rates since the late 1990s.

Turning our attention to the EU-28 countries (together with Iceland and Norway), Figure 8 shows a similar picture, from 1995 to 2017. The four largest EU economies saw their average top statutory CIT rates decline steadily over the period, despite a temporary spike in France in the early 2010s (Figure C.4). A similar picture emerges from the Benelux and Austria, with the largest drops observed during the early 2000s (Figure C.5). In the case of Nordic countries, Denmark and Iceland were the only countries with top statutory CIT rates above 30% in 1995, and saw these rapidly converge to levels below 25% by 2017, with

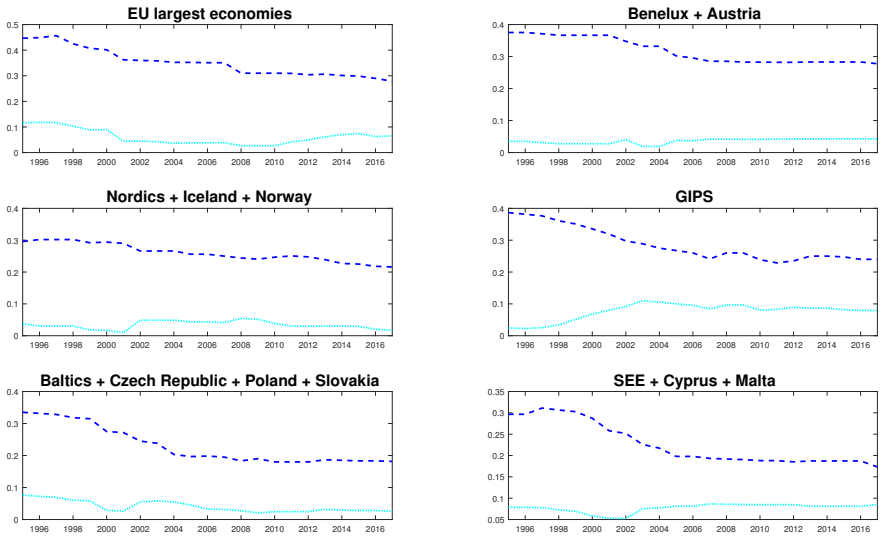

Figure 8: Top statutory corporate income tax (CIT) rates in the EU-28 (1995-2017). Country coverage: all EU-28 countries plus Iceland and Norway. EU-28 countries are divided into country groups. The four EU largest economies are France, Germany, Italy and the United Kingdom. Belgium, the Netherlands and Luxembourg (Benelux) are grouped with Austria. The three Nordic countries - Denmark, Finland and Sweden - are grouped with Iceland and Norway. The GIPS countries include Greece, Ireland, Portugal and Spaon. The three baltic countries - Estonia, Latvia and Lithuania - are shown together with the Czech Republic, Poland and Slovakia, forming the group of North Eastern European (NEE) economies. South Eastern European (SEE) economies include Bulgaria, Croatia, Hungary, Romania and Slovenia, as well as Cyprus and Malta. The figure depicts a global downward trend in corporate taxation throughout the period, broadly accompanied by a convergence of tax rates within country groups, with the exception of GIPS countries.

all five countries showing top CIT rates within a narrow 5% interval (Figure C.6).

In turn, the only lasting period of divergence in CIT rates can be observed in the so-called GIPS countries. This can largely be attributed to the progressive decrease in the top statutory CIT rate in Ireland, from 40% in 1995 to 12.5% in 2003[31]. Yet, by 2010 all remaining countries had top statutory CIT rates at or below 30%[32]. Finally, the Eastern European economies also experienced large CIT rate drops, with most of the convergence occurring in the late 1990s and early

[31]Focusing on top statutory CIT rates hides, however, the full Irish story. A special 10% CIT rate was in fact introduced in 1981, initially only for manufacturing companies, but later extended to include, for instance, financial services. This replaced the previous 'Export Sales Relief' system, first introduced in 1956, under which all exports were effectively exempt from corporate taxation. Yet, the special 10% rate also had to be phased out under EU laws and was replaced by the current 12.5% corporation tax, which applies to all firms' trading profits.

[32]The temporary spike in Greece and Portugal after 2010 is most likely to reflect short-term budgetary pressures and can be traced to the peak of the EMU sovereign debt crisis and the conditional bailout programmes (Figure C.7).

2000s, again coinciding with the pre-accession period. Hungary, in turn, with the lowest top statutory CIT rate of all Eastern European economies at the beginning of the period, already below 20% in 1995, halved its top statutory CIT rate to just above 10% in 2017, making it the EU country with the lowest top statutory CIT rate (Figures C.8 and C.9)[33]. Thus, with somehow different timings and despite some temporary spikes seen in some countries, top statutory CIT rates have been fastly declining in the EU.

The fall of top statutory CIT rates is observed across most OECD countries and has been focus of substantial research (Devereux et al. 2002, Devereux et al. 2008, Overesch and Rincke 2011). Virtually all OECD countries have reduced their CIT rates between 1982 and 2007 (Loretz, 2008) and recent reports show evidence of increasing tax competition in recent years within the EU (OECD, 2017). In the opposite direction, the average tax-to-GDP ratio amongst OECD countries reached 34.3% in 2016, the highest level ever recorded. The share of personal income taxes, social security contributions and value-added taxes are at their highest point, at around a quarter of GDP on average, or three quarters of total tax revenue. Namely, VAT revenues reached a peak of nearly 7% of GDP, or about a fifth of total tax revenues (OECD, 2016). The sources of tax revenue have thus been dramatically changing over the last decades.

Personal income tax (PIT) rates have shown interesting paths over the last decades. Underlying the general downward trend that can be observed across the EU, particularly from 1995 until the late 2000s, top statutory PIT rates have been diverging significantly since the early 2000s (Figure 9). Disaggregating by country groups, allows us to get a neater picture of what happened over this

[33]The notable exceptions to this trend are Malta, with a flat rate of 35% over the entire period, while Estonia and Slovenia had a somewhat delayed response, just after 2004.

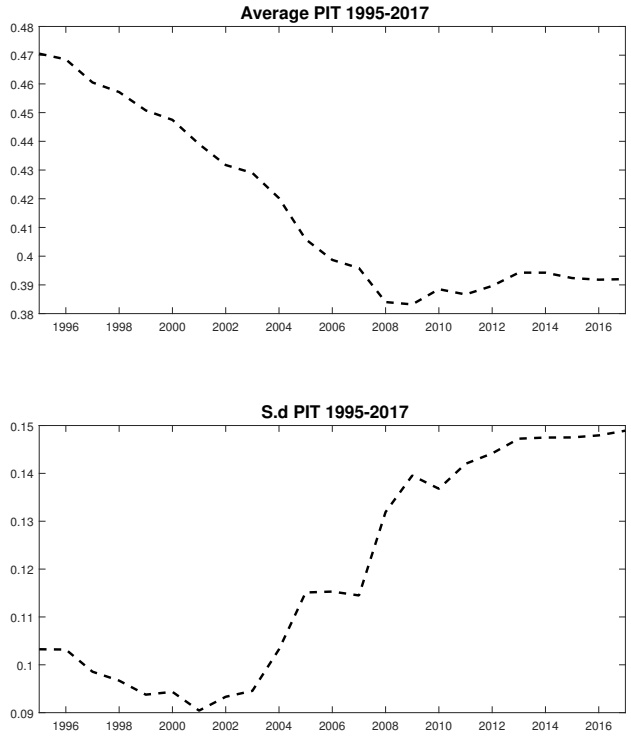

Figure 9: Average and standard deviation of top statutory personal income tax (PIT) rates in EU-28 countries (1995-2017). Country coverage: all EU-28 countries plus Iceland and Norway. The figure depicts a global downward trend in personal income taxation, accompanied by a considerable divergence of top PIT rates since the early 2000s.

period, particularly since the early 2000s, when top statutory PIT rates started to diverge. Looking at the bottom two graphs of Figure 10, we can immediately disentangle a decreasing trend in Eastern European countries which started, by and large, in the late 1990s and lasted until the late 2000s[34].

Five out of the eleven Eastern European economies more than halved their top statutory PIT rates during this period and all had lower PIT rates in 2017 than in 1995, with the exception of Slovenia. The remaining four graphs in Figure 10 show

[34]The divergence in top statutory PIT rates of SEE countries can be explained by the relatively high top PIT rates of Croatia and Slovenia, which remained in the 40-50% band throughout the entire period. In the same period, for example, Bulgaria, Hungary and Romania more than halved their top PIT rates, from 40-50% to 10-20%. Malta maintained a constant 35% rate, while Cyprus slightly decreased the top PIT rate from 40 to 35% (Figure C.15).

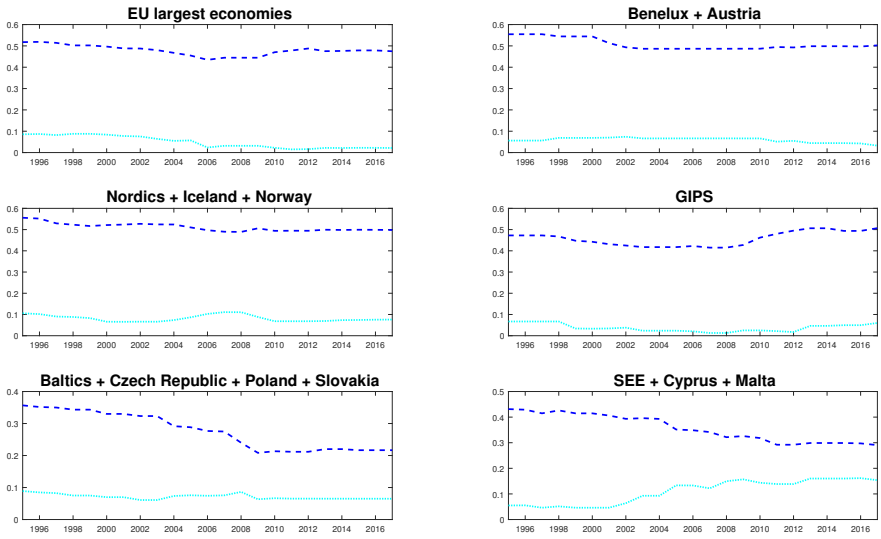

Figure 10: Top statutory personal income tax (PIT) rates in the EU-28 (1995-2017). Country coverage: all EU-28 countries plus Iceland and Norway. EU-28 countries are divided into country groups. The four EU largest economies are France, Germany, Italy and the United Kingdom. Belgium, the Netherlands and Luxembourg (Benelux) are grouped with Austria. The three Nordic countries - Denmark, Finland and Sweden - are grouped with Iceland and Norway. The GIPS countries include Greece, Ireland, Portugal and Spaon. The three baltic countries - Estonia, Latvia and Lithuania - are shown together with the Czech Republic, Poland and Slovakia, forming the group of North Eastern European (NEE) economies. South Eastern European (SEE) economies include Bulgaria, Croatia, Hungary, Romania and Slovenia, as well as Cyprus and Malta. The figure shows that the downward trend in the EU can be mostly attributed to the considerable slump in top PIT rates in Eastern European economies. The divergence of tax rates within the EU, can also be explained by the fall of top PIT rates in both NEE and SEE economies, as well as the recent increases in GIPS countries.

no clear marked trend. It is worth noting however the convergence of PIT rates in the four largest economies in the EU towards the 45-50% level, mostly explained by the large drops in France and Germany (Figure C.10). On the other hand, GIPS countries experienced a slight increase in top PIT rates over the period, particularly in the 2008-2012 period.

Consumption tax rates, unlike CIT or PIT rates, followed a markedly increasing path across the EU, between 2000 and 2017 (Figure 11). Most notably, this increase in VAT rates is common to all country groups (Figure 12). Furthermore, with a few exceptions, all countries have increased their VAT rates over this

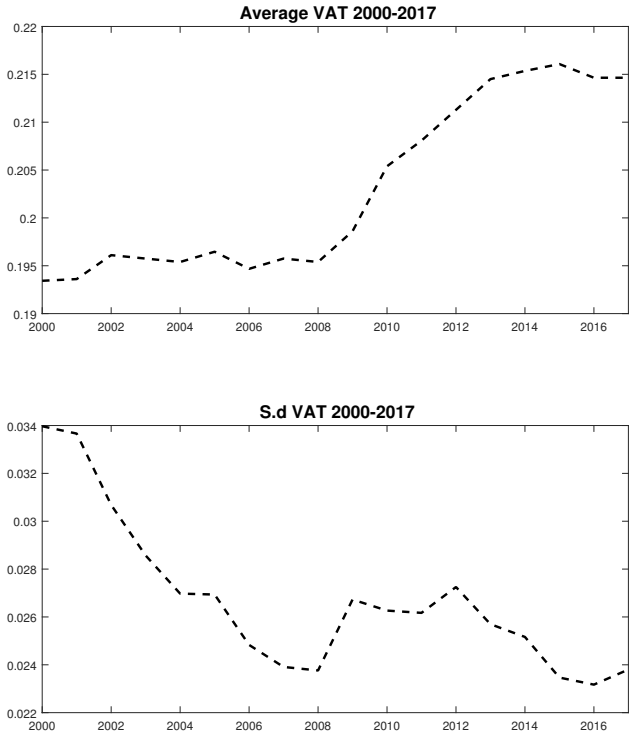

Figure 11: Average and standard deviation of top value added tax (VAT) rates in EU-28 countries (2000-2017). Country coverage: all EU-28 countries. The figure depicts an upward trend in personal income taxation, accompanied by a convergence of top VAT rates since the early 2000s.

period[35]. Illustrating this fact is that all but five EU-28 countries have VAT rates at or above 20% in 2017, while in 2000 only thirteen countries had VAT rates above this level.

The trends in CIT, PIT and VAT rates described above point very clearly towards several directions. First of all, the secular decrease in CIT rates across the EU-28 is clear. Secondly, top statutory PIT rates have also steadily decreased across the EU-28. While these drops were felt most strongly in Eastern European countries, they were also a common feature of recent tax developments in Nordic

[35]Austria, Belgium, Denmark, Sweden and Bulgaria have maintained VAT rates constant between 2000 and 2017, at levels at or above 20%. Czech Republich and Slovakia are the only countries which experienced an overall decrease in VAT rates over this period (Figures C.16-C.21).

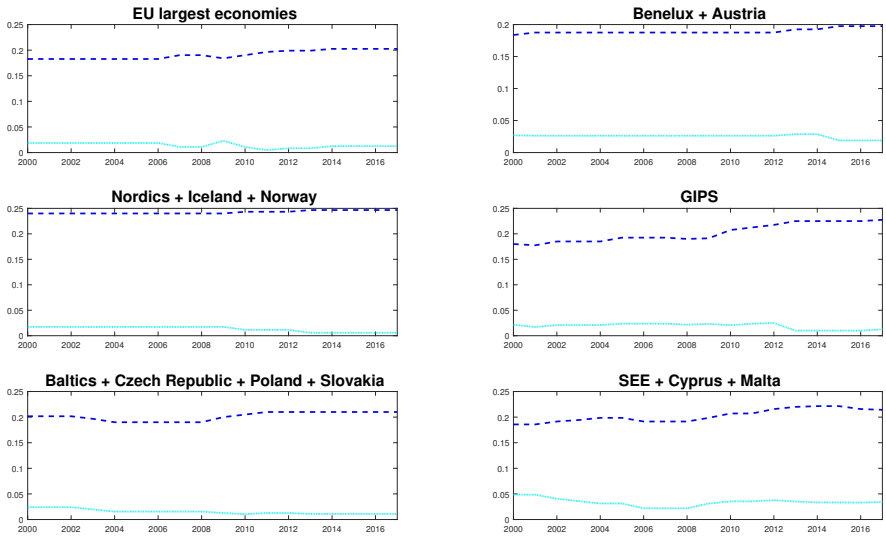

Figure 12: Top value added tax (VAT) rates in the EU-28 (2000-2017). Country coverage: all EU-28 countries plus Iceland and Norway. EU-28 countries are divided into country groups. The four EU largest economies are France, Germany, Italy and the United Kingdom. Belgium, the Netherlands and Luxembourg (Benelux) are grouped with Austria. The three Nordic countries - Denmark, Finland and Sweden - are grouped with Iceland and Norway. The GIPS countries include Greece, Ireland, Portugal and Spaon. The three baltic countries - Estonia, Latvia and Lithuania - are shown together with the Czech Republic, Poland and Slovakia, forming the group of North Eastern European (NEE) economies. South Eastern European (SEE) economies include Bulgaria, Croatia, Hungary, Romania and Slovenia, as well as Cyprus and Malta. The figure shows the upward trend in VAT in the EU is common across most country groups. The general convergence of VAT tax rates within the EU is also a common feature across different country groups.

countries, France, Germany and the Benelux. The observed divergence in PIT rates is perhaps best explained as a product of the large drops in Eastern Europe since the late 1990s, rather than by the increase in PIT rates of GIPS countries after 2008, which appears to be rather cyclical. Finally, the increasing trend in VAT rates is common to virtually all EU-28 economies. Although this shift seems more modest in terms of scale, it became particularly strong in the last decade, as the average EU-28 VAT rate increased by 2 percentage points (Table 1), and comparable to the generalized drops in CIT rates in terms of scope, as 26 out of 28 EU economies have maintained or increased their VAT rates during the period. Looking at effective tax rates confirms the trends identified above. In addition,

the observed rise in effective labour tax rates between 2007 and 2017, together with the marked fall in top statutory PIT rates documented since 1995, points towards a decrease in progressivity in labour income tax schedules across the EU.

Table 1: Average EU-28 tax rates (1982-2017). Country coverage: all EU-28 countries. As for 1982, the same sub-sample of EU countries from Figure 7 is used. Effective tax rates are taken from the Taxation Trends in the European Union report (EC - DG Taxation and Customs Union, 2018). The methodolody for computing implicit and effective tax rates is in accordance with standard practice, explained in detail in Appendix B of the abovementioned report. This table confirms the trends described above: the marked decrease in top-statutory CIT rates since the early 1980s is a result of two large waves of CIT rate decreases, firstly in the late 1980s and early 1990s, and then in the early 2000s. The decrease in PIT rates appears to have been stronger until the late 2000s and have stabilized since then. On the other hand, the increase in VAT rates appears stronger after the late 2000s. Available computations of effective tax rates seem to broadly follow these trends.

Top statutory tax rates	1982*	1995	2000	2007	2017
CIT	50.8%	34.7%	31.8%	24.3%	21.9%
PIT		47.1%	44.7%	39.6%	39.2%
VAT			19.3%	19.6%	21.5%
Effective tax rates				**2007**	**2017**
Capital				22.1%	20.1%
Labour				35.4%	36.1%
Consumption				19.5%	20.6%

3.3 Model

Introducing flexible labour supply into a model of endogenous growth implies that the equilibrium growth rate of the economy is now influenced by all fiscal variables introduced in this framework, namely taxes on capital income, labour income, and consumption, and both government consumption and production expenditure. This allows our model to better capture the real effects of taxes and government expenditure on the economy. Capital, labour income, and consumption taxes can however produce different general equilibrium effects, both of different magnitudes and through different mechanisms. In addition, government

expenditure on both consumption and productive goods also becomes part of the trade-off loci that describe and determine the equilibrium of the economy. Thus, different types of government expenditures also have different effects on aggregate variables. These two features are of particular relevance in the context of our analysis of optimal fiscal policy and of different fiscal harmonization scenarios.

Several papers have introduced endogenous labour supply into growth models (see for instance Rebelo 1991, Stokey and Rebelo 1995, Benhabib and Perli 1994, Ladrón-de Guevara et al. 1997, and Turnovsky 2000). The scope and focus of our model is most closely related to Turnovsky (2000), insofar as our ultimate goal is to analyse the effects of fiscal policy on the long-run equilibrium of an economy, through the effect of different government tax and spending decisions on growth and welfare outcomes.

3.3.1 Environment

A closed economy consists of J jurisdictions, sharing a common market. Households are born in a given jurisdiction j, $j = 1, ..., J$, and cannot move across jurisdictions. Each jurisdiction is populated by N identical households, each with an infinite planning horizon and a full understanding of the path of the economy. The representative agent in this economy is endowed with a unit of time, which can be allocated to leisure, l, or to work, $1 - l$, and capital, k_j, which is assumed to be infinitely durable. Output of the representative firm, y_j, is determined by a Cobb-Douglas production function:

$$y_j(t) = A' G_j(t)^{\alpha} k_j(t)^{1-\alpha} (1 - l_j)^{\alpha} \equiv A' \big(\frac{G_j(t)}{k_j(t)}\big)^{\alpha} (1 - l_j)^{\alpha} k_j(t) \qquad (11)$$

where $G_j(t)$ denotes the flow of productive government spending[36]. We furthermore impose the restriction $0 \leq \alpha \leq 1$. The representative firm faces perfect competition in both factors and final goods markets. Productive factors are paid according to their marginal physical products, positive but diminishing, and there are non-increasing returns to scale in private factors. We can thus write the real wage rate and the (gross) rate of return to capital as:

$$w_j = \text{MPL} \equiv \frac{\partial y_j}{\partial(1-l_j)} = \alpha \frac{y_j}{1-l_j}, \qquad r_j^k = \text{MPK} \equiv \frac{\partial y_j}{\partial k} = (1-\alpha)\frac{y_j}{k_j} \tag{12}$$

There are however constant returns to scale in capital and government production expenditure. This ensures perpetual endogenous growth, as the production function is linearly homogeneous in the two factors that can be accumulated. The government decides in each period on the share of aggregate output, g_j, to be spent on the productive public good[37]:

$$G_j(t) = g_j Y_j(t) \tag{13}$$

Combining (13) and (11), we thus obtain our expression for the aggregate output in economy j in each period t, $Y_j(t)$:

$$Y_j(t) = (A g_j^{\alpha})^{\frac{1}{1-\alpha}} (1-l_j)^{\frac{\alpha}{1-\alpha}} K_j \tag{14}$$

[36]This type of spending can be thought of any government expenditure that increases the productive potential of the economy. This can be either pure infrastructure spending or can be considered as government R&D expenditures, including on human capital formation. Furthermore, we assume that this type of government goods or services are not subject to congestion costs, so that $G_j(t)$ is a pure (productive) public good. In the spirit of AK models, the capital stock of the economy can be thought of an aggregate of physical and human capital.

[37]We focus here on the equilibrium in a decentralized market economy. Further considerations and comparisons between the equilibria under a centrally planned economy and a decentralized outcome are left to the Optimal Policy section, where optimal fiscal policy in the decentralized market economy aims to replicate the equilibrium in the centrally planned economy.

Households in the decentralized market economy purchase consumption goods and re-invest their capital out of the proceeds from after-tax income, generated by their labour and capital holdings. The objective of the representative household is to maximise her own welfare, given government decisions, which is defined by the following intertemporal isoelastic utility function:

$$\int_0^\infty e^{-\delta t} \frac{1}{\gamma} \Big[c_j l_j^\theta H_j^\eta \Big]^\gamma dt \tag{15}$$

subject to the budget constraint:

$$\dot{k}_j(t) = (1 - \tau^K_{d^i_j}) r^k_{d^i_j} k_j(t) + (1 - \tau^L_j) w_j(t)(1 - l_j) - (1 + \tau^C_j) c_j(t) - \frac{T}{N} \tag{16}$$

where τ^K, τ^L and τ^C denote the tax rates on capital income, labour income and consumption, respectively. The household's share of lump-sum taxes, T/N, is in the policy simulations set to zero[38]. In other words, the government budget constraint has to clear in every period, without resorting to deficit-financing and rulling out the use of lump-sum taxation.

Regarding capital income taxation, the subscript d^i_j on both the (gross) rate of return and the tax rate, highlights the fact that households can decide to invest their capital holdings in any of the j jurisdictions, paying the implied tax rate, according to the principle of source taxation. Hence $(1 - \tau^K_{d^i_j}) r^k_{d^i_j}$ is the average (after-tax) rate of return earned on the stock of capital $k_j(t)$ invested in each period by the representative household[39]. Finally, government consumption

[38] Even though lump-sum taxation is assumed away in the following sections, where different tax harmonization are analyzed, it is kept in the model namely in order to allow for one-off policy simulations, such as uncompensated increases or decreases in government spending shares or tax rates. The following parametric restrictions are also imposed: $-\infty < \gamma \leq 1$, $\eta > 0$, $\theta > 0$, as well as the following joint restrictions: $\gamma(1 + \eta) < 1$, $(1 + \eta + \theta)\gamma < 1$.

[39] Facing equal (after-tax) returns, households will prefer to invest in their home jurisdiction. This can be interpreted as a "home investment bias" and avoids multiple equilibria in our model.

expenditure, H_j, is also set as a fraction of aggregate output:

$$H_j(t) = h_j Y_j(t) \tag{17}$$

In the absence of debt, the government chooses tax rates and the level of government expenditures that satisfy the balanced-budget rule, in each period:

$$\tau^L N_j w(1 - l_j) + \tau^K r_k K_j + \tau_c C_j + T_j = (g_j + h_j) Y_j \tag{18}$$

Finally, before moving on to the equilibrium of the model, we can sum the household budget constraint, (16), over all the N households in the economy to obtain the aggregate resource constraint of each economy j:

$$\dot{K}_j = (1 - h_j - g_j) Y_j - C_j \tag{19}$$

3.3.2 Equilibrium

An equilibrium in this environment is achieved when firms maximise their profits, consumers maximise their utilities, and all markets clear. Furthermore, equilibrium across the J jurisdictions, implies that the after-tax rate of return on capital is equalized across all countries. With perfect capital mobility, any deviation from the equilibrium (after-tax) rate of return in a jurisdiction would imply full capital inflows into or outflows from this economy. All jurisdictions thus enter into a Bertrand competition for capital, offering the same (after-tax) rates of return. Hence, the equilibrium can be defined as a set of policies for each jurisdiction j, $(\tau_j^K, \tau_j^L, \tau_j^C, g_j, h_j)$, corresponding to a path of consumption, labour, savings and investment decisions for all individuals, $\{c_j^i(t), l_j^i(t), k_j^i(t), d_j^i(t)\}$, and wages, rental

rates and production decisions in each jurisdiction $\{w_j(t), r_j(t), y_j(t)\}$ such that (i) households maximise their 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 productivities of labour and capital and (iii) governments decide on a set of policies, taking as given the policies chosen by other jurisdictions and understanding the path of the economy resulting from those policy choices.

Carrying out the consumer optimization problem and aggregating over the N households leads to the macroeconomic equilibrium which, under plausible conditions, always lies on a balanced growth path[40]. Defining $\Omega(l_j) \equiv \frac{\alpha}{\theta(1-\alpha)}\Big(\frac{l_j}{1-l_j}\Big)$, enables us to write the following four optimality conditions, which represent the macroeconomic equilibrium in each jurisdiction j:

$$\frac{1-\beta}{\Omega(l_j)}\Big(\frac{C_j}{Y_j}\Big) = \frac{(1-\tau_j^L)}{(1+\tau_j^C)} \tag{20}$$

$$\psi_j = \frac{1}{1-\gamma(1+\eta)}\Big[(1-\tau_j^K)(1-\beta)\Big(\frac{Y_j}{K_j}\Big) - \rho\Big] \tag{21}$$

$$\psi_j = \Big[(1-g_j-h_j) - \Big(\frac{C_j}{Y_j}\Big)\Big]\Big(\frac{Y_j}{K_j}\Big) \tag{22}$$

$$\frac{Y_j}{K_j} = (\alpha g_j^{\alpha})^{\frac{1}{1-\alpha}}(1-l)^{\frac{\alpha}{1-\alpha}} \tag{23}$$

[40]In a centrally planned equilibrium, the benevolent social planner chooses the paths of aggregate capital, K, consumption, C, and leisure time, l, such that the utility of the representative agent is maximized, subject to the aggregate resource constraint of the economy. Deriving the optimality conditions for this problem, yields five conditions that define the equilibrium. These include the intratemporal optimality condition, the Euler equation or intertemporal optimality condition, the resource constraint of the economy and the production function, as in the decentralized equilibrium. In addition, the sixth optimality condition represents the shadow value of output. Another difference with the decentralized equilibrium is that, since there are no taxes in this economy, these necessarily do not show up in the equilibrium conditions. These conditions determine jointly the equilibrium leisure time, the consumption-output and output-capital ratios, the relative value of output to capital, and the equilibrium growth rate of the economy along a balanced growth path. Unless otherwise stated, throughout this chapter upper case letters generally stand for aggregates, whereas lower case letters denote per capita variables. Please refer to Appendix C for more details on the derivation of the social planner's equilibrium.

Equation (20) represents the intra-temporal optimality condition, between consumption and leisure time. It states that the marginal rate of substitution between labour (or output) and consumption equals the relative price of output in terms of consumption. The household takes the size of government as given (i.e. independent of his decisions) and responds to tax incentives. The fact that higher consumption taxes reduce the equilibrium consumption-income ratio is straightforward. Having elastic labour supply brings an additional factor into the equation, as a higher tax on labour income, given leisure time l_j, also reduces this ratio. Given output, a higher tax on wages reduces after-tax income. Equation Equation (21) represents the Euler equation, where the relevant return is the net private (after-tax) rate of return on capital. This corresponds to the usual equilibrium condition equating the growth rate of the economy to the difference between the rate of return on capital and the intertemporal rate of time preference, or discount rate, multiplied by the intertemporal elasticity of substitution. Note that this condition is slightly modified by the presence of government consumption in the household's utility function. Equation (22), in turn, is simply the aggregate resource constraint (19), re-written per unit of capital stock. The left-hand-side of the equation also stands for the equilibrium growth rate of the economy. Finally, equation (23) is the production function (14), again re-written per unit of capital.

In order to obtain the RR locus, along which the equality of the growth rates of capital and consumption is ensured, we substitute for (Y/K) from (23) into (21)[41]. The long-run equilibrium of the economy is obtained by equating this locus to the PP locus, which ensures equilibrium in the product market. We can obtain the latter by substituting for (C/Y) and (Y/K) into (22). An increase in leisure time

[41] Contrary to that of the centrally planned economy, this locus is always negative, as there is an "externality" of government consumption expenditure which is now ignored by the representative household.

unambiguously reduces the output-capital ratio, as well as the return to capital and the growth rate. This also increases the consumption-output ratio, which has a negative effect on the rate of growth of capital. As l increases, employment decreases and the marginal productivity of labour consequently increases. The trade-off along this locus thus becomes steeper as l increases. The two loci determining equality of consumption and capital growth rates and product market equilibrium, RR and PP respectively, jointly determine the long-run equilibrium of the economy[42]. The RR locus represents the combinations of long-run supply of labour (or leisure time) and growth rate of the economy along which the equality of growth rates of (or after-tax rate of return on) capital and consumption is ensured. In a decentralized market economy, this trade-off is always negative, as agents take the level of government spending as given. A higher fraction of time devoted to leisure reduces the marginal productivity of capital and the growth rate of consumption must fall accordingly, and so does the growth rate of the economy[43]. The PP curve, in turn, is always downward sloping. A higher fraction of time devoted to leisure reduces the marginal productivity of capital and its after-tax rate of return and increases the C/Y ratio. This has a negative effect on the rate of growth of the economy. As the employment rate decreases, i.e. as l becomes higher, the marginal product of labor increases, and the trade-off

[42]The two trade-off relationships that define the RR and PP curves are both non-linear and impose restrictions on the model, so that a balanced growth equilibrium exists. It can be shown that a unique balanced growth equilibrium exists if and only if $\gamma < \frac{\rho}{(1-g_j-h_j)(\alpha g_j^{\alpha})^{1/(1-\alpha)}(1+\eta)}$. This is obtained from setting $l = 0$ in the equilibrium loci of the centrally planned economy and imposing that RR has to lie below the PP locus, as otherwise the existence an equilibrium cannot be ensured, given that the PP locus becomes steeper as l increases.

[43]In a centrally planned economy this is not necessarily the case. If individuals value government consumption spending, i.e. for $\eta > 0$, for reasonably high levels of leisure time this effect is dominated by the effect a varying equilibrium leisure time produces on government spending. An increase in l reduces output, thereby mechanically decreasing total government spending. This, in turn, has an negative effect on the marginal utility from consumption, providing further incentives for individuals to reduce consumption. This implies that the savings rate increases and more investment, which translates into a higher equilibrium growth rate of the economy. As the employment rate increases, l decreases, this effect becomes partially offset by the direct effect of leisure time on the marginal productivity of capital. Please refer to Appendix C for more details on the equilibrium in a centrally planned economy.

along this locus becomes progressively steeper. This mechanism is equivalent to that observed in the planner's problem, where the PP curve also unambiguously exhibits a negative slope. The RR and PP loci can be expressed as follows:

$$\psi_j = \frac{1}{1-\gamma(1+\eta)}\left[(1-\tau_j^K)(1-\alpha)(Ag_j^{\alpha})^{\frac{1}{1-\alpha}}(1-l_j)^{\frac{\alpha}{1-\alpha}} - \delta\right] \tag{24}$$

$$\psi_j = \left[(1-g_j-h_j) - \frac{1-\tau_j^L}{1+\tau_j^C}\Omega(l_j)(1-\alpha)\right](Ag_j^{\alpha})^{\frac{1}{1-\alpha}}(1-l_j)^{\frac{\alpha}{1-\alpha}} \tag{25}$$

3.3.3 Qualitative effects of fiscal shocks

Having obtained the two curves that determine the equilibrium of the economy, (24) and (25), we can analyse qualitatively the effect of changes in each of the five fiscal instruments in our economy. Composite changes in these fiscal instruments (as is required to ensure revenue-neutral changes) require a more detailed analysis and we leave these exercises for the next sections, where optimal fiscal policy is characterised and different tax harmonization scenarios are studied, within a calibrated growth model. The effects of changes in any of the tax rates, τ^K, τ^L or τ^C, have similar qualitative effects on both the fraction of time devoted to leisure, l_j and the equilibrium growth rate of the economy, ψ_j:

$$\frac{\partial \psi_j^*}{\partial \tau_j^i} < 0 \qquad \frac{\partial l_j^*}{\partial \tau_j^i} > 0 \qquad i = C, K, L \tag{26}$$

Hence, an increase in tax rates leads to a decrease in both the equilibrium growth rate and the fraction of time spent working. Yet, note that the underlying mechanisms behind these qualitatively similar responses are different.

As can be seen from Figure 13, a decrease in labour income tax rates, τ^L, leads

to a downward shift in the PP curve and a corresponding small shift of the equilibrium along the original RR locus. Given leisure, there is an immediate decrease in the growth rate of the economy and an increase in the consumption-output ratio. The return on consumption is now lower and agents shift away from consumption and leisure, increasing working hours. This leads to an increase in output and the equilibrium growth rate of the economy. A decrease in consumption taxes, τ^C, has similar effects on the PP curve and the dynamic equilibrium of the economy moves in the same fashion along the original RR curve. The downward shift in the PP curve illustrates an immediate decrease in the growth rate of the economy, given working hours or leisure. As the economy adjusts along the original RR curve to its new long-run equilibrium, there is a shift away from consumption and from leisure into work. The growth rate of the economy is higher in the new equilibrium, with more time devoted to work and a higher marginal productivity of capital.

In turn, a decrease in the capital income tax rate, τ_j^K, produces similar qualitative effects but through a more complex mechanism. As it produces an upward rotation of the RR locus, this implies that, given the fraction of time devoted to work, there is an immediate increase of the growth rate of the economy. This increases immediately the return on consumption, which causes the reverse effect and a substitution away from leisure towards labour. This increases progressively the rate of return on capital, equalizing to the growth rate of consumption.

The increase in employment in the economy increases output and leads to a further increase in the growth rate of the economy. The ultimate equilibrium is now reached along the original PP curve, with a higher fraction of time devoted to work, $(1 - l_j)$, and a higher equilibrium growth rate, ψ_j.

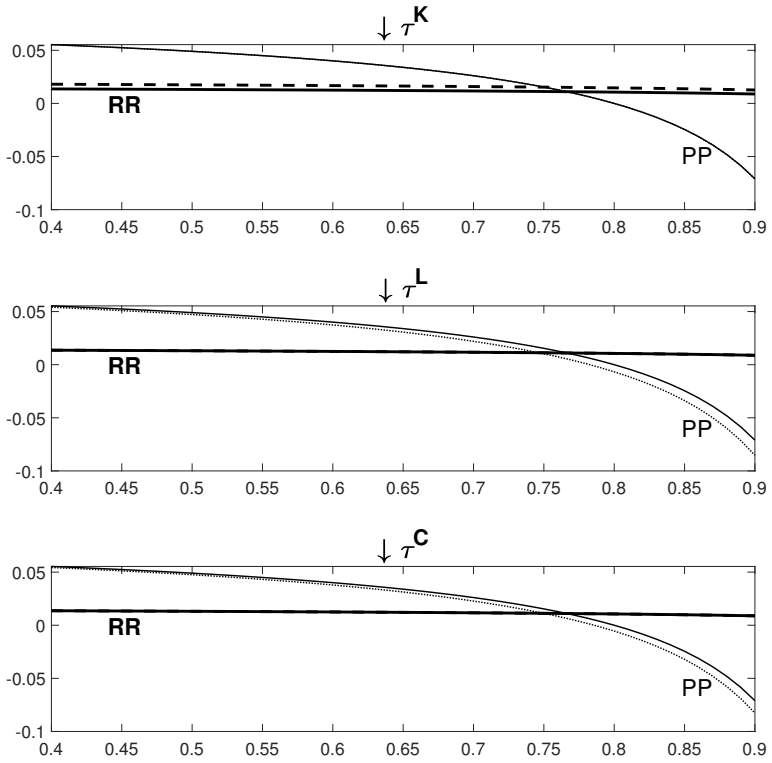

Figure 13: Fiscal shocks: changes in tax rates. This figure depicts the qualitative general equilibrium effects of one-off decreases in different tax rates, through their implications for the two loci that define the equilibrium in the economy, PP and RR. Tax decreases are implicitly compensated by an increase in lump-sum taxes, so to keep a balanced government budget. Leisure time varies along the horizontal axis, whereas the growth rate of the economy can be read along the vertical axis. Any one-off decrease (financed via lump-sum taxes) in tax rates leads to a higher growth rate of the economy, despite the different underlying mechanisms behind these equilibrium changes. A decrease in the capital income tax rate, τ^K, leads to an increase in the net rate of return on capital and, hence, an upward shift in the RR locus. The new equilibrium, along the original PP locus, features a higher growth rate of the economy and a slight decrease in leisure time. The effects of a decrease in the labour income tax rate, τ^L, and the consumption tax rate, τ^C, are similar. They affect the intra-temporal decision margin of individuals and both lead to an increase in working hours (decrease in leisure time). The growth rate of the economy also increases slightly, as the new equilibrium features a higher marginal productivity of capital.

Looking at the effects of changes in government consumption and production expenditure, we can again identify the following common qualitative effects:

$$\frac{\partial \psi_j^*}{\partial g_j^i}, \frac{\partial \psi_j^*}{\partial h_j^i} > 0 \qquad \frac{\partial l_j^*}{\partial g_j^i}, \frac{\partial l_j^*}{\partial h_j^i} < 0 \tag{27}$$

Yet, again, different types of government expenditure work through different channels. An increase in government production expenditure produces different changes from an increase in government consumption expenditure. As can be seen from Figure 14, an increase in government consumption expenditure causes a downward shift in the PP curve, which ultimately leads households to substitute away from consumption and leisure towards labour. The main effect of this increase is thus through the intratemporal decision margin of households. More working hours lead to a higher equilibrium growth rate. The effects of an increase in government consumption expenditure, h_j, are thus similar to those of a decrease in either labour income or consumption tax rates.

An increase in government production expenditure has similar qualitative properties, increasing the amount of hours worked and the equilibrium rate of return on capital, but with an additional effect. This is analogous to that of a decrease in the capital income tax rate. Additional productive government spending increases the productivity of labour and this induces households to shift further away from leisure and into work, which reinforces the initial increase in the growth rate of the economy. In the bottom graph of Figure 14, it can be observed that, in addition to the movement in the PP locus, the RR locus shifts upwards, reflecting this shift in leisure time after an increase in the marginal return to work. Note finally that the real effect from government consumption expenditure is relatively uncommon in the endogenous growth literature. In the present case, however, government consumption expenditure does not simply crowd out private consumption - leaving no real effects on the long-term macroeconomic equilibrium - due to its impact on the labour-leisure margin. A one-off increase in government consumption expenditure is accompanied by an increase in lump-sum taxation,

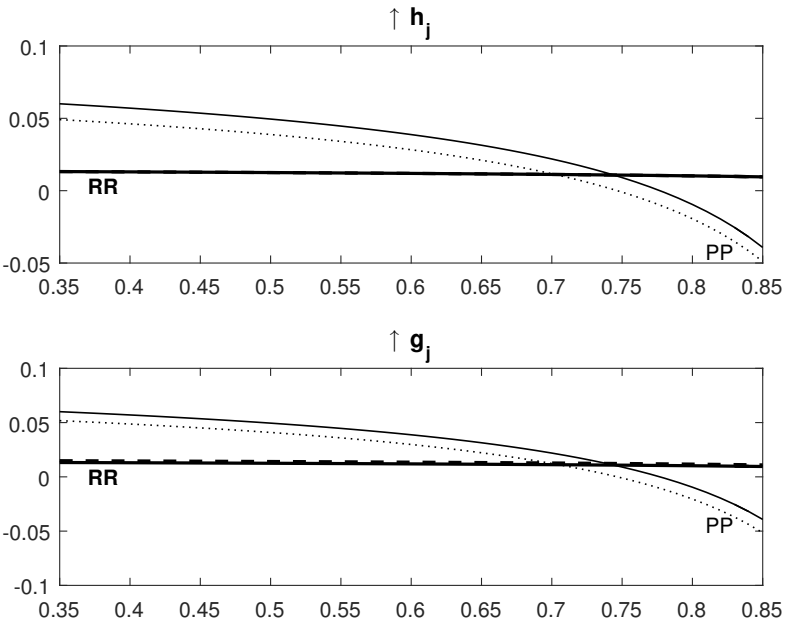

Figure 14: Fiscal shocks: changes in government expenditure shares. This figure depicts the qualitative general equilibrium effects of (one-off) increases in the share of government consumption and production expenditure, respectively, through their implications for the two loci that define the equilibrium in the economy, PP and RR. Any one-off increase (financed via lump-sum taxes) in government spending leads to a higher growth rate of the economy. Yet, different underlying mechanisms are at work behind these equilibrium changes. An increase in government consumption expenditure, h_j, affects primarily the intra-temporal decision margin of individuals and leads to an increase in working hours (decrease in leisure time). The growth rate of the economy also increases slightly, as the new equilibrium, along the original RR locus, features a higher marginal productivity of capital. In turn, an increase in government productive expenditure, g_j, leads to a direct increase in the rate of return on capital and, hence, to an upward shift in the RR locus. The PP locus also shifts in a similar fashion to the increase in government consumption spending, but now the effects are milder. The new equilibrium features a higher growth rate of the economy and an unambiguous increase in working hours, as both movements in the RR and the PP loci reinforce each other.

so that the government budget constraint clears, and this implies a decrease in individual wealth. This has the effect of raising the marginal utility of wealth and consumption, thereby inducing households to increase working hours, which increases the equilibrium growth rate of the economy. This effect is similar to that of a decrease in consumption or labour income taxes. We can also derive a further relationship, between the (qualitative) effects of increasing government expenditure:

$$\frac{\partial \psi_j^*}{\partial g_j^i} > \frac{\partial \psi_j^*}{\partial h_j^i} > 0 \qquad \frac{\partial l_j^*}{\partial g_j^i} < \frac{\partial l_j^*}{\partial h_j^i} < 0 \tag{27'}$$

Looking at the effects of mixed changes in government expenditures, Figure 15 depicts the effects of a re-balancing of government expenditures, i.e. of proportional increases in a given category of government expenditure through a corresponding decrease in the other category. Note that this does necessarily mean that these changes are revenue-neutral, since they have different effects on the equilibrium of the economy. More careful policy simulations are performed in the next section, analyzing optimal fiscal policy and different tax harmonization scenarios. Figure 16 shows the effects of increases in government consumption and production expenditure together with increases in capital and labour income taxes, respectively.

The effects of mixed fiscal policy changes are necessarily just the reflection of those just seen, with one-off changes in government expenditure or tax rates. Yet, these allow to better grasp the qualitative effects of more complex fiscal policy reforms, through composite changes in government expenditures and taxes. In Figure 15, it is apparent that a re-balancing of government expenditure towards consumption expenditure implies a downward shift in the PP curve, with households substituting away from consumption and leisure towards labour. This effect is again similar to that of a decrease in labour income taxes or consumption taxes. However, this increase in government consumption expenditure is now obtained at the expense of lower government productive expenditure. This has an effect similar to an increase in capital income taxes. The RR locus is shifted downwards, which implies that, given the fraction of time devoted to leisure, the growth rate of the economy is now lower. This decrease in the return on consumption causes a substitution away from labour. The rate of return on capital thus also decreases. The PP locus is shifted upwards, reflecting a further shift on intratemporal decisions away from labour towards leisure. The final effect is

obtained by aggregating both effects. The growth rate of the economy is unequivocally reduced, while the effect on labour hours is ambiguous, depending on the relative magnitude of the shifts in the PP curve, given the downward shift of RR. The case for a re-balancing of government expenditures towards productive expenditure, at the expense of government consumption expenditure, produces the opposite effects. The final result (bottom graph in Figure 15) is an upward shift on both the RR and the PP loci. The effect on the growth rate is now positive, while the effect on working hours is again ambiguous.

The cases depicted in Figure 16 are now meant to highlight two "opposite" cases. On the one hand, an increase in government consumption expenditure financed via an increase in the capital tax rate is expected to deliver the worst outcome in terms of the growth rate of the economy. This is accompanied by a decrease in leisure time, given the downward shift of both the PP and the RR loci. Contrary to the effects of the tax cuts depicted in Figure 13, an increase in capital income taxes, τ^K, now produces a downward rotation of the RR locus and implies an immediate decrease of the growth rate of the economy, given leisure time. At the same time, as households substitute away from labour towards leisure, the decrease in total working hours in the economy leads to a further decrease in the growth rate of the economy. The increase in government consumption expenditure causes a downward shift in the PP locus, leading households to substitute leisure for labour. This partially counteracts the effect of a higher capital income tax rate and rebalances the long-term equilibrium of the economy towards a slightly higher equilibrium growth rate.

On the other hand, an increase in government productive expenditure financed out of higher labour taxes produces an upward shift of the RR curve, while it shifts

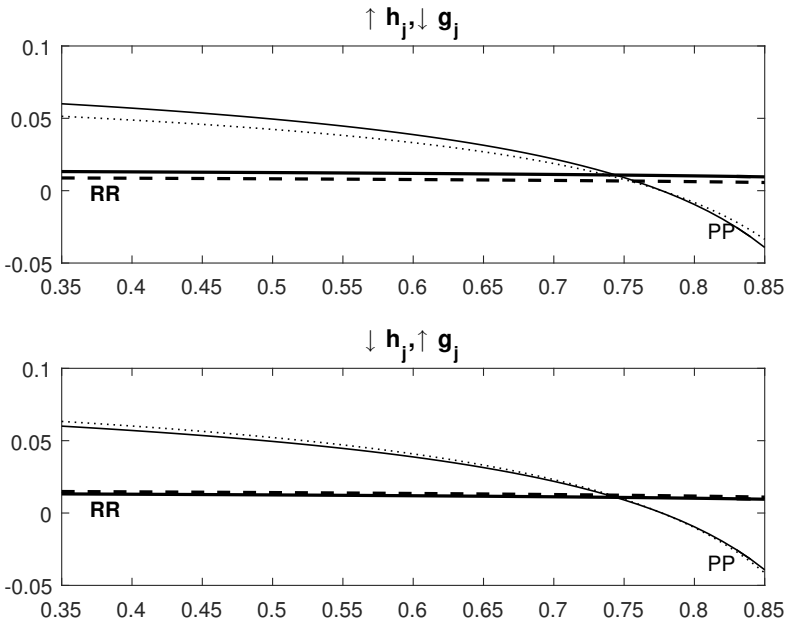

Figure 15: Composite fiscal shocks: compensated changes in government expenditure shares. This figure depicts the qualitative general equilibrium effects of shifts in the composition of government expenditure. The key mechanisms are illustrated by the shifts in both PP and RR curves. Underlying these shifts are the offsetting mechanisms produced by the two different types of government expenditure. The final equilibrium effects can be seen as a by-product of those analyzed in the previous figure. An increase in government consumption expenditure, h_j, compensated by a decrease in government production expenditure, g_j, affects both the intra-temporal and the inter-temporal decision margins of individuals. While it leads to an unambiguous decrease in the growth rate of the economy, as the decrease in government production spending decreases the marginal productivity of capital, the effect on leisure time is ambiguous. On the one hand, individuals will want to work less due to an substitution effect related to the decrease in the marginal productivity of capital. On the other hand, the income effect implies that they will want to increase their working hours, as now any given labour market equilibrium will imply lower returns. The PP locus becomes flatter. An increase in government production expenditure, g_j, compensated by a decrease in government consumption expenditure, h_j, leads to opposite effects. The PP locus becomes steeper and the RR is shifted upwards. The final effect on the (net) rate of return on capital is unambiguously positive, while the labour supply effect will depend on the relative magnitudes of the substitution and income effects.

the PP curve downwards. An increase in the labour income tax rate, τ_j^L, leads to an upward shift in the PP curve. Given leisure, there is an immediate increase in the growth rate of the economy and the consumption-output ratio increases. Households are driven away from the labour market and decrease their working hours. This leads to an immediate decrease in output and the growth rate of the economy, with a lower return to capital and consumption. The increase in productive expenditure has an opposing effect, towards higher working hours and

equilibrium growth rate. The productivity of labour increases and induces households to shift further away from leisure and into work, reinforcing the increase in the growth rate of the economy. The RR locus also shifts upwards, in addition to the movement in the PP locus, reflecting the shift in working hours after an increase marginal returns. The final effect in terms of both equilibrium leisure time and growth rate of the economy is ambiguous and depends on the relative magnitudes of the shifts in tax rates and government production expenditure.

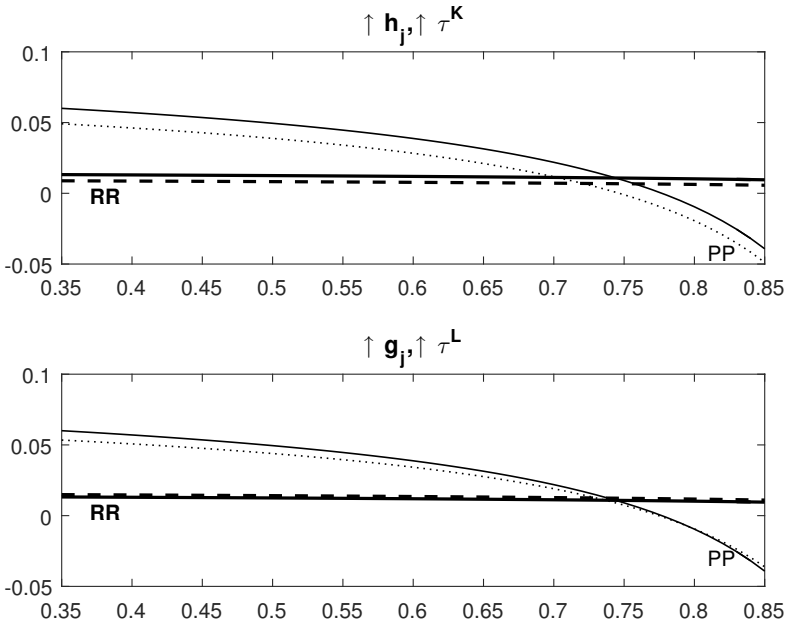

Figure 16: Composite fiscal shocks: compensated changes in government expenditure shares and tax rates. The final equilibrium effects can be seen as a by-product of those analyzed in the previous figure. An increase in government consumption expenditure, h_j, financed via an increase in capital income taxes, τ^K, implies a downward shift in the PP and RR loci. The final effect on the (net) rate of return on capital is unambiguously negative while the labour supply effect is ambiguous. For small shifts in the RR locus, it is possible that the labour supply effects of an increase government consumption expenditure outweigh the effects on the effects of a decrease in the (net) rate of return on capital. An increase in government production expenditure, g_j, financed via an increase in labour income taxes, τ^L, have an ambiguous effect on the equilibrium labour supply, but a positive effect on the growth rate of the economy (proportional to the (net) rate of return on capital), as the upward shift of the RR curve is reinforced by a the rotation of the PP locus. The qualitative effect appears similar to that of a one-off increase in government production expenditure, only now the labour supply effects are further dampened by the increase in taxation of the labour factor.

Finally, the effects of changes in government expenditure financed via distor-

tionary taxes can be, in general, expressed more formally as follows:

$$\left(\frac{\partial \psi^*}{\partial z_j}\right)_{\tau_j^i} = \left(\frac{\partial \psi^*}{\partial z_j}\right)_T + \frac{\partial \psi^*}{\partial \tau_j^i}\frac{\partial \tau_j^i}{\partial z_j} \qquad z = g, h \qquad i = C, K, L$$

3.4 Optimal policy

In this section, we look more in depth at optimal fiscal policy in a decentralized market economy. We first derive analytically the expressions that characterize optimal government expenditure shares and tax rates. Second, we calibrate our model to an average EU-28 economy and discuss the main parameters and key facts that each attempt to target. We focus in particular on the calibration of the fiscal parameters for the average EU-28 economy, as the main benchmark against which we aim to assess the subsequent policy scenarios. We start then by looking at different policy scenarios around optimal fiscal policy.

Thirdly, bearing in mind the competitive pressures faced by EU jurisdictions in the context of a perfectly mobile capital tax base, we focus in particular on the outcomes that maximise the (after-tax) rate of return on capital. These are the equilibria which, in a (uncoordinated) fiscal competition environment, are consistent with full capital mobility. Having the first insights on the incentives of EU jurisdictions setting fiscal policy in an environment of fiscal competition, we move on to look at a broader scope of fiscal policies, where tax rates are also allowed to move freely, within pre-defined bounds. We characterize the "extreme tax competition" equilibrium as a theoretical point to which EU jurisdictions can be thought to converge in the long run, according to our theoretical framework, in the absence of any tax harmonization agreements (or limits to factor mobil-

ity). In a nutshell, this is our equivalent to a Nash equilibrium without (fiscal) coordination. With this basic framework in mind, the next section looks more closely at policy scenarios involving several different types of fiscal harmonization agreements. These include simple tax harmonization agreements as well as wider EU fiscal agreements, with scope for a larger EU budget or, in other words, partial centralization of spending powers in some areas.

3.4.1 Optimal fiscal policy

In order for a government in the decentralized economy equilibrium to obtain the optimal fiscal policy, it must be able to replicate the first-best equilibrium obtained by a benevolent social planner in the centrally planned economy. The optimal government expenditure shares on productive and consumption goods and services, respectively, can be obtained by deriving the optimality conditions with respect to these two variables[44]:

$$\hat{g}_j = \alpha \qquad\qquad \hat{h}_j = \eta(1-\beta)\Omega(l_j) \tag{28}$$

Bearing these optimal expenditure shares in mind, one can obtain the optimal tax rates in the decentralized economy, which will ensure that the optimality conditions in decentralized equilibrium can exactly replicate the first-best allocation optimality conditions in the centrally planned equilibrium. The optimal capital income tax rate is obtained by ensuring the two intertemporal optimality conditions are equal, so that the Euler equation (21) equals that of the centrally

[44]Please refer to Appendix C for more details on the equilibrium in a centrally planned economy. The optimal policy conditions presented in this subsection are those that can replicate, in the context of a decentralized equilibrium, the first-best equilibrium obtained under a centrally planned economy. The resulting conditions thus represent the optimal fiscal policy rules that, given production and preference parameters, mimic the first-best allocation. These are simply obtained by

planned economy. Hence, the capital income tax rate must satisfy:

$$1 - \tau_j^K = \frac{1 - g_j - h_j + \eta(C/Y)}{1 - \hat{g}_j} \tag{29}$$

Equality of growth rates are ensured if the capital income tax rate is set to equate the private (after-tax) rate of return on capital with the social rate of return on capital. The optimal capital tax rate will crucially depend on the deviation in the *total* share of government expenditure relative to its optimum level. The *composition* of these government expenditures, i.e. the specific shares of government production and consumption expenditure, are in this case irrelevant to the problem of setting the optimal capital tax rate. Recalling (28) and that $(\hat{C/Y})_j = (1 - \beta)\Omega(l_j)$, it is straightforward to see that, if $g_j + h_j \gtrless \hat{g}_j + \hat{h}_j$, then $\tau_j^K \gtrless 0$. Hence, if the aggregate government expenditure share is above its optimum level, this has a negative effect on the social rate of return on capital. Yet, households fail to "internalize" this negative spillover produced by excessive government spending and over-invest. With higher-than-optimal aggregate government expenditure, this can be corrected by setting a positive capital income tax rate. Similarly, one can obtain the optimal tax rates on consumption and labour income, which ensure equality of intratemporal optimality conditions, (20) and (20A), respectively. Consumption and labour income tax rates must satisfy:

$$\frac{1 - \tau_j^L}{1 + \tau_j^C} = \frac{1 - g_j - h_j + \eta(C/Y)}{1 - \hat{g}_j} \tag{30}$$

Again, the composition of government expenditures is orthogonal to the problem of setting the optimal labour income and consumption tax rates. A similar condition holds for the optimal level of the tax rates, if aggregate government expenditures are not at their optimum level: for $g_j + h_j \gtrless \hat{g}_j + \hat{h}_j$, $1 - \tau_j^L \lessgtr 1 + \tau_j^C$. In this

case, if government spending is above the optimum, this distorts the intratemporal decisions of households. The distortion can be corrected by setting a higher tax on labour, thereby giving an incentive for agents to devote more time for leisure, as they are working more hours than optimum. In particular, this means that there should be a "decoupling" between the tax on leisure and on consumption, the two "goods" from which households derive utility. By decreasing the tax on leisure, relative to consumption, this gives the incentive to shift away from consumption and labour towards leisure. If aggregate government expenditure is below its optimum level, then a higher tax on leisure (lower labour income tax rate) relative to consumption, implies a shift away from leisure towards work and consumption. Finally, if government expenditures are set optimally $g_j + h_j = \hat{g}_j + \hat{h}_j$, then:

$$\tau_j^K = 0 \qquad \tau_j^L = -\tau_j^C \tag{31}$$

Hence, optimal fiscal policy implies that the capital income tax rate should be set to zero. Furthermore, the optimal tax on labour income should be exactly symmetric to the tax on consumption. Hence, a negative labour income tax can be interpreted as a tax on leisure. The above expression states a general principle of public finance: the two goods from which households derive utility should be uniformly taxed at the optimum[45].

Before moving on to discuss the calibration of our model, let us introduce a measure of welfare, which will be our "barometer" for comparing different policy scenarios, namely the gains from moving from the benchmark economy into an

[45]Looking at (18) and substituting for equilibrium wages and the intratemporal optimality condition evaluated at the optimum, the first-best optimum can be achieved for $\hat{\tau}_j^L(\alpha - \frac{\Omega(l_j)}{1-\alpha})\hat{Y} + T = (\hat{g}_j + \hat{h}_j)\hat{Y}$. This implies that an equilibrium without lump-sum taxation can only be achieved for $\alpha < \frac{\Omega(l_j)}{1-\alpha}$. The first-best optimum is thus achieved by imposing a consumption tax to counteract the "subsidy" given to leisure: $\hat{\tau}_j^L = -\hat{\tau}_j^C = \frac{\eta(1-\alpha)\hat{\Omega}(l_j)+\alpha}{\alpha-(\hat{\Omega}(l_j)/1-\alpha)} < 0$.

optimal policy equilibrium. The measure of economic welfare corresponds to the optimized utility of the representative household, obtained by evaluating (15) at its optimum, where the j subscripts are dropped for presentation purposes:

$$W = \frac{1}{\gamma} \frac{c_0^{\gamma} l^{\theta\gamma} h^{\eta\gamma} \left(\frac{Y}{K}\right)^{\eta\gamma} K_0^{\eta\gamma}}{\rho - (1+\eta)\gamma\psi} \tag{32}$$

Having fully characterized the optimal fiscal policy in the decentralized economy and obtained a welfare function, we can focus on the calibration of our model with the aim of performing simulations of alternative fiscal policy scenarios.

3.4.2 Calibration and model simulations

It is important to stress from the outset that the simulations presented henceforth should be seen as "theory with numbers" only. These are intended to provide a picture of the order of magnitude of the potential welfare gains or losses from fiscal policy changes, rather than exact estimations of welfare deviations. We start by looking at a benchmark economy and assess whether our model fits key moments, such as the growth rate of the economy and average leisure time (or working hours), based on a calibration for an average EU-28 economy. We then look at how shifts towards optimal policy (and around this point) may affect these variables as well as economic welfare. Further simulations are performed in the next section, with the aim of highlighting how tax competition may alter the fiscal incentives of jurisdictions facing full capital mobility. In particular, we focus on how the equilibria here described are shifted and how different fiscal harmonization scenarios may restrain the changes induced by competitive pressures.

The benchmark economy is calibrated to mimic an average EU-28 economy. Starting with the production side of the economy, we calibrate α to obtain a share

of physical capital of around 0.3. Having an "AK economy" implies that capital is to be interpreted as an aggregate measure including both physical and human capital. If we consider the share of human capital to account for about 2/3 of the aggregate measure of capital, we thus obtain that $1 - \alpha = 0.92$ and, hence, a share of 1/3 of output going to physical capital. The productivity parameter A is calibrated as a "growth residual", given all remaining parameters, to target the EU-28 average growth rate in the 2000-16 period, at around 1.5% (according to World Bank data). This calibration also implies that government production expenditure is a pure "labour-augmenting" technology.

Table 2: Benchmark model calibration. A detailed description of the model parameters is provided in the main text. These are divided into production, preference and fiscal policy parameters. The benchmark calibration attempts to reflect an average EU-28 economy and enable meaningful fiscal policy simulations. The small value for α is related to the "AK economy" structure of the model: aggregate capital is to be interpreted as a composite measure of physical and human capital. With a share of two-thirds of human capital in the aggregate capital measure, about one-third of output accrues to physical capital. The other main targeted moments are the average EU growth rate in the 2000-16 period, at around 1.5%, and an intertemporal elasticity of substitution of around 0.5 ($IES = (1-\gamma)^{-1}$). Fiscal parameters are chosen to replicate EU averages. According to the structure of the model, the capital tax τ^K is a composite measure of the average top statutory corporate and income tax rates across the EU. The labour tax τ^L mimics a (weighted) average of the implicit tax rate on labour across the EU.

Production parameters			Preference parameters	
A	0.2		γ	-1
α	0.08		θ	0.3
			η	0.3
			ρ	0.05
		Fiscal parameters		
h_j	0.2		τ^C	0.2
g_j	0.2		τ^L	0.38
T	$\gtrsim 0$		τ^K	0.31

Similarly, looking at preference parameters, the equality between θ and η, as both parameters are calibrated to a value of 0.3, implies purely "leisure-augmenting" government consumption expenditures. Another implication of this calibration is that the optimal ratio of government consumption expenditure to private consumption is about 0.3. The parameter γ is calibrated to obtain an intertemporal elasticity of substitution ($IES = 1/(1-\gamma)$) of 0.5, fitting a well-

established empirical fact that this is close to but smaller than unity. Finally, ρ is set to 0.05, also similar to values generally found in the literature.

Turning now to the fiscal parameters, these are calibrated to target key moments of available EU fiscal data (European Commission, 2017b). Looking first at the revenue side of the government budget constraint, the consumption tax rate, τ^C, is set to 20% in order to fit the average implicit tax rate on consumption for the EU-28, at around 20.5% in 2015 (20.4% in the Eurozone). The *implicit* tax rate is used, rather than just an average VAT measure, as it provides a composite measure, including VAT as well as excise duties (namely on tobacco, alcohol and energy)[46]. The average implicit tax rate on consumption is thus the ratio of all consumption taxes to the final consumption expenditure of EU households. The tax rate on labour income, τ^L, is set to target the implicit tax rate on labour. This is calculated as the ratio of taxes and social contributions to the total compensation of employees and payroll taxes. Although the average EU-28 implicit tax rate on labour income was at 36% in 2015, this is set at a slightly higher level to capture a higher implicit tax rate in Eurozone countries (close to 39% in the same year) and the upward trend observed in the data[47]. Note also that labour and consumption taxes together account for around 80% of total EU tax revenues.

Turning now to to the tax rate on capital income, τ^K, it is important to recall that capital is in this model an aggregate measure of physical capital, as well as human capital. Hence, the tax rate on capital income must reflect this fact and represent a composite measure of physical as well as human capital taxation.

[46]Despite significant differences in the relative importance of underlying components on the overall implicit tax rate, VAT accounts for between 65 and 75% of this measure. The highest value is recorded in Sweden, just above 75%, whereas in Greece only 54% is accounted for by VAT revenues. The average VAT tax rate in the EU-28 is at 21.5%.

[47]Once again, the average tax rate "hides" significant differences between EU countries. While Belgium shows the highest implicit tax rate on labour income, at around 44%, closely followed by Italy and Austria, Malta, Bulgaria and the United Kingdom reach implicit tax rates on labour income below 25%

Starting with physical capital taxation, the most important source of government revenue is the corporate income taxation. The average EU-28 top statutory tax rate on corporate income is 22% in 2017, down from 29% in 2002 and following a secular downward trend (for reference, the average top tax rate on corporate income in 1982 was 47% across the OECD). Similarly, the effective EU-28 tax rate on corporate income is at 21% in 2016 and has followed a similar trend in the EU since 2002 (i.e. indicating that statutory corporate tax rate cuts were not accompanied by a broadening of corporate tax bases)[48]. Having our average tax rate on physical capital, we consider the taxation on human capital. Here, we consider the top personal income tax rate as the main indicator. The average EU-28 top personal income tax rate was 39% in 2017. Once again, this has followed a markedly downward trend over the past decades[49]. Our calibration of the capital income tax rate is an average between these two measures, i.e. the average EU-28 top statutory corporate tax rates and top personal income tax rate[50].

Finally, for completeness, note that another measure could be considered both for the labour income and the capital income tax rate. While the implicit tax rate on labour income reflects the average tax burden shared across the entire income distribution, the top personal income tax rate reflects the tax burden at the top of the income distribution. Another measure, the tax wedge, reflects how the tax burden is shifted between the bottom and the top of the income distribution. The tax wedge is the difference between total labour costs to the employer and

[48]Note that the *effective* tax rate measure is not exactly similar to the *implicit* tax rate we mentioned before. This is an indicator of the tax rate on a given investment, after applying basic tax rules, namely taking into account different depreciation allowances in national systems, largely based on the methodology defined by Devereux and Griffith (1999) or Devereux (2008).

[49]As a general reference, the average personal income tax rate in the EU-28 countries was above 45% in the late 1990s. Several differences arise between EU countries, as it ranges from above 55% in Sweden or Portugal to at or below 15% in Hungary, Czech Republic in Bulgaria.

[50]We use a simple average rather than a weighted average, as for the measure of capital itself, in order to account for the fact that different tax retention provisions across different countries may imply that some of the income accruing to "human" capital can in fact pay a lower tax rate, closer to the corporate tax rate.

the net pay of the employee. The underlying idea is that policymakers can target directly the bottom of the income distribution and, in order to boost employability in this cohort of the population, cut labour costs at lower levels. Yet, given the mixed picture across EU-28 countries and wide fluctuations across relatively short periods of time, we do not consider this measure in our calibration. All the parameters are summarised in Table 2.

With the benchmark calibration set, we perform various numerical simulations, with different policy scenarios. The parameters set out to represent a benchmark average EU-28 economy lead to a plausible equilibrium, shown in the first row of Table 3. The average growth rate of the economy is targeted directly to reach an average of 1.5%. This also implies a net (after-tax) rate of return on capital of around 8% and a fraction of time spent in leisure activities of 0.78. The fraction of hours devoted to work is thus 0.22, which implies about 1900 hours of work in the year, i.e. around 48 weeks with weekly 40h of working time. The measure of welfare is not given in the benchmark scenario as it is meant to serve only as a comparison between different policy scenarios. The benchmark scenario should thus, again, be interpreted as a theoretical "average" EU economy. For this reason, we have set g_j and h_j to clear the government budget constraint, while at the same time keeping an "agnostic" view on the relative composition of government expenditures of EU countries. We only kept in mind the need to keep plausible values for l_j and ψ_j, given the choices of tax rates. In addition, given that several "merit goods" provided by EU governments, such as housing benefits or universal healthcare, can be considered as also having a productive role, this assumption does not seem problematic for the validity of the following policy simulations.

Before moving on to analyzing the policy scenarios set out in Table 3, one item

is important to mention. The item representing lump-sum taxes, $t = T/Y$, is meant to reflect the restriction that lump-sum taxation has to be greater than but close to zero. Given its effect on welfare and the potential undesired effects on the subsequent analysis of different fiscal policy scenarios, we restrict this to be within a narrow interval from the benchmark, close to a value of about 0.03[51].

Moving into the first-best policy regime has wide equilibrium implications in all variables, as can be seen in the second row in Table 3. Namely, the growth rate of the economy is almost doubled, from 1.48 to 2.9%, and this leads a significant increase in economic welfare of the order of $15 - 20\%$. The first striking element is perhaps the large shift in taxation implied by the first-best optimal policy scenario. The labour-leisure choice is in this case subsidized at 55%, while the tax rate on consumption is set at 55%, implying a dramatic rise in the levels seen in the benchmark economy. Finally, as already discussed, optimal fiscal policy involves abolishing capital taxation. These shifts also imply a move into a "regressive" taxation scheme, with a heavy reliance on indirect taxation and zero capital taxes, as well as a large shift in working hours. Households in this scenario spend about one third of their time in labour market activities.

Interestingly, a policy reform which would almost mimic the first-best allocation under the optimal policy scenario, involves eliminating income taxes. This is shown in the third row of Table 3, where we can observe that, in terms of both the equilibrium growth rate and welfare, this delivers similar results to optimal policy. The main difference is that, given that there is also no subsidy to labour income, the consumption tax rate is slightly lower ($\tau^C = 47\%$), and leisure time is higher ($l = 0.74$), implying a relatively small shift from benchmark. From this

[51]Some simulations bring this value up to 0.04, but this is merely a result of the clearing of the government budget constraint and the approximation to two decimal places.

point of view, this can be considered as the second-best policy scenario.

Table 3: Optimal policy. A detailed description of different scenarios presented in this table is offered in the main text. For comparison purposes, three scenarios are first highlighted: the benchmark and optimal policy scenarios are first presented, including the fiscal parameter values and corresponding simulations of equilibrium values of leisure hours, "budgetary surplus" (compensated by assumption with lump-sum taxes or transfers), (net) rate of return on capital, equilibrium growth rate and welfare changes, with respect to the benchmark case. The third scenario, featuring zero income taxes, closely mimics the first-best policy, apart from the equilibrium leisure time. The remaining policy scenarios are presented sequentially, where labour income and consumption taxes are set to the optimal level and not allowed to vary. The relatively large welfare effects, when deviating more from the benchmark or optimal policy scenarios are justified namely by the form of the welfare function. Namely, larger changes in the equilibrium growth rate, ψ_j, imply important deviations in the equilibrium. On the other hand, the large changes in government consumption expenditure implied by some policy scenarios, also imply large welfare deviations. The more extreme policy simulations are reported in the last rows with the aim to improve intuition rather than represent realistic policy scenarios.

	τ^K	τ^L	τ^C	h_j	g_j	l_j	t	$(1-\tau)r_j$	ψ_j	ΔW
Benchmark	0.31	0.38	0.20	0.20	0.20	0.78	0.03	8.41%	1.48%	
Optimal policy	**0.00**	**-0.55**	**0.55**	**0.17**	**0.08**	**0.66**	0.04	11.69%	**2.91%**	**17.94%**
Zero income taxes	**0.00**	**0.00**	0.47	0.17	0.08	0.74	0.04	11.41%	2.79%	17.14%
h_j too small	-0.13	-0.55	0.55	**0.08**	0.08	0.68	0.04	13.15%	3.54%	8.85%
g_j too large	0.13	-	-	0.17	**0.17**	0.64	0.04	10.92%	2.57%	11.04%
$g_j + h_j$ "optimal"	0.00	-	-	**0.08**	**0.17**	0.66	0.04	12.50%	3.26%	2.92%
Lowest h_j + high g_j	**0.00**	-	-	**0.01**	**0.24**	0.65	0.03	12.88%	**3.43%**	**-76.02%**
Capital subsidies	**-0.23**	-	-	**0.01**	**0.08**	0.69	0.04	14.27%	**4.03%**	**-54.75%**

The remaining policy scenarios presented in Table 3 are meant to explore the area around optimal policy, particularly on the expenditure side. These are aimed at uncovering some likely incentives of governments facing full capital mobility. This implies that governments engage in fiscal competition to attract mobile factors. Hence, we can interpret the (after-tax) rate of return on capital, $(1-\tau^K)r_j$, as the objective function of different jurisdictions. Holding labour income and consumption taxes constant, the first two policy simulations show the results of reducing government consumption expenditure, with the revenue being instead directed towards direct capital subsidies (row 4), and of increasing government production expenditure, with revenue being raised by an increase in capital in-

come taxes (row 5). The latter policy involves a larger shift in working hours (relative to benchmark) and a decrease in the growth rate. The former case implies a significant increase in the growth rate, while the welfare gains from this policy shift are only nearly half of those observed under optimal fiscal policy.

Another policy scenario, depicted in row 6, considers a shift in government expenditure shares, from consumption towards production expenditure, keeping the aggregate size of government expenditures constant. This is a "hybrid" of the two simulations seen in rows 4-5, but is illustrative of policymaker incentives facing fiscal competition. This revenue-neutral shift implies larger growth gains than optimal policy, but almost eliminates any welfare gains from the policy shift. Without access to (direct) capital subsidies, as is plausible to assume in the context of EU competition regulations, the expenditure-side incentive for policymakers is clear: government production expenditure is largely above the optimum, while the reverse happens to government consumption expenditure. This "misallocation" effect of government expenditure is the source of the very limited welfare gains (or losses), despite a large growth dividend. Governments, rather than aiming to set optimal expenditure shares (given optimal tax rates), instead induce a distortion in the economy, leading individuals to over-invest and substitute away from leisure into work. The main mechanism is similar to one analyzed in the previous section, with a re-balancing of government expenditure (Figure 15). We refer henceforth to this as a *fiscal competition-induced government investment distortion*.

The last two rows of Table 3 aim at bringing more intuition about this distortion, which is key in our model. Holding again labour income and consumption taxes constant, we observe that the incentive for governments without access to capital subsidies is indeed to engage in a "race to top" in government production

expenditure, while reducing consumption expenditure to its minimum. Yet, we observe that this form of "indirect" capital subsidization generates a distortion which is significantly larger than when governments have access to direct capital subsidies. This is because government production expenditure, unlike direct capital subsidies, introduce (direct) distortions both on inter-temporal decisions of households, i.e. on consumption-savings decisions, and on the intra-temporal choice between labour and leisure. This induces agents to reduce their leisure time (despite a slight counteracting effect due to the reduction in government consumption expenditure) below the optimum, while providing an incentive to over-invest. Instead, direct capital subsidies only imply the latter distortion. Government production expenditure goes to its optimum level and capital subsidies lead households to over-invest, even taking into account small aggregate size of government expenditure. This yields a larger growth rate of the economy, while implying smaller welfare losses. The labour-leisure margin is also indirectly affected, as now households have the incentive to increase leisure (relative to the first-best allocation), given the sub-optimal size of government aggregate expenditures.

3.4.3 Tax competition

Once we allow all tax rates to move beyond optimal policy, we can uncover further incentives of policymakers in a environment of full capital mobility and interjurisdictional fiscal competition. Table 4 compares the outcomes under several different policy scenarios with the first-best optimal policy.

Rows 2-5 (Table 4) depict the cases under which governments have no access to direct capital subsidies. Tax boundaries are set somehow arbitrarily[52], again

[52]We assume upper and lower boundaries, for consumption and labour income taxes respective, at the 90% level.

in an exercise of "theory with numbers", without harming the key economic intuition from the model simulations. Three fiscal incentives clearly emerge from these four policy scenarios. Governments facing tax competition engage in a race to the top in the least distortive tax base, i.e. consumption taxes, in order to maximise the (after-tax) rate of return on the most mobile tax base. Furthermore, consumption is taxed, not only to fund productive government spending, but also subsidize the labour-leisure choice of individuals. The growth-maximising case implies $\psi_j = 3.63\%$, while the time households spend at work is close to 40%. This is the first of two scenarios, which we refer to as the two "extreme tax competition" equilibria cases, where the fiscal competition-induced government investment distortion is exacerbated. The over-investment in government productive expenditure indirectly subsidizes capital and generates considerable distortions, leading to over-investment and a significant decrease in leisure time, both relative to the benchmark and the (first-best) optimal policy scenario. The welfare losses relative to benchmark are also potentially very significant, particularly in this first "extreme tax competition" equilibrium.

Allowing for capital subsidies implies a significantly different outcome, as different distortions are here at play (rows 6-9 - Table 4). Although the race to the top on consumption taxation is once again clear - the revenues of which are now directed towards direct capital subsidies rather than to increasing government production expenditure -, the incentive to set the labour income tax as a subsidy for the labour-leisure choice of households is now weakened. At the same time, note that it is also not used as another source of tax revenue to subsidize capital. Instead, the labour income tax rate is set at an "optimum" level, from the point of view of maximizing the (after-tax) rate of return on capital. This

Table 4: Tax competition. A detailed description of different scenarios presented in this table is offered in the main text. For comparison purposes, the benchmark and optimal policy scenarios are again presented in the first two rows. All fiscal parameter values are presented, together with corresponding simulations of equilibrium values of leisure hours, "budgetary surplus" (compensated by assumption with lump-sum taxes or transfers), (net) rate of return on capital, equilibrium growth rate and welfare changes, with respect to the benchmark case. The remaining policy scenarios are divided in two sections, depending on whether (direct) capital subsidies are allowed or not. Different equilibria are presented sequentially. Labour income and consumption taxes are allowed to vary within bounds ($-\tau^L, \tau^C \leq 90\%$). The reported changes in welfare are again relative to the benchmark economy. The large welfare effects in most policy simulations are justified namely by the form of the welfare function. Larger changes in the equilibrium growth rate, ψ_j, imply important (persistent) deviations in the equilibrium. The deviations from the benchmark or optimal policy set are sizeable. On the other hand, the large changes in government consumption expenditure implied by all alternative policy scenarios, also imply very large welfare deviations. The more extreme policy simulations, with reported welfare changes of above 100%, are explained by the extreme size of the distortions and are reported with the aim to improve intuition rather than represent realistic policy scenarios. Compared with the four scenarios featuring direct capital subsidies, it is however worth noting that these imply significantly smaller distortions.

	τ^K	τ^L	τ^C	h_j	g_j	l_j	t	$(1-\tau)r_j$	ψ_j	ΔW
Benchmark	0.31	0.38	0.20	0.20	0.20	0.78	1.48%			
Optimal policy	0.00	-0.55	0.55	0.17	0.08	0.66	0.04	11.69%	2.91%	17.94%
$\boldsymbol{\tau^K \geq 0\%}$										
	0.00	**-0.90**	0.55	0.01	**0.22**	0.62	0.04	12.90%	3.44%	-68.66%
	0.00	-0.55	**0.90**	0.01	**0.34**	0.65	0.03	13.30%	3.61%	-108.66%
	0.00	**-0.90**	**0.90**	0.01	**0.32**	0.61	0.04	13.34%	**3.63%**	**-89.44%**
	0.00	0.00	0.90	0.01	0.36	0.73	0.04	13.05%	3.50%	-108.39%
Capital subsidies										
	-0.15	-0.55	**0.90**	0.01	**0.24**	0.67	0.04	14.75%	4.24%	-71.35%
	-0.41	-0.55	0.90	0.01	**0.08**	0.70	0.04	16.29%	4.91%	-55.70%
	-0.40	**-0.70**	0.90	0.01	0.08	0.69	0.04	16.26%	4.89%	-55.18%
	-0.45	**0.00**	**0.90**	0.01	**0.08**	0.78	0.04	16.30%	**4.91%**	**-61.90%**

implies that the level chosen will respond to the trade-off between providing an incentive to invest while not acting as a disincentive for households to spend more time at work. Comparing rows 7-9, allows us to shed light on this issue. On the one hand, a larger incentive to the labour-leisure choice, relative to the optimum, immediately reduces the growth rate. On the other hand, progressively decreasing this incentive in order to marginally increase capital subsidies yields a positive growth dividend. The final result, in this particular case, is that leisure time is

higher than in the optimal policy scenario, similar to the benchmark economy, and, by implication, also substantially higher than in the previous extreme tax competition scenario, without capital subsidies. The welfare losses, relative to benchmark, are also significantly lower, when allowing for capital subsidies. It also delivers the highest (after-tax) rate of return on capital and highest growth rate of the economy ($\psi_j = 4.91\%$), above three times the benchmark growth rate.

In a nutshell, fiscal competition profoundly alters the incentives of policymakers. The potential welfare losses, as result of competitive pressures can also be quite sizable. In particular, the incentive for governments to dramatically shift their revenue sources from direct (and progressive) towards indirect (and least distortive) taxes is clear. Similarly, the potential shift on the government expenditure side is apparent from our analysis. Governments facing fiscal competition will have the incentive to re-direct tax revenues towards expenditures that (directly or indirectly) subsidize capital and thereby maximise the after-tax rate of return on this factor. Bearing this in mind, we now turn our attention towards the policy implications of the above in terms of the design of potential EU fiscal harmonization agreements.

3.5 Fiscal harmonization

That the consequences of interjurisdictional fiscal competition for fiscal policy and welfare can be significant is not new. This has been subject of a substantial body of research over the last few years (Winner 2005, Loretz 2008, Keen and Konrad, Lehmann et al. 2014), highlighting the effects and potential risks of unfettered tax competition on government policies. The previous section has highlighted the main trends that can emerge in fiscal policy across the EU - both

on the revenue and on the expenditure side - as a result of competitive pressures to attract mobile capital. Two main shifts emerge: on the one hand, there will be a tendency of governments to raise tax revenues through the least distortionary taxes, and the less "mobile" tax bases, leading to an even greater reliance on indirect taxation, namely VAT. This is consistent with the findings of Loretz (2008), indicating that increasing fiscal competition is inducing a significant shift towards consumption taxes. On the other hand, there is a fiscal competition-induced government investment distortion, which implies that policymakers tend to overspend on government productive goods and services, at the expense of government expenditure that benefits households' welfare. We will now look at how different fiscal harmonization agreements may be able to prevent such large shifts and ultimately ensure that international economic integration does not bring about significant damage to economic welfare across the EU.

3.5.1 Capital income tax harmonization

We start with a simple policy simulation, implying that a minimum threshold or common rate for capital income taxes is imposed across the EU at 10%. This value is chosen, albeit somehow arbitrarily, to stand in the interval between the benchmark economy and optimal policy. Table 5 illustrates various policy scenarios, under which both labour income and consumption taxes, as well as government expenditures, are allowed to vary, in order to uncover the incentives of policymakers setting fiscal policy, under capital income tax harmonization.

Perhaps the first striking fact is that, once again, the three main incentives identified earlier, under full fiscal competition, clearly emerge: different jurisdictions (i) engage in a race to the top in consumption taxes, in order to (ii) (over-

)spend on government productive activities and (iii) subsidize the labour-leisure choice of individuals. Yet, the growth-maximising case now necessarily implies a smaller growth rate ($\psi_j = 3.16\%$) and less leisure time, with households spending now over 40% of their time at work. This also implies an even larger government investment distortion, with a higher capital income tax rate, as governments now compensate for this by further increasing government production expenditure. Hence, by introducing a new distortion via above-optimum capital taxation (and also necessarily higher than the uncoordinated fiscal competition equilibrium), the harmonization of capital income taxes exacerbates another distortion, the fiscal competition-induced government investment distortion, and result sin even larger welfare losses. In other words, capital income tax harmonization, rather than preventing harmful fiscal competition between jurisdictions, shifts competition towards other tax bases and actually intensifies fiscal competition. Furthermore, insofar as it may even exacerbate existing expenditure-side distortions, this is likely to come at no gain in terms of distributional effects or social welfare.

Particularly given the relatively limited importance of corporate taxation in the aggregate tax revenues of EU countries (and across the OECD, in general), one message is thus clear: capital income tax harmonization is unlikely to deter fiscal competition. Instead, it produces further distortions, namely on the government expenditure side. This also suggests that the distributional effects of capital income tax harmonization cannot be taken for granted.

3.5.2 Labour income tax harmonization

Considering now the imposition of a minimum threshold (or common rates) for labour income taxes across the EU, these are chosen again to stand in the interval

Table 5: Capital income tax harmonization. A detailed description of different scenarios presented in this table is offered in the main text. For comparison purposes, the benchmark and optimal policy scenarios are again presented in the first two rows. All fiscal parameter values are presented, together with corresponding simulations of equilibrium values of leisure hours, (net) rate of return on capital, equilibrium growth rate and welfare changes, with respect to the benchmark case. Labour income and consumption taxes are allowed to vary within bounds $(-\tau^L, \tau^C \leq 90\%)$. The reported changes in welfare are again relative to the benchmark economy. The large welfare effects in the presented policy simulations are justified namely by the form of the welfare function. Larger changes in the equilibrium growth rate, ψ_j, imply important (persistent) deviations in the equilibrium. The deviations from the benchmark or optimal policy set are sizeable and the large changes in government consumption expenditure implied by all alternative policy scenarios again imply very large welfare deviations. The more extreme policy simulations, with reported welfare changes of above 100%, are explained by the extreme size of the distortions under such equilibria and are reported with the aim to improve intuition rather than represent realistic policy scenarios. The order of magnitude can nonetheless be compared both to the benchmark or the optimal policy cases and other policy simulations. It is namely worth comparing the (growth-maximizing) equilibria under capital income tax harmonization and full tax competition (Table 4): the harmonization of capital taxes only leads to a further distortion in government production expenditure, leading to a further decrease in leisure time and the growth rate of the economy.

	τ^K	τ^L	τ^C	h_j	g_j	l_j	ψ_j	ΔW
Benchmark	0.31	0.38	0.20	0.20	0.20	0.78	1.48%	
Optimal policy	0.00	-0.55	0.55	0.17	0.08	0.66	2.91%	17.94%
$\boldsymbol{\tau^K = 10\%}$								
	-	-0.55	0.55	0.01	0.31	0.64	3.00%	-93.77%
	-	-0.90	0.55	0.01	0.29	0.60	3.02%	-84.99%
	-	**-0.90**	**0.90**	0.01	**0.39**	0.59	**3.16%**	**-129.18%**
	-	-0.70	0.90	0.01	0.40	0.61	3.15%	-138.68%

between the benchmark economy and optimal policy. The scenarios presented in Table 6 consider $\tau^L = 20\%$. Various policy scenarios are illustrated, with capital income and consumption taxes, as well as government expenditures, allowed to vary. The benchmark and optimal policy scenarios, discussed at length in the previous section, are also presented, to allow for simple comparisons.

Two main incentives identified earlier are now present: governments engage in a race to the top in consumption taxes, in order to fund productive government spending. Allowing for capital subsidies, implies that policymakers will have the incentive to set government production expenditure at the optimal level, and instead directly subsidize capital. Assuming no capital subsidies, the growth-maximising case now implies a smaller growth rate ($\psi_j = 3.44\%$) than under full

tax competition, but higher than that implied by capital income tax harmonization. Leisure time increases, relative to both optimal policy and capital income tax harmonization, with households spending now approximately the same time at work as in the benchmark economy. Although the tax burden on labour income is now lower and government production expenditure higher than in the benchmark economy, consumption taxes are also higher and government consumption expenditure is again driven to its lowest level.

Table 6: Labour income tax harmonization. A detailed description of different scenarios presented in this table is offered in the main text. For comparison purposes, the benchmark and optimal policy scenarios are again presented in the first two rows. All fiscal parameter values are presented, together with corresponding simulations of equilibrium values of leisure hours, (net) rate of return on capital, equilibrium growth rate and welfare changes, with respect to the benchmark case. Labour income and consumption taxes are allowed to vary within bounds $(-\tau^L, \tau^C \leq 90\%)$. The reported changes in welfare are again relative to the benchmark economy. The large welfare effects in the presented policy simulations are justified namely by the form of the welfare function. Larger changes in the equilibrium growth rate, ψ_j, imply important (persistent) deviations in the equilibrium. The deviations from the benchmark or optimal policy set are sizeable and the large changes in government consumption expenditure implied by all alternative policy scenarios again imply very large welfare deviations. Note that, despite resulting in an equivalent decrease in government consumption expenditure, the magnitude of the welfare drop is less significant once (direct) capital subsidies are allowed. The *order of magnitude* can be compared to that of other policy simulations, both the two baseline cases presented in-table and other alternative policy simulations, for instance under capital income or consumption tax harmonization.

	τ^K	τ^L	τ^C	h_j	g_j	l_j	ψ_j	ΔW
Benchmark	0.31	0.38	0.20	0.20	0.20	0.78	1.48%	
Optimal policy	0.00	-0.55	0.55	0.17	0.08	0.66	2.91%	17.94%
$\boldsymbol{\tau^L = 20\%}$								
	0.00	-	0.70	0.01	0.32	0.77	3.36%	-91.80%
	0.00	-	**0.90**	0.01	**0.37**	0.77	**3.44%**	**-116.73%**
	-0.46	-	**0.90**	0.01	**0.08**	0.82	**4.85%**	**-59.02%**

The counteracting effect of consumption taxes and government production expenditure on leisure time can be seen by comparing rows 3 and 4. This explains the very small effect on leisure time, while the growth rate is significantly higher than in the benchmark case and in first-best optimal policy. The fiscal competition-induced government investment distortion plays again an important role on the latter, while the distortion introduced by labour income taxes (relative to the op-

timal policy scenario) does not seem to produce significant changes at this margin. Instead, labour income tax harmonization has an effect on the intra-temporal decision margin between labour and leisure, namely by preventing a "race to the top" in the subsidy to labour. Allowing for capital subsidies leads to a different equilibrium. While maximizing the (after-tax) rate of return on capital, it also does not further accentuate the government investment distortion. It does, however, again imply that consumption is taxed to subsidize capital, with potentially strong distributional effects. Labour income tax harmonization - both with or without direct capital subsidization - implies smaller welfare losses than capital income tax harmonization, which is partially explained by the smaller distortions created by this policy. Nevertheless, it also implies a shift towards indirect taxation, particularly for lower levels of labour income taxation. Hence, the potentially large welfare losses can once again be traced to the two main distortions induced by fiscal competition: the progressive shift towards consumption, or indirect, taxation and the government investment distortion, which translates into a large shift in the composition of government expenditure.

3.5.3 Consumption tax harmonization

Looking now at the scenario of consumption tax harmonization (or of an agreement over maximum VAT rate thresholds) across the EU, this is again chosen to stand in the interval between the benchmark economy and optimal policy. The scenarios presented in Table 7 consider $\tau^C = 40\%$. Different policy scenarios are considered, where capital income and labour income taxes, as well as government expenditures, are allowed to vary. Again, the benchmark economy and first-best optimal policy are presented.

The harmonization of consumption taxes has now a crucial effect, as it acts on a key distortion induced by fiscal competition, unlike capital or labour income tax harmonization. Government can no longer rely on consumption taxation, or on the least distortive tax base, as means to raise government revenues to be channeled towards capital subsidies, either in direct or indirect form. Hence, without a "race to the top" in consumption taxes, we can look first at a scenario where this is the only tax in the economy, with income taxes being abolished (as in the "second-best" scenario presented in Table 3). The expenditure side incentive to devote government expenditures towards productive activities is again obvious, as shown in row 3 (Table 7).

Table 7: Consumption tax harmonization. A detailed description of different scenarios presented in this table is offered in the main text. For comparison purposes, the benchmark and optimal policy scenarios are again presented in the first two rows. All fiscal parameter values are presented, together with corresponding simulations of equilibrium values of leisure hours, (net) rate of return on capital, equilibrium growth rate and welfare changes, with respect to the benchmark case. Labour income and consumption taxes are allowed to vary within bounds $(-\tau^L, \tau^C \leq 90\%)$. The reported changes in welfare are again relative to the benchmark economy. The large welfare effects in the presented policy simulations are justified namely by the form of the welfare function. Larger changes in the equilibrium growth rate, ψ_j, imply important (persistent) deviations in the equilibrium. The deviations from the benchmark or optimal policy set are sizeable and the large changes in government consumption expenditure implied by all alternative policy scenarios again imply very large welfare deviations. In the more extreme case, with a reported welfare change of above 100%, this is explained by the extreme size of the distortions under such equilibrium, featuring a very large shift from government consumption towards production expenditure, without a sizeable "growth dividend". This is reported with the aim to improve intuition rather than represent a realistic policy scenario. Note that, despite a similar decrease in government consumption expenditure, the magnitude of the welfare drop is much less significant once capital subsidies are allowed. The *order of magnitude* can nonetheless be compared to that of other policy simulations, both the baseline cases and other alternative policy simulations, for instance with capital income or labour income tax harmonization. Further details presented in Table 8.

	τ^K	τ^L	τ^C	h_j	g_j	l_j	ψ_j	ΔW
Benchmark	0.31	0.38	0.20	0.20	0.20	0.78	1.48%	
Optimal policy	0.00	-0.55	0.55	0.17	0.08	0.66	2.91%	17.94%
$\boldsymbol{\tau^C = 40\%}$								
	0.00	0.00	-	0.01	0.21	0.74	3.23%	-68.28%
	0.00	**-0.75**	-	0.01	**0.17**	0.64	**3.27%**	**-58.00%**
	-0.18	0.00	-	0.01	0.08	0.76	3.61%	-52.82%
	-0.17	-0.10	-	0.01	0.08	0.75	3.61%	-52.26%
	-0.19	**0.10**	-	0.01	**0.08**	0.78	**3.62%**	**-54.12%**

Yet there is now an incentive set income taxes optimally, given consumption taxes. In equilibrium, this implies that capital income taxes remain at their lowest level, while labour income taxes are set "optimally" to maximise the (after-tax) rate of return on capital. Without capital subsidies, this will imply a subsidy to labour, closer to the optimal policy scenario, and setting government production expenditures at a higher-than-optimal level, yet with a much smaller scope to over-invest in this item. Hence the fiscal competition-induced government investment distortion is somehow "minimized", given the harmonized level of (or maximum threshold on) consumption taxes.

Allowing for capital subsidies (lines 5-7), the intuition is similar. Given consumption taxes, capital subsidies, labour income taxes and government production expenditure are "optimized" to deliver the highest (after-tax) growth rate. As in previous cases, allowing for capital subsidies implies that government production expenditure is driven to its optimum level ($\hat{g}_j = 0.08$), while in this case we will observe a positive labour income tax at $\tau^L = 20\%$, used to marginally increase the subsidy to capital. For this reason, with capital subsidies, working hours will be the lowest, similar to the benchmark value ($l_j = 0.78$). The growth rate will also be higher than without capital subsidies ($\psi_j = 3.62\%$), as government production expenditure is now also set at the first-best level. In turn, without capital subsidies, leisure hours ($l_j = 0.64$) are closer to the first-best scenario, as well as the growth rate of the economy ($\psi_j = 3.27\%$). In both cases, the magnitude of welfare losses is significant, although significantly smaller than in either of the scenarios of capital and labour income tax harmonization. The losses can mostly be attributed to the expenditure side distortion, introduced by capital mobility and fiscal competition.

3.5.4 Tax harmonization: a summary

Having analyzed the three main tax policy harmonization options, as well as the equilibria implied by those for the average EU-28 economy, we can now succinctly compare these scenarios and elaborate a bit further on the potential merits of each of these. Furthermore, we can consider policy scenarios where more than one tax is harmonized. This analysis should also put us in a position to highlight the main limitations of our approach, before moving on to another form of fiscal harmonization: the centralization of spending powers or, in the EU case, a significant enlargement in the size (and scope) of the EU budget.

Table 8 summarizes the three "benchmark" cases (rows 1-3) and the three equilibria reached with different tax harmonization scenarios, with no capital subsidies (rows 4-6). In addition, for labour income and consumption tax harmonization, the two equilibria with capital subsidies are also shown (rows 7 and 8). Capital income tax harmonization immediately stands out as the policy option that potentially carries the largest welfare losses. This is because it does not tackle two of the key (revenue-side) distortions introduced by fiscal competition, with full capital mobility: the over-subsidization of the labour-leisure choice and the shift towards indirect taxation. It also exacerbates the another distortion brought about by fiscal competition, the government investment distortion. The large welfare losses - even relative to the extreme tax competition equilibrium - can be explained by the very low leisure time and lower growth rate. Interestingly, the total share of government spending is unchanged when compared to the benchmark scenario, but the composition of government spending is dramatically shifted.

Looking through the different equilibria presented in Table 8, a significant share of the welfare losses can generally be attributed to the shift in the composition in

Table 8: Tax harmonization: summary. All the policy simulations with equilibria consistent with interjurisdictional fiscal competition (i.e. the "constrained" growth-maximizing cases analyzed earlier) are shown in this Table. The two policy scenarios which include direct capital subsidies are shown separately. The large welfare effects in the presented policy simulations - namely the tax competition scenario, as well as the harmonization of capital and labour income taxes - are explained by the underlying large changes in the equilibrium growth rate, ψ_j, and the level of government consumption expenditure, implied by all alternative policy scenarios. The two more extreme cases, with reported welfare changes of above 100%, feature very large shifts in the composition of government expenditures, without a sizeable "growth dividend". The magnitude of the welfare drops - even with the equivalently large decreases in government consumption expenditure - is much less significant once capital subsidies are allowed. Finally, note that the harmonization of consumption tax rates is the only option which limits the main distortion, related to the "race to the top" in government production expenditure, created by fiscal competition and further reinforced under the other tax harmonization scenarios.

	τ^K	τ^L	τ^C	h_j	g_j	l_j	ψ_j	ΔW
Benchmark	0.31	0.38	0.20	0.20	0.20	0.78	1.48%	
Optimal policy	0.00	-0.55	0.55	0.17	0.08	0.66	2.91%	17.94%
Tax competition	0.00	-0.90	0.90	0.01	0.32	0.61	3.63%	-89.44%
$\tau^K \geq 0\%$								
$\tau^K = 10\%$	-	-0.90	0.90	0.01	0.39	0.59	3.16%	-129.18%
$\tau^L = 20\%$	0.00	-	0.90	0.01	0.37	0.77	3.44%	-116.73%
$\tau^C = 40\%$	0.00	-0.75	-	0.01	0.17	0.64	3.27%	-58.00%
Capital subsidies								
$\tau^L = 20\%$	-0.46	-	0.90	0.01	0.08	0.82	4.85%	-59.02%
$\tau^C = 40\%$	-0.19	0.10	-	0.01	0.08	0.78	3.62%	-54.12%

government spending, which leaves government consumption expenditure at inefficiently low levels. Yet, the five different equilibria presented here uncover further interesting features. Compared to capital income tax harmonization, labour income tax harmonization acts directly in one key distortion: the "race to the top" in the subsidy to labour-leisure choice, which supposes a shift towards lower progressivity in labour income tax schedules, is circumvented. The considerable increase in leisure time, relative to both capital income tax harmonization and optimal policy, reflects this fact. Nonetheless, the shift from direct towards indirect taxation is not prevented. This leads to a sizable subsidy to capital, either via government production expenditure (row 5) or direct subsidies (row 7), the latter generally being assumed away in the context of EU competition regulations.

Yet, together with competitive pressures brought by capital mobility and international economic integration, this also intensifies the shift towards government production expenditure, causing larger distortions in the economy.

Finally, the case of consumption tax harmonization is considered. To be fully consistent with the model, this can be thought of as a general harmonization of (or, equivalently, imposition of maximum thresholds on) consumption taxes. This includes VAT, as well as, for instance, excise duties. This case is particularly interesting as it is the only tax harmonization scenario which proves adequate to limit a general shift from direct towards indirect taxation. Furthermore, by effectively limiting the ability of governments to raise revenues through less distortive (and mobile) tax bases, it also hinders a "race to the top" in (direct or indirect) capital subsidization. Comparing the two equilibria with capital subsidies, this is particularly clear. The bottom line is that the fiscal competition-induced government investment distortion is thereby diminished and the inter-temporal distortion that leads households to over-invest (relative to the first-best equilibrium) is, by implication, also restricted.

One message is thus clear from the comparison of different tax harmonization scenarios. If policymakers aim to curb the distortions induced by fiscal competition, the "order of preference" in tax harmonization agreements should be directed towards the harmonization of the least distortive taxes, on less mobile tax bases. Consumption tax rates, and particularly VAT rates, thus appear as the first candidate in such task. On the contrary, the harmonization of more distortive taxes, with more mobile tax bases, such as capital income taxes, rather than deterring fiscal competition, potentially leads to a shift in fiscal competition towards non-distortive taxation and government production expenditure. Rather

than correcting existing distortions, this brings further sources of distortion into the economy and is thus likely to do more harm than good, with no obvious gains in terms of the scope for redistributive policies at the national level.

Finally, considering joint tax harmonization scenarios reinforces the main message of this paper. Perhaps counter-intuitively, the harmonization of capital income taxes (or of income taxes, in general), by exacerbating the distortions originally triggered by fiscal competition, are likely to imply the largest welfare losses. Table 9 shows different joint tax harmonization scenarios, first with the tax rates analyzed so far, then over different rates. The joint harmonization of income taxes (row 1) implies a "race to the top" in indirect taxation and that the government investment distortion is magnified, resulting in the largest share of government production expenditure. It becomes again apparent that only consumption tax harmonization (eventually coupled with the harmonization of income taxes) is the only policy option capable of minimizing this distortion (rows 2-5).

Other tax harmonization scenarios highlighted in rows 6-10 shed light on how different *levels* of consumption tax rate harmonization may affect welfare. Assuming away labour income taxation, the optimum level of consumption tax harmonization is at a relatively low level, in the interval of $10 - 20\%$. This implies that, on the one hand, the level of consumption taxation is low enough to deter the fiscal competition-induced government investment distortion and, on the other hand, high enough to avoid inefficiently high capital income taxation. Capital income taxation cannot also be completely ruled out. Comparing rows 6 and 10, for instance, we observe that sustaining low levels of consumption taxation might be preferable than having the economy in an equilibrium with higher-than-optimal consumption taxes, even if that implies positive capital income taxes in

equilibrium. This also suggests that, in the presence of fiscal competition, optimal consumption taxation may be lower than in a closed economy environment.

Table 9: Joint tax harmonization: summary. All the policy scenarios consistent with interjurisdictional fiscal competition are shown in this Table. All fiscal parameter values are presented, together with corresponding simulations of equilibrium values of leisure hours, (net) rate of return on capital, equilibrium growth rate and welfare changes, with respect to the benchmark case. Non-harmonized taxes are allowed to vary within bounds ($\tau^K, -\tau^L, \tau^C \leq 90\%$). The reported changes in welfare are again relative to the benchmark economy. The first four rows combine the previous harmonized tax rates into pairs of joint tax harmonization scenarios. The fifth row works as a benchmark, combining all the three tax harmonization cases. Rows 6-9 set labour income taxes to zero and vary the (harmonized) tax rate on consumption. These simulations show that, in an environment of full capital mobility, the optimal harmonized level of consumption tax rates can be lower than in the optimal policy scenario, implicitly assuming a closed economy. All the scenarios presented in this table are equilibrium outcomes, where only one tax rate is allowed to vary at the time, again so to maximize the after-tax rate of return on capital, ϕ_j (i.e. consistent with interjurisdictional fiscal competition, like the "constrained" growth-maximizing cases analyzed earlier). A more detailed explanation of the different joint tax harmonization options is offered in the main text. The levels of tax rate harmonization, unless stated otherwise, are at the same levels as before, i.e. for the combination of any of the following two: $\overline{\tau}^K = 10\%$, $\overline{\tau}^L = 20\%$, $\overline{\tau}^C = 40\%$. These values were all chosen to stand between the benchmark and the optimal policy points. The four last rows feature a mix between labour income and consumption tax harmonization, with $\overline{\tau}^L = 0\%$ (equivalent to a "flat tax rate" system) and varying levels of consumption tax rates.

	τ^K	τ^L	τ^C	h_j	g_j	l_j	ψ_j	ΔW
$\overline{\tau}^K + \overline{\tau}^L$	-	-	**0.90**	0.01	**0.43**	0.76	**2.97%**	**-128.45%**
$\overline{\tau}^K + \overline{\tau}^C$	-	**-0.90**	-	0.01	**0.23**	0.60	**2.91%**	**-69.30%**
$\overline{\tau}^L + \overline{\tau}^C$	**0.00**	-	-	0.01	**0.22**	0.78	**3.17%**	**-65.20%**
$\overline{\tau}^L + \overline{\tau}^C$	**-0.19**	-	-	0.01	**0.08**	0.80	**3.61%**	**-55.32%**
$\overline{\tau}^K + \overline{\tau}^L + \overline{\tau}^C$	-	-	-	0.01	**0.29**	0.76	**2.79%**	**-82.64%**
$\overline{\tau}^L = 0\%$								
$\overline{\tau}^C = 0\%$	**0.14**	-	-	0.01	**0.08**	0.74	**2.10%**	**-60.02%**
$\overline{\tau}^C = 10\%$	**0.04**	-	-	0.01	**0.08**	0.74	**2.55%**	**-58.48%**
$\overline{\tau}^C = 20\%$	**0.00**	-	-	0.01	**0.11**	0.75	**2.90%**	**-54.23%**
$\overline{\tau}^C = 40\%$	**0.00**	-	-	0.01	**0.21**	0.74	**3.22%**	**-64.10%**

3.5.5 Federal budget: towards a new EU Cohesion Policy?

None of the above tax harmonization scenarios tackles another fundamental source of potential welfare losses, both relative to the benchmark economy and to the first-best allocation, under optimal fiscal policy. Fiscal competition between jurisdictions implies important shifts in government expenditure composition. A by-product of the so-called fiscal competition-induced government investment distortion is a persistent under-spending in government activities directly benefiting

households' welfare, or, in short, government consumption expenditure[53].

How to design a fiscal harmonization scheme that is able, at the same time, to address the main distortions introduced both on the taxation and on the expenditure side? Assuming away the possibility (or desirability) of having large shares of earmarked government expenditure - particularly taking into account the hybrid nature of a vast majority of public goods, both with a "productive" and a "welfaristic" role - we consider the centralization (rather than harmonization) of spending powers. Starting from a broad principle of public finance, the principle of subsidiarity[54], the following proposals take as given that, on the one hand, certain government expenditures can be "centralized" while being tailored to different local needs (e.g. healthcare) and, on the other hand, that it is politically feasible to consider a scenario under which a 'federal budget' is broad enough to cover some comon fundamental areas of government intervention (e.g. unemployment insurance). Recent proposals that go in this direction, although generally more focused on the response of EU economies to the business cycle, include for example the creation of a common European unemployment mechanism (Beblavý and Maselli 2014, Abraham et al. 2018a, Dolls et al. 2018).

Tables 10 and 11 consider different policy scenarios, under which a significant share of government expenditures is set at the central or federal level. We first start from a share of the budget which corresponds to 20% of aggregate output, approximately equivalent to the US federal budget. Another underlying assumption is that the areas of intervention of a common EU budget ought to be predomi-

[53]This type of expenditure can be interpreted in a broad sense. Even acknowledging the productive character of some of the following areas of intervention, we can broadly identify government consumption expenditure as spending on merit goods or as welfare spending. This can range from healthcare and education spending towards government benefits or welfare-improving public infrastructure.

[54]This principle is also frequently acknowledged as one of the leading principles underlying the design of EU treaties and institutions, and, in general, in the design of federal institutions. (REFERENCES HERE)

nantly of a welfaristic nature, including for instance unemployment insurance and targeted family benefits, or a share of healthcare and education spending.

It is assumed throughout the exercise that sub-central jurisdictions, EU countries, still keep full discretion over the size and composition of national government expenditure. Furthermore, it is also initially assumed that the EU budget is funded by EU countries, broadly in a negotiation process that implies pluri-annual financial agreements, similar to the current EU financing framework. This implies however an unrealistic large share of government expenditure centralization while jurisdictions have full discretion on setting tax rates. Rows 3-4 in Table 10 represent the two equilibria reached under this scenario, with and without capital subsidies, respectively. These are meant to work as a 'benchmark' case and allow further comparison with the remaining policy scenarios, under which the same share of government expenditure is also centralized, coupled with some degree of tax harmonization across EU countries. Rows 5-7 present different scenarios of joint tax harmonization. One trend emerges from the equilibria reached under the three different policy scenarios: only consumption tax harmonization averts a "race to the top" in government production expenditure at the sub-central level. Interestingly, for a high level of consumption tax rates, there is an incentive for governments to set government production expenditures below optimum (row 7). This is because, given government consumption expenditures above (first-best) optimum, policymakers attempt to correct this distortion by ensuring that *aggregate* government spending remains close to optimum and by giving an incentive for households to invest more[55].

Taking this into account, rows 8-10 show the results for different levels of the

[55]Tables D.1 and D.2 in Appendix show further results and how different fiscal harmonization scenarios reach different equilibria highlighted here.

consumption tax rate. Only consumption taxes are harmonized (together with the centralization of a share of government spending), whereas both capital and labour income taxes are allowed to move freely, bearing again in mind the incentive of sub-central jurisdictions to maximize the after-tax or private rate of return on capital. A similar picture emerges: given the size and composition of the federal budget, and given consumption tax rates, policymakers will have the incentive to set income taxes and government productive expenditures "optimally".

Policymakers at the federal level can thus be thought to face three key issues, setting the size and composition of the federal budget, as well as the harmonized level of consumption taxes, that maximizes economic welfare and is consistent with interjurisdictional fiscal competition. The three scenarios highlighted in Table 10 suggest one important trade-off when setting the "optimal" rate of consumption taxes. A higher-than-optimal consumption tax rate implies an incentive for sub-central jurisdictions to subsidize capital. A lower-than-optimal consumption tax rate implies that sub-central jurisdictions will tax labour income too heavily, in order to fund government productive expenditure. One immediate implication is that higher consumption tax rates across the EU imply a higher growth rate of the economy, although this does not necessarily imply higher welfare.

Table 11 shows the results for a more limited fiscal reform[56]. The scenarios included here assume a smaller EU budget, approximately equal to 3% of GDP. One can think of this as a scenario under which the composition of the EU budget is broadly kept at the current level, while, for instance, a common European unemployment insurance system is set in place. Hence, the scope of the EU budget remains limited, while the increase in size can be explained by this "fixed" expenditure across EU countries. Row 3 summarizes the equilibrium reached

[56]Please refer to Table D.3 in Appendix for the complete set of policy simulation results.

Table 10: EU federal budget. All the policy scenarios consistent with interjurisdictional fiscal competition are shown. For comparison purposes, the benchmark and optimal policy scenarios are presented in the first two rows. All fiscal parameter values are presented, together with corresponding simulations of equilibrium values of leisure hours, (net) rate of return on capital, equilibrium growth rate and welfare changes, with respect to the benchmark case. Non-harmonized taxes are allowed to vary within bounds ($\tau^K, -\tau^L, \tau^C \leq 90\%$). The reported changes in welfare are again relative to the benchmark economy. It is assumed throughout the different scenarios that the share government consumption expenditure is set equal to the benchmark level ($h_j = 20\%$). This supposes a relatively high level of centralization of spending powers. A more detailed discussion of the different policy scenarios is offered in the main text. The levels of tax rate harmonization are presented in the table. These values were all chosen to stand between the benchmark and the optimal policy points. The three last rows feature only consumption tax harmonization, showing a potentially optimal level of consumption tax rate harmonization below the optimal policy level.

	τ^K	τ^L	τ^C	h_j	g_j	l_j	ψ_j	ΔW
Benchmark	0.31	0.38	0.20	0.20	0.20	0.78	1.48%	
Optimal policy	0.00	-0.55	0.55	0.17	0.08	0.66	2.91%	17.94%
$\boldsymbol{h_j = 20\%}$								
	0.00	**-0.90**	**0.90**	-	**0.14**	0.61	**3.24%**	**4.02%**
	-0.15	**-0.20**	**0.90**	-	**0.08**	0.72	**3.57%**	**6.86%**
$\tau^K = 10\% + \tau^L = 20\%$	-	-	**0.90**	-	**0.25**	0.76	**2.73%**	**-10.64%**
$\tau^K = 10\% + \tau^C = 40\%$	-	**-0.45**	-	-	**0.08**	0.66	**2.40%**	**7.91%**
$\tau^L = 20\% + \tau^C = 50\%$	**-0.02**	-	-	-	**0.07**	0.78	**2.74%**	**9.77%**
$\overline{\tau}^C = 50\%$	-0.02	0.19	-	-	0.07	0.78	2.74%	9.23%
$\overline{\tau}^C = 45\%$	**0.00**	**0.16**	-	-	**0.06**	0.77	**2.62%**	**9.88%**
$\overline{\tau}^C = 40\%$	0.00	0.32	-	-	0.05	0.81	2.47%	8.21%

when this is coupled with consumption tax harmonization, at a relatively low level, close to the benchmark economy ($\tau^C = 19\%$). This level is also chosen so that a "race to the top" in government production expenditure is prevented. Although the potential welfare losses are clear, they can be attributed to below-optimal government consumption expenditures.

Yet, these policy simulations clearly suggest that even a limited expenditure-side reform at the EU level, coupled with some degree of tax harmonization, can go a long way in ensuring that the (potentially large) welfare losses from interjurisdictional EU fiscal competition are thwarted[57].

[57] Rows 9-11 in Table D.3 show the results for a similar policy reform coupled instead with capital income tax harmonization. Clearly, given the incentive for governments to over-invest - by resorting to indirect taxation - the potential welfare losses are still not prevented and can be traced back to the fiscal competition-induced government investment distortion.

Table 11: Limited EU budget. All the policy scenarios consistent with interjurisdictional fiscal competition are shown. For comparison purposes, the benchmark and optimal policy scenarios are presented in the first two rows. All fiscal parameter values are presented, together with corresponding simulations of equilibrium values of leisure hours, (net) rate of return on capital, equilibrium growth rate and welfare changes, with respect to the benchmark case. Non-harmonized taxes were allowed to vary within pre-defined bounds. It is assumed throughout the exercise that the EU budget is increased to a ratio of 3% of GDP. Under this scenario, the policy simulations show consumption taxes are harmonized at a level of $\tau^C = 19\%$, just below the current EU-28 average in the benchmark scenario, deliver the best result, in terms of the computed welfare measure.

	τ^K	τ^L	τ^C	h_j	g_j	l_j	ψ_j	ΔW
Benchmark	0.31	0.38	0.20	0.20	0.20	0.78	1.48%	
Optimal policy	0.00	-0.55	0.55	0.17	0.08	0.66	2.91%	17.94%
$\boldsymbol{h_j = 3\%}$								
$\overline{\tau}^C = 19\%$	**-0.01**	**0.10**	-	-	**0.08**	0.77	**2.80%**	**-16.24%**

3.6 Concluding remarks

Fiscal competition between EU countries is likely to bring large welfare losses and, sooner rather than later, imply very large shifts in tax and spending structures of EU governments. Some form of fiscal coordination is thus commonly advocated in order to prevent such type of non-cooperative Nash equilibrium. An obvious question immediately follows: how should policymakers design a future EU fiscal harmonization agreement? In this context, several fiscal reform proposals have been put forward. Tax harmonization proposals, in particular, have taken many different forms over the past decades, but have almost solely focused on capital income tax harmonization. This paper proposes a fundamentally different approach to fiscal harmonization.

Two main messages emerge. Firstly, capital income tax harmonization is no panacea. If EU countries aim to curb interjurisdictional fiscal competition and prevent large welfare losses that can potentially emerge from it, indirect taxes, rather than income taxes, should become priority targets of any fiscal reform proposals. Perhaps counter-intuitively, this is due to the fact that the incidence of

indirect taxes, such as value-added taxes, generally falls over least distortive tax bases and thus provide the most efficient way for governments to raise revenues. In the context of intense fiscal competition among EU countries, governments have the incentive to direct tax revenues towards capital subsidization. This can come in two distinct forms: direct subsidies, typically ruled out in the context of EU and WTO regulations, and indirect subsidies, through higher government productive expenditures. We refer to this as a fiscal competition-induced government investment distortion. A race to the top thus emerges in indirect taxation and government production expenditure in a non-cooperative or unconstrained fiscal competition scenario. Indeed, if only direct taxes - such as corporate or personal income taxes - are harmonized, this is likely to reinforce this shift and produce even larger distortions in fiscal policies across EU member states.

Secondly, revenue side reforms - such as the introduction of harmonized VAT taxation across the EU - must be accompanied by expenditure side reforms. This is because the government investment distortion implies potentially large shifts on the composition of government expenditure. In particular, indirect capital subsidization through higher government productive expenditures comes at a price: a race to the bottom in government expenditures of a predominantly welfaristic nature. We have thus analyzed different scenarios which suppose a larger EU budget. In a nutshell, even limited reforms - such as the introduction of a common European unemployment insurance mechanism or larger EU budget contributions in targeted areas of government welfare expenditure - can go a long way in preventing the potentially large welfare losses from fiscal competition between EU countries, if coupled with an harmonized VAT taxation framework. The results of our simulations also suggest a strikingly different approach for EU Cohesion

Policy, with implications on both the size and areas of intervention of the EU budget. In particular, while a significant share of the current EU budget is devoted to agricultural and structural policies, in order to promote the catching-up of economically disadvantaged regions, the results from our policy simulations suggest that a progressive shift of EU Cohesion policies towards welfaristic spending is paramount to achieve a common European fiscal agreement consistent with deepening capital mobility and economically integrated EU economies.

The size and scope of a federal EU budget will nonetheless necessarily depend, on the one hand, on how different fiscal reforms can be implemented while ensuring that enough fiscal discretion is kept at the national level. On the other hand, on the political feasibility of such reforms, constrained namely by different policy preferences across countries, which can bring important constraints at least on the *levels* of (harmonized) taxation and size of the EU budget. Regarding a common European unemployment insurance system, Abraham et al. (2018a) have shown that significant welfare gains can be achieved from implementing common policies in all countries involved, while at the same time leaving room for national adjustments on the generosity of unemployment benefits. A consistent EU fiscal harmonization agreement is thus most likely to succeed if it goes in the direction of setting common minimum (and maximum) thresholds, rather than aiming at harmonizing tax and spending decisions at the national level.

One main limitation emerges from this analysis: the model is silent about the dynamics of income inequality and redistribution in different environments of fiscal competition or partial fiscal harmonization. Yet, at least one question emerges: if countries are unable to set positive capital income taxes (or even progressive labour income tax schedules), how to solve the problem of income redistribution in

a world of capital mobility and deepening economic integration? This paper suggests the issues of income redistribution and tax harmonization should be treated separately, at first. Tax harmonization must first and foremost ensure that the distorting incentives of tax competition can effectively be constrained and welfare losses minimized. Concerns with income inequality and redistribution should then be addressed, again with the need to ensure that national tax schemes are consistent with fiscal competition incentives. Guerreiro et al. (2018), for instance, suggest that, in the absence of lump-sum or discriminatory personal income tax regimes, a tax on automation (which can go up to almost 40%) coupled with a universal transfer can be the best way to redistribute. In the EU, the introduction of such taxes must necessarily be coordinated and the universal transfer system can be set in place in connection with a common unemployment insurance mechanism. Finally, one classical conclusion from the literature on optimal capital taxation is that policymakers ought to tax wealth rather than capital income, because the latter distorts the intertemporal investment-savings decisions of households, while the former can be seen as a lump-sum tax. One problem with such option ensuring credible commitment (Diamond and Saez, 2011). This has also been suggested as a motivation for a switch from capital income to consumption taxation. A common system of progressive consumption taxation can thus potentially reap two virtues of wealth and consumption taxation, as a way to redistribute and limit the distortive incentives of income taxation. This paper thus reinforces the view that a shift towards consumption taxation can be desirable, particularly a context of intense fiscal competition, and indeed more feasible and less distortive than attempting to sustaun high capital income taxes across the EU.

IV

Fiscal Decentralization and Debt Limits in OECD Countries

IV Fiscal Decentralization and Debt Limits in OECD Countries

Abstract

Governments can be understood to have two main fiscal policy targets over the short-term: macroeconomic and debt stabilization. Yet, there can often be a trade-off between both. Fiscal policy across OECD countries has become pro-cyclical over recent decades, particularly within the EMU. We assess the role of fiscal decentralization and endogenous debt limits on the fiscal stance of OECD countries and assess whether this may have played a role in the fiscal responses before and after the recent European sovereign debt crisis. Both the average level of structural fiscal balances and their responsiveness to indebtedness conditions are found persistently weaker beyond the 70 percent debt-to-GDP threshold, pointing towards a fiscal fatigue phenomenon. The effect of fiscal decentralization appears to be more complex, not least because of the large heterogeneity in both the size and scope of fiscal decentralization across OECD countries. Large intergovernmental transfer systems do appear however negatively associated with the fiscal stance, particularly when sub-national governments have a wide policy scope.

4.1 Introduction

The message from the large literature on real business cycles, macroeconomic stabilization and public finance is clear: fiscal policy should be counter-cyclical. In this context, discretionary fiscal policy, as measured by structural or cyclically-adjusted balances, should at best be acyclical, while automatic stabilizers are let to work in order to smooth the business cycle. In particular, in environments like the European Monetary Union (EMU), where member countries share a common currency and have no control over monetary policy, fiscal policy becomes the sole instrument to respond to asymmetric macroeconomic shocks and is thus expected

to respond adequately in order to smooth the business cycle (Galí et al., 2003)[58]. As the EMU sovereign debt crisis has shown, accumulating 'rainy day funds' is thus paramount for countries to ensure fiscal discretion over the business cycle.

Yet, the empirical literature on fiscal policy cyclicality finds broadly mixed results and fiscal policy is frequently found acyclical in developed economies, or even pro-cyclical. Recent studies shed more light on this phenomenon. For instance, Vegh and Vuletin (2015) find that tax policies tend to be acyclical in developed economies but pro-cyclical in developing countries. Kaminsky et al. (2005), Ilzetzki and Végh (2008) and Cuadra et al. (2010) find similar results in the context of developing economies. Recent evidence also suggests that fiscal fatigue may influence the fiscal stance, as the ability of governments to increase primary balances may be undermined by rising stocks of debt (Ghosh et al. 2013, Checherita-Westphal and Žďárek 2017 and Pappadà and Zylberberg 2018). Many other factors have been identified as determinants of fiscal policy cyclicality. Frankel et al. (2013) find a causal relationship between strong institutions and countercyclical fiscal policies[59]. Many contributions have also highlighted how fiscal policy responses can be influenced by different political economy factors, such as the existence of formal fiscal rules and electoral cycles (Lindbeck 1976, Barro 1979, Alesina and Sachs 1988, Rogoff and Sibert 1988, Alesina and Roubini 1992, Jones et al. 2000, Persson and Tabellini 2001, Hallerberg et al. 2007).

In light of the above, we study the fiscal behaviour of twenty-five OECD countries, from 1995 to 2016, thirteen of which are within the EMU (nineteen are

[58]Moreover, as public debt is issued in a currency over which governments have no control, the rationale for counter-cyclical policies is reinforced, as countries become prone to speculative attacks and can eventually face the need to switch off automatic stabilizers.

[59]Tornell and Lane (1999) suggest that, in a context of weak institutions, a lower concentration of power leads to a less pro-cyclical fiscal policy. This is related to a "voracity effect", which makes fiscal policy too expansionary in upswings, due to the influence of different interest groups.

current EU member countries). Discretionary fiscal policy is found markedly pro-cyclical, which suggests a divergence in practice between policy and theory. We thus re-assess the main determinants of fiscal responses in developed economies and how these might have been affected by different factors. The literature on fiscal reactions functions is generally concerned with two issues: fiscal policy cyclicality and sustainability (Bohn 1998, Galí et al. 2003 Lane 2003). In this paper, we focus in particular on the issue of fiscal policy cyclicality. Consistently with the literature, we include other determinants of policy cyclicality commonly identified.

We aim in particular to assess the role of fiscal decentralization and endogenous debt limits on the fiscal stance of OECD and EU economies and assess whether this may have played a role in the fiscal responses before and after the recent European sovereign debt crisis. However, it is well-known that fiscal decentralization, as a complex phenomenon, is hard to measure clearly. Different effects of fiscal decentralization on the fiscal stance can also be considered. On the one hand, local and regional governments with wide spending powers may have a negative impact on fiscal coordination, thereby influencing the fiscal stance and making it less responsive to the business cycle at the national level. On the other hand, such coordination problems might not actually be present, either because sub-national governments do not have strong revenue-raising powers and rely on intergovernmental grants or because the level of spending autonomy is limited. The latter case implies that sub-national governments can be seen as regional and local administrative divisions or agencies of the central government. In this context, we explore the effects of fiscal decentralization by using different measures of fiscal decentralization. We profit in particular from the detailed measures of expenditure and revenue decentralization made available by the OECD. In addition, we use a

novel dataset which measures the fiscal discretion of regional governments. The Local Authority Index (LAI) presents comparable data for 39 European countries, analyzing and reporting changes in the extent of fiscal and political decentralization. In particular, the measures of decentralization presented in this dataset capture in detail the extent to which local authorities have fiscal discretion over their budgets, and was put together as part of the project "Self-rule Index for Local Authorities" (European Commission, 2015).

Other studies have also focused on the link between fiscal decentralization and the fiscal stance (Afonso and Hauptmeier 2009, Schaltegger and Feld 2009, Baskaran 2010, Eyraud et al. 2011, Eyraud et al. 2012, Foremny and von Hagen 2012). The decentralization of spending powers is associated with lower public debt (Baskaran, 2010) and improving fiscal balances of the general government, particularly if coupled with decentralization of revenue-raising powers (Eyraud et al., 2012). On the other hand, it is also suggested that ensuring sustainable fiscal policy at the central level is key for the effective performance of sub-national governments facing adverse macroeconomic conditions (Foremny and von Hagen, 2012). In a related study, Asatryan et al. (2015) find that greater revenue autonomy tends to foster fiscal discipline at the sub-national level. The potential effect of fiscal decentralization on long-term fiscal sustainability and macroeconomic stabilization thus vary widely. Sub-national governments can act as mere agencies of the central government and have little room for fiscal maneuver, or instead as act as autonomous institutions with extensive fiscal powers, independently of the central government. The extent to which both revenues and expenditures are decentralized may nonetheless also vary in any of these cases.

The main aim of this study is to assess how the degree of *de facto* sub-national

fiscal decentralization affects fiscal performance. *De jure* fiscal decentralization does not necessarily affect long-term fiscal sustainability or have direct implications for macroeconomic stabilization. *De facto* fiscal decentralization, on the other hand, with extensive fiscal autonomy at the sub-national level, may affect macroeconomic stabilization, as ultimately the aggregate fiscal response will depend on the sum of different fiscal behaviours at the national and sub-national levels. Long-term fiscal sustainability may also be affected, if fiscal decentralization is coupled with pervasive fiscal incentives at the sub-national level. The potential concerns raised by the existence of high levels of vertical fiscal imbalances, created when large intergovernmental transfer systems are in place to finance extensive expenditure responsibilities at the sub-national level, are again ambiguous. The literature on fiscal federalism suggests vertical fiscal imbalances can generate common pool incentives and eventually cause long-term fiscal sustainability problems. Yet, this can also be seen as the result of an optimal organization of tax and spending responsibilities in federal systems.

We find five main policy patterns. Firstly, discretionary fiscal policy, as measured by structural primary balances, is found predominantly pro-cyclical over the period. Secondly, consistent with long-term fiscal sustainability concerns, the fiscal stance is found to respond positively to rising debt-to-GDP ratios. Thirdly, a persistent negative effect of election periods on the fiscal stance is also clear, suggesting the relevance of electoral budget cycles. These findings are robust across different specifications and sample characteristics. Yet, the existence of dissimilar fiscal responses across different debt-to-GDP levels suggests the importance of endogenous debt limits. Fourthly, in this context, we find that both the average level of structural fiscal balances and their responsiveness to rising debt

levels is persistently weaker beyond the 70 percent debt-to-GDP threshold. This points towards the relevance of fiscal fatigue in debt overhang environments. Finally, the effect of fiscal decentralization appears to be more complex. Revenue decentralization appears to exhibit a negative relationship with the average level of structural balances. Yet, once considering the level of sub-national autonomy, this effect disappears and, instead, the degree of vertical fiscal imbalances appears with a strong negative relationship with the fiscal stance. This result is reinforced by two additional findings. On the one hand, while a higher level of expenditure decentralization exhibits a negative relationship with average corporate taxation, revenue decentralization appears associated with higher average personal income tax rates. On the other hand, exploring other indicators of sub-national fiscal autonomy, we can observe that vertical fiscal imbalances appear once again negatively related to the fiscal stance, particularly when sub-national governments are involved in the provision of a wide range of public services. The responsiveness to the business cycle does not appear directly affected, suggesting that coordination problems do not play a major role in explaining the cyclical behaviour of discretionary fiscal policy.

In the next section we review the main literature on fiscal reaction functions. We also shed light on possible links between fiscal decentralization and the cyclicality of fiscal policy, based on the classic literature on public finance and fiscal federalism. We present our data and methodology in the third section. In the fourth section, we explore the main results and present robustness checks. Finally, in the last section we offer some concluding remarks, discuss the main limitations of our paper and highlight some possible avenues for future research.

4.2 Literature review and motivation

Fiscal policy is one of the most important tools for policymakers in developed economies and is widely used both for redistributive and stabilization purposes. In the context of the EMU, it is in fact the only stabilization tool at the disposal of national governments to counter asymmetric macroeconomic shocks. In this context, the fiscal background also imposes important constraints on the fiscal stance (Galí et al., 2003), in light of the rules set out by the Maastrich Treaty and the Stability and Growth Pact (SGP), or more recently the Fiscal Compact (TSCG)[60], Accordingly, the great emphasis recently put on national fiscal responsibility and long-term debt sustainability led to a renewed set of contributions in the literature. In this section, we aim to briefly review the literature on fiscal reaction functions, focusing in particular on the recent contributions. We then focus on the empirical assessments of the fiscal behaviour of EU and OECD countries, in order to obtain a first grasp of the main policy patterns observed in recent decades across developed economies. Finally, we review shortly the literature on fiscal federalism, aiming to identify the main mechanisms that may link fiscal decentralization and the fiscal stance, before moving on to explore the data and methodology used in this paper,

4.2.1 Fiscal reaction functions: theoretical frameowork

The motivation for the large literature that has developed on fiscal reaction functions since the contribution of Bohn (1998) can be traced further back to the early work of Barro (1979), exploring long-term fiscal policy sustainability. Namely, this

[60]The Treaty on Stability, Coordination and Governance in the Economic and Monetary Union (TSCG), in its formal denomination, came into force after the European sovereign debt crisis, building upon the SGP and aiming to introduce better surveillance mechanisms (the so-called preventive arm) and to reinforce budgetary controls (the so-called corrective arm).

literature stemmed from an early positive theory of "optimal" fiscal policy, identifying factors that can influence the choice between taxes and the issue of debt. While these early models generally accepts that Ricardian equivalence can be seen as a valid long-run relationship, they introduce other "second-order" or short-run considerations, which include for instance the overall tax burden, to obtain an optimal level of debt creation. This analysis thus concentrates on variables that could in principle be dominated in the long-run by "first-order" effects. The early model of Barro (1979) is thus used as the underlying theoretical framework to test whether there is an effect of government spending, temporary variations in income, or of expected inflation on new debt issuance[61]. In Bohn (1998), a similar focus can be found on the behaviour of the US fiscal balances in the post-war period. The aim was to assess whether the US government satisfied its intertemporal budget constraint, by setting fiscal policy appropriately in response to changes in the debt-to-GDP ratio. To this end, a fiscal reaction function is established, in order to evaluate the response of the fiscal stance, extracting the effect of non-discretionary elements of fiscal policy (viz. automatic stabilizers and debt service). Other determinants of government fiscal behaviour are included as control variables. A positive link is found between the debt-to-GDP ratio and fiscal balances, interpreted as evidence of long-term US fiscal policy sustainability[62].

The literature on fiscal reaction functions can be divided into two main categories. Using a common analytical framework and empirical tools, the focus is frequently placed on two main issues: long-term debt sustainability and fiscal

[61]The theoretical hypotheses set out by this model are tested with post-war US data. By and large, the empirical results confirm the underlying theory. The magnitude of countercyclical debt responses, however, appears somewhat larger than implied by the theory, which is interpreted as an indicator of US government concerns with stabilization policy in the post-war period.

[62]Ghosh et al. (2013) point out, however, that this may not be enough to preclude rising debt-to-GDP ratios. Hence, a positive relation between debt-to-GDP and fiscal balances should instead more cautiously be interpreted as a weak sustainability criterion.

policy cyclicality. The literature can thus be understood as a predominantly "normative" empirical literature assessing the overall quality of fiscal policy, through the short-run response of fiscal balances to different factors. Recent contributions have focused on both issues[63]. In the former case, the main concern is in assessing the fiscal response to rising debt ratios, whereas in the latter case the response to a measure of short-term macroeconomic performance, generally the output gap, is explored. All these approaches however follow the initial spirit of Bohn (1998), focusing on the quality of fiscal policy, as both (counter-)cyclicality and long-term sustainability can be seen as two desirable properties of fiscal policy. Hence, policymakers can be thought to have, not just one, but two needles on their fiscal policy compass: cyclicality and sustainability. As pointed out by Fatás and Mihov (2010), while sustainability relates to a long-term quality of fiscal policy, it is also connected in many ways to short-term macroeconomic stabilization.

Looking now at the left-hand side of fiscal reaction functions, both strands of the literature focus on similar measures of fiscal balances, with the aim to capture the *response* of fiscal policy to different variables. Hence, the focus on primary rather than overall fiscal balances - thereby extracting the debt service, which depends on the "stock" of past fiscal decisions -, or, more commonly, the use of cyclically-adjusted measures of the fiscal stance, aiming to extract the cyclical components of fiscal policy, namely the effect of automatic stabilizers. The use of the cyclically-adjusted primary balance (CAPB) is thus consistent with the primary focus of the literature, insofar as it is able to isolate the discretionary component of fiscal policy, i.e. the fiscal reaction, from aggregate measures of

[63]On fiscal sustainability: Bohn (2005), Afonso (2008), De Mello (2008), Mendoza and Ostry (2008), Afonso and Hauptmeier (2009), Afonso et al. (2010), Daniel and Shiamptanis (2013), Ghosh et al. (2013), Weichenrieder and Zimmer (2014). On fiscal policy cyclicality: Turrini et al. (2008), Golinelli and Momigliano (2009), Fatás and Mihov (2010), Battilossi et al. (2013), Égert (2014).

the fiscal balance, which are necessarily influenced by other characteristics of the fiscal stance[64]. In addition, the inclusion of automatic stabilizers on the left-hand side of a fiscal reaction function can be particularly problematic, as the size and magnitude of this component becomes reliant on specific country characteristics, which show high persistence over time[65].

4.2.2 Fiscal reaction functions: empirical specification

The estimation of models that relate the fiscal stance to the output gap, the ratio of public debt and other fiscal variables brings several challenges that must be addressed, before any econometric inference can validly be drawn. The variables in the equation form a fundamental identity, which prevails in any circumstance. We can thus start by writing the fundamental government budget constraint:

$$B_t = G_t - T_t + (1 + r_t)B_{t-1}$$

where B_t is the stock of government debt in period t, expressed as the sum of primary spending, G_t, and the interest rate, r_t, paid on the existing stock of debt, B_{t-1}, net of government revenues, T_t, in any period t. The above can also be written as a difference equation, defining the overall fiscal balance:

$$\Delta B_t = B_t - B_{t-1} = G_t - T_t + r_t B_{t-1}$$

we thus can write the budget deficit in each period as the sum of primary government balances, $(G_t - T_t)$, and debt service, $r_t B_{t-1}$. Hence, if the amount of taxes collected in a given period is just enough to cover primary spending, a gov-

[64] Another indicator used to measure the fiscal reaction of governments is real primary spending (Battilossi et al., 2013).

[65] These characteristics include for instance the size of governments (Fatás and Mihov, 2010), as well as the composition of government spending and the degree of overall tax progressivity (Galí et al., 2003).

ernment will exhibit a zero primary balance, whereas the overall fiscal balance is likely to be negative, resulting in an increase in the stock of debt, $\Delta B_t > 0$. In other words, if the primary surplus $(T_t - G_t)$ cannot cover the debt service in each period $r_t B_{t-1}$, the stock of government debt will rise.

The econometric estimation of a fiscal reaction function generally departs from the fundamental budget identity and includes a lagged dependent variable, implying that primary balances exhibit a high persistence. This is often interpreted as governments being unable to set out sufficient fiscal reforms to dramatically change a country's fiscal position in a single year (Afonso, 2008) or, alternatively, that past fiscal behaviour also explains the current fiscal stance (Turrini et al., 2008). The basic specification of a fiscal reaction function is thus expressed as:

$$s_{i,t} = \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \varepsilon_{i,t} \tag{33}$$

where $b_{i,t-1}$ is lagged government debt, $\hat{y}_{i,t-1}$ is the output gap, $\varepsilon_{i,t}$ is the error term and $s_{i,t}$ is the primary fiscal balance, generally adjusted for its cyclical component. The subscript i, $i = 1, \ldots, N$ refers to the cross-sectional dimension of the estimation, denoting different countries or regions, whereas the index t, $t = 1, \ldots, T$ refers to the time-series dimension, indicating different time periods. The use of primary measures in the estimation of fiscal justifications is again justified with the focus on fiscal *reactions* to the business cycle or a rising stock of debt. The use of cyclically-adjusted primary balances reinforces this idea. By isolating the effect of discretionary measures from that of automatic stabilizers, the estimation will present a more accurate picture of governments' fiscal behaviour.

Along with the two main theoretical determinants of the fiscal stance, the econometric estimation of fiscal reaction functions also involves the inclusion of

several other determinants of the fiscal stance:

$$s_{i,t} = \alpha_i + \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \Lambda^{(n)} X^{(n)}_{(i,t)} + \varepsilon_{i,t} \qquad (33')$$

The general specification for the econometric estimation of a fiscal reaction function thus includes the intercept parameter α_i, capturing country fixed effects. The parameter β, in turn, captures the persistence of the fiscal stance. The key parameters are γ and δ, capturing debt sustainability (through the response of fiscal balances to the stock of debt) and fiscal policy cyclicality (or the response of the fiscal stance to the economic cycle), respectively. Finally, $\Lambda^{(n\times 1)}$ is a $(n \times 1)$ vector of parameters capturing the effect of a set of n control variables, $X^{(n)}_{(i,t)}$, such as political economy variables, fiscal rules, or time-fixed effects. In this case, we include decentralization measures in our estimation, as part of this set of variables, as well as dummies for election years and debt thresholds.

Looking more in depth at two key parameters in this equation, γ and δ, the sustainability parameter, γ, is expected to exhibit a positive and significant sign, indicating a positive fiscal response, i.e. larger fiscal surpluses, to rising debt levels, in line with fiscal sustainability concerns of policymakers. Thus, $\gamma > 0$ is an indicator of fiscal policy sustainability or, in other words, that a government follows a Ricardian fiscal regime (Afonso, 2008). An increase in the primary balance (cyclically-adjusted or unadjusted) in response to an increase in government debt, thus suggests that current primary surpluses can ensure a sustainable path of government debt, which can be financed via current and future tax revenues. For $\gamma = 0$, no evidence of a systematic fiscal response to debt levels is found, whereas $\gamma < 0$ could suggest a scenario of long-term fiscal unsustainability or, in other words, of a non-Ricardian fiscal regime. Increases in debt would thus be followed

by looser fiscal policy and the debt path would ultimately tend to become unsustainable. The cyclicality parameter, δ, is also expected to also exhibit a positive and significant sign, indicating a countercyclical fiscal policy. In an economic upswing, fiscal balances would thus be rising, while contractionary measures are put in place by the government. During an economic downturn, a higher fiscal deficit would be the result of expansionary fiscal policies that can (partially) smooth the business cycle. If however we have $\delta = 0$, no significant systematic response is found to the output gap, in which case we can infer in favour of a predominantly acyclical fiscal policy. Finally, a cyclicality parameter significantly smaller than zero, $\delta < 0$, shows evidence of pro-cyclical fiscal policies across the sample period and countries considered. This implies that fiscal policy, rather than playing an active role in smoothing the economic cycle, actually amplifies it and potentially makes upswings and downturns persist for longer periods[66]. The discussion of the remaining parameters in the fiscal reaction function is left to a latter part, where we fully discuss the econometric specification of the fiscal reaction functions used in this paper.

4.2.3 Fiscal reaction functions: main results

Having set out our basic framework, highlighting the main strands in the literature and the fundamental estimation framework, we are now in position to explore more in depth the main results found in the literature. The strand of the literature that is more concerned with fiscal policy cyclicality focuses in particular on the response of fiscal balances to the output gap. The concern is in particular whether patterns of pro-cyclicality or counter-cyclicality can be found and what

[66]Note also that both variables, $b_{i,t-1}$ and $\hat{y}_{i,t-1}$, indicate a lagged, rather than real-time, response of fiscal balances, as policymakers typically face information lags and cannot respond to rising debt levels or economic downturns contemporaneously.

may help to explain these. Despite the large consensus around the desirability of counter-cyclical fiscal policy behaviour, from the macroeconomic stabilization perspective, it is nonetheless found in the literature that fiscal policy in the EU follows a rather pro-cyclical behaviour (Turrini et al., 2008). This rather surprising pattern can be found in a wide array of contributions on fiscal reaction functions. Égert (2014), for instance, looks at fiscal policy cyclicality for OECD countries over the 1970-2008 period and finds evidence of counter-cyclicality, particularly stronger economic downturns. Yet, this appears to be largely a result of automatic stabilizers. Looking at the contribution of discretionary fiscal measures, the results suggest instead a pattern of acyclicality with large differences between countries included in the sample. Countries with "healthier" public finances, i.e. with lower debt levels and higher average primary surpluses, were also found in a better position to react during economic downturns, by implementing expansionary fiscal policies. In addition, disaggregating between different expenditure components, investment spending is found to be more pro-cyclical, whereas government subsidies were found mostly counter-cyclical.

These findings are in line with those found in Lane (2003), stressing the importance of looking at disaggregated measures of government spending, as aggregates can lead to ambiguous conclusions and hide different patterns in different spending items. Similarly, Fatás and Mihov (2010), in a comparison between fiscal behaviour in the EMU and other OECD countries between 1970 and 2007, find that discretionary fiscal policy tended to be pro-cyclical in the EMU, once the effect of automatic stabilizers is isolated. In contrast, evidence is found of counter-cyclical fiscal policy in the United States. Galí et al. (2003) find a general trend towards more counter-cyclical fiscal behaviour in EMU countries, following

a trend observed in most developed economies. Golinelli and Momigliano (2009), focusing on the fiscal responses of EMU countries, from 1994 to 2008, find that results are sensitive to model specification, often yielding contradicting results. In particular, the results are found strongly reliant on the choice of the dependent variable, as cyclically-adjusted measures yield different results from considering government primary balances. Similarly, in terms of data used, real time and ex-post data generate different results. With respect to ex-post data, fiscal policy is found acyclical in this sample[67]. Also looking at EMU countries, between 1980 and 2005, Turrini et al. (2008) finds a pro-cyclical bias during economic upswings, mostly driven by government expenditures. Taking a more long-run view, Battilossi et al. (2013) find a gradual shift from pro-cyclical towards counter-cyclical fiscal policy in Spain, following the transition from dictatorship to democracy in the 1970s. This supports the "learning process" view also suggested in other papers (Galí et al., 2003).

Overall, the results in the literature on fiscal policy cyclicality suggest a predominantly acyclical discretionary fiscal response to the business cycle in OECD countries. Once the effect of automatic stabilizers is taken into account, the response tends to appear counter-cyclical, as otherwise expected (Galí et al., 2003). Another issue that stands out is the variability and the strong differences seen between econometric samples, countries, data sources and different measures (Golinelli and Momigliano, 2009). Together with the results in Lane (2003), highlighting that different expenditure items exhibit different cyclicality patterns, the above seems to call for a careful approach to econometric inference and for more

[67]This approach is seen to tackle the issue of "actual" fiscal policy, as opposed to "policy intentions". Using real-time data only, Golinelli and Momigliano (2009) find asymmetric reactions to the economic cycle, with pro-cyclical responses in downturns and counter-cyclical during economic upswings. These results are interpreted by the authors as evidence against the view that points pro-cyclicality of fiscal policy as one of the main causes behind the fiscal stress experienced in later periods by EMU countries (Persson and Tabellini, 2001).

detailed analysis of all the information dimensions offered by different samples[68].

The literature on fiscal reaction functions focusing on debt sustainability also had an extensive development after the seminal contribution of (Bohn, 1998). For instance, looking at the Brazilian fiscal performance from 1995 to 2004, De Mello (2008) finds that all levels of government positively contributed towards a sustainable fiscal path, increasing primary balances in response to higher debt levels. Even with a warning regarding the quality of the fiscal adjustment, given the bias towards public investment rather than current expenditure cuts, it is pointed out that (formal) debt limits at the regional level contributed towards a fiscal performance in line with long-term sustainability concerns in Brazil. Afonso (2008), for instance, looking at the EU-15 countries experience from 1970 to 2003, tests the hypothesis of the existence of Ricardian fiscal regimes, finding that EU-15 member countries did react with higher primary surpluses to rising debt-to-GDP ratios, particularly at higher debt levels. However this effect appears weaker during election periods, the results are interpreted as pointing towards an overall fiscal performance in line with sustainability concerns. Similarly, Afonso and Hauptmeier (2009), looking at the fiscal reactions of EU countries over the period of 1990 to 2005, find overall a positive response of the fiscal stance to rising government debt levels, with a significant influence of fiscal rules, in the context of the SGP framework. A negative effect of spending decentralization is found however, contributing negatively to the response of primary fiscal balances to debt levels. The rationale behind this effect can be explained namely by coordination problems in more decentralised governments (Ter-Minassian and Fedelino).

[68]In addition, as suggested by Cimadomo (2016), the results of studies making use of cyclically-adjusted measures need to be taken with a pinch of salt. The difficulties involved in the measurement of the output gap, as well as the cyclical conditions that influence the fiscal stance, suggest that further robustness checks are particularly welcome.

On the other hand, Ghosh et al. (2013) estimate fiscal reaction functions for a group of 23 OECD economies from 1970 and 2007 and find a non-linear response of fiscal balances to debt levels, interpreting this as a sign of 'fiscal fatigue' in countries facing high debt ratios. In contrast with Afonso (2008), a weaker responsiveness of primary balances is found at higher debt levels, namely when debt-to-GDP ratios reach the 90-100% interval, and even turns negative after the 150% boundary. This also contrasts with the early findings of Bohn (1998). Mendoza and Ostry (2008), on the other hand, find a weaker response of primary balances to changes in debt for countries with higher debt-to-GDP ratios. Weichenrieder and Zimmer (2014) also find contrasting evidence for a sample of EU countries, indicating that fiscal responsiveness to the debt stock varied substantially, between periods and countries. In particular, more indebted countries are found to become progressively less responsive to the debt-to-GDP ratio, after the accession period to the EMU.

Large differences can again be found in the fiscal responses of governments to rising debt levels. In particular, the responses at high debt thresholds seem to be particularly heterogeneous, which brings into question the issue of fiscal sustainability itself. On the one hand, governments concerned about sustainability, would try to increase primary balances in order to ensure that outstanding liabilities are covered. On the other hand, the capacity to do so may be undermined after certain debt thresholds are reached. In addition, a positive response of fiscal balances to higher debt-to-GDP ratios may not prove in itself sufficient to offset a strong upward trend in debt levels (Ghosh et al., 2013). Recent literature suggests that fiscal fatigue may become an important player in environments characterised by an excessive debt burden, or debt overhang, as the ability of governments to

increase primary balances becomes constrained (Checherita-Westphal and Žďárek 2017 and Pappadà and Zylberberg 2018). Several other factors can also influence the fiscal stance, such as electoral cycles or other political economy variables. Furthermore, these may influence fiscal reactions in a non-linear fashion. We now briefly explore the literature on fiscal federalism in order to disentangle possible channels through which fiscal decentralization can influence the fiscal stance.

4.2.4 Fiscal federalism

In its well-known argument, Tiebout (1956) suggested that citizens "voting with their feet" act as monitors of sub-national governments. Accordingly, fiscal federalism would support better policies, as local and regional governments tend to have more detailed information about needs and preferences of local populations (Oates 1993, 1999, 2005, 2008), and this leads to a more efficient structure of governance. The conditions under which this may happen, would however depend ultimately "on the proper structure of fiscal institutions" (Oates 1993, p. 242)[69].

A large body of empirical literature on fiscal federalism has since developed. Namely, several empirical studies can be found on the relationship between fiscal decentralization and fiscal performance (Schaltegger and Feld 2009, Baskaran 2010, Eyraud et al. 2011, Eyraud et al. 2012, Foremny and von Hagen 2012)[70]. Eyraud et al. (2011), for instance, find that the vertical fiscal imbalances, resulting from the unequal devolution of expenditure and revenue-raising responsibilities,

[69] In a related strand of the literature, Weingast (1995) early proposed the notion of *market-preserving* federalism. According to this theory, fiscal federalism would protect markets against Leviathan governments by creating self-enforcing restrictions on political institutions and foster economic development by promoting inter-jurisdictional fiscal competition. Weingast underlines the importance of federal systems, in order to align the incentives of policymakers with citizen welfare.

[70] A large strand of the empirical literature explores the link between fiscal decentralization and economic growth (Davoodi and Zou 1998, Iimi 2005, Thornton, Rodríguez-Pose and Ezcurra, among others), with broadly mixed results. In one particular account, Martinez-Vazquez and McNab (2003), highlight that this relationship is likely to be affected by a wide array of different mechanisms and, hence, the sign and magnitude of such relationship is most likely to vary widely. Kyriacou et al. (2015) suggests a mediating role between government quality in the relationship between fiscal decentralization and regional convergence.

are damaging for overall fiscal performance, especially when regional disparities are high. This issue has been extensively studied and recognised both as a cause of perversely structured decentralized systems and as a consequence of the desired properties of tax systems. In particular, the presence of large vertical fiscal imbalances together with non-credible commitment of central or federal governments not to provide further fiscal transfers is thought to be at the heart of a soft budget constraint problem, which may foster lax fiscal behaviour at the sub-national level and endanger the fiscal sustainability[71]. Jones et al. (2000) show evidence of how the fiscal behaviour of sub-central government influenced fiscal outcomes in Argentina, where sub-central governments remained mainly financed from federal revenues. This "divorce" between spending and tax decisions, resulting in heavy reliance on intergovernmental grants, then paved the way for a large "expansionary bias" at the sub-national level and reinforced bailout incentives for the central government. The implications of common pool problems, partially stemming from the limited capacity of sub-national governments to raise own revenues is also analyzed in De Mello (2000). The over-spending bias at the sub-national level can be worsened in the case of coordination failures and poor local governance. The incentives of sub-national governments facing high vertical fiscal imbalances can be thought as a derivation from those present under soft budget constraints[72].

[71]This issue was identified in the early literature. Oates (1993) suggests that a strong dependence on intergovernmental transfers may undermine the fundamental incentives of local governments to ensure the sustainability of local public finances. Similarly, Weingast points out that a fundamental condition for federal governance structures to produce the right incentives and support interjurisdictional competition is that sub-central governments "bear the full financial consequences of their decisions". The absence of such condition would instead promote wasteful spending decisions, rent-seeking and corruption at the local level. A large body of literature has also devoted particular attention to the issue of soft budget constraints (Bucovetsky 1997, De Mello 2000, Goodspeed 2002, Rodden et al. 2003, Oates 2005, Besfamille and Lockwood 2008, 2008, Weingast, Pettersson-Lidbom 2010 Asatryan et al. 2015).

[72]In the fiscal federalism literature, the view that "money sticks where it hits" (Oates 1999, p. 1129) hints that an excessive reliance on intergovernmental grants can foster overspending, a phenomenon known as 'flypaper effect' (Hines Jr and Thaler 1995, Becker 1996, Inman 2008).

4.2.5 Motivation

The potential effect of fiscal decentralization on long-term fiscal sustainability and macroeconomic stabilization may vary widely. On one extreme, the central government can be responsible for collecting all government revenues and have full discretion on the distribution of intergovernmental grants. On the other extreme, sub-national governments can have extensive fiscal powers and collect a significant share of own revenues locally, enough to fully cover main expenditure areas. In the former case, sub-national governments can be seen as agents of the central government and have very limited effective fiscal discretion. In the latter case, sub-national governments may act independently of the central government, with extensive fiscal discretion. The extent to which revenues and expenditures are decentralized may also vary widely in both cases.

A distinctive feature is thus the degree of sub-national fiscal autonomy. *De jure* fiscal decentralization does not necessarily affect long-term fiscal sustainability or have direct implications for macroeconomic stabilization. Central governments may in practice manage to keep full discretion over aggregate spending and use their fiscal powers, namely the size of intergovernmental fiscal transfers, as part of their response to the business cycle or rising debt levels. *De facto* fiscal decentralization, on the other hand, with extensive fiscal autonomy at the sub-national level, may affect macroeconomic stabilization, as central governments are left with reduced fiscal powers to respond to the business cycle or to rising debt levels. Ultimately, aggregate fiscal sustainability will depend on the sum of different fiscal behaviours at the central and sub-national levels.

In addition, as sub-national governments may or may not have extensive spending and revenue-raising powers, the potential concerns related to vertical fiscal

imbalances are also ambiguous. On average, around 30% of public expenditures are decentralized across OECD countries, whereas sub-national governments are only responsible for raising around 20% of own revenues. This fiscal imbalance, generally created in federal systems, may have an effect on how fiscal policy in conducted at the sub-national level (Bouton et al., 2008). While intergovernmental fiscal designs take several different forms, it is generally recognized that a heavy reliance of sub-national governments on intergovernmental grants may foster lax fiscal behaviour and eventually endanger long-term fiscal sustainability. However, the existence of large intergovernmental grant systems can also potentially leave a high degree of fiscal discretion at the central level. Namely, depending on the design of such systems (intergovernmental grants can be earmarked, formula-based, subject to annual or pluri-annual political negotiation or, in practice, can be a mix of these), different "effective" levels of fiscal autonomy and bargaining power are left at the central, regional and local levels of government.

The literature on fiscal federalism suggests that the existence of large vertical fiscal imbalances can generate common pool incentives and eventually cause sustainability problems. Yet, this can also be the result of an optimal organization of tax and spending responsibilities in a federal system. It is thus an open question how fiscal decentralization affects aggregate fiscal performance and whether vertical fiscal imbalances arise as the result of an optimal organization of tax and spending responsibilities, or instead are the origin of common pool problems harming long-term fiscal sustainability. In the next section, we aim to explore the dataset used to explore this phenomenon empirically, through the estimation of fiscal reactions functions for twenty-five OECD countries, between 1995 and and 2016. We also present the methodology and explore the main econometric

specifications used in this paper.

4.3 Data and methodology

4.3.1 Data

In order to get a first snapshot of the fiscal behaviour across the OECD, it is important to look at the time dimension of the main variables and how these evolved across different countries. By plotting the evolution of fiscal balances from 1995 to 2016, one can perceive a gradual worsening of fiscal balances in the wake of the EMU sovereign debt crisis, particularly visible in Greece, Ireland, Portugal and Spain (Figure 17). For most countries in the sample a recovery of both cyclically-adjusted (CAPB) and underlying primary balances (UPB) is perceived from about 2009 onwards, again particularly evident in those countries under greater fiscal pressure during the EMU sovereign debt crisis. By comparing the paths of CAPB and UPB, our choice for the latter measure for our baseline estimates is justified with the more stable behaviour of this measure. In effect both track each other very closely, but it is clear that the CAPB measure is affected by one-off measures, related for instance to bank bailout episodes during the financial crisis, which are beyond the scope of this paper[73].

Another noteworthy snapshot of the budgetary environment across the OECD over the last two decades can be obtained with the comparison of diverging country-paths for the (potential) debt service and the debt-to-GDP ratio. Looking at Figure 18, two distinct trends become apparent. Firstly, the markedly distinct records concerning the the evolution of debt-to-GDP ratios. Yet, a common up-

[73] We also run separate regressions using the CAPB as dependent variable for our baseline specifications. The results are shown in Appendix (Table F.1).

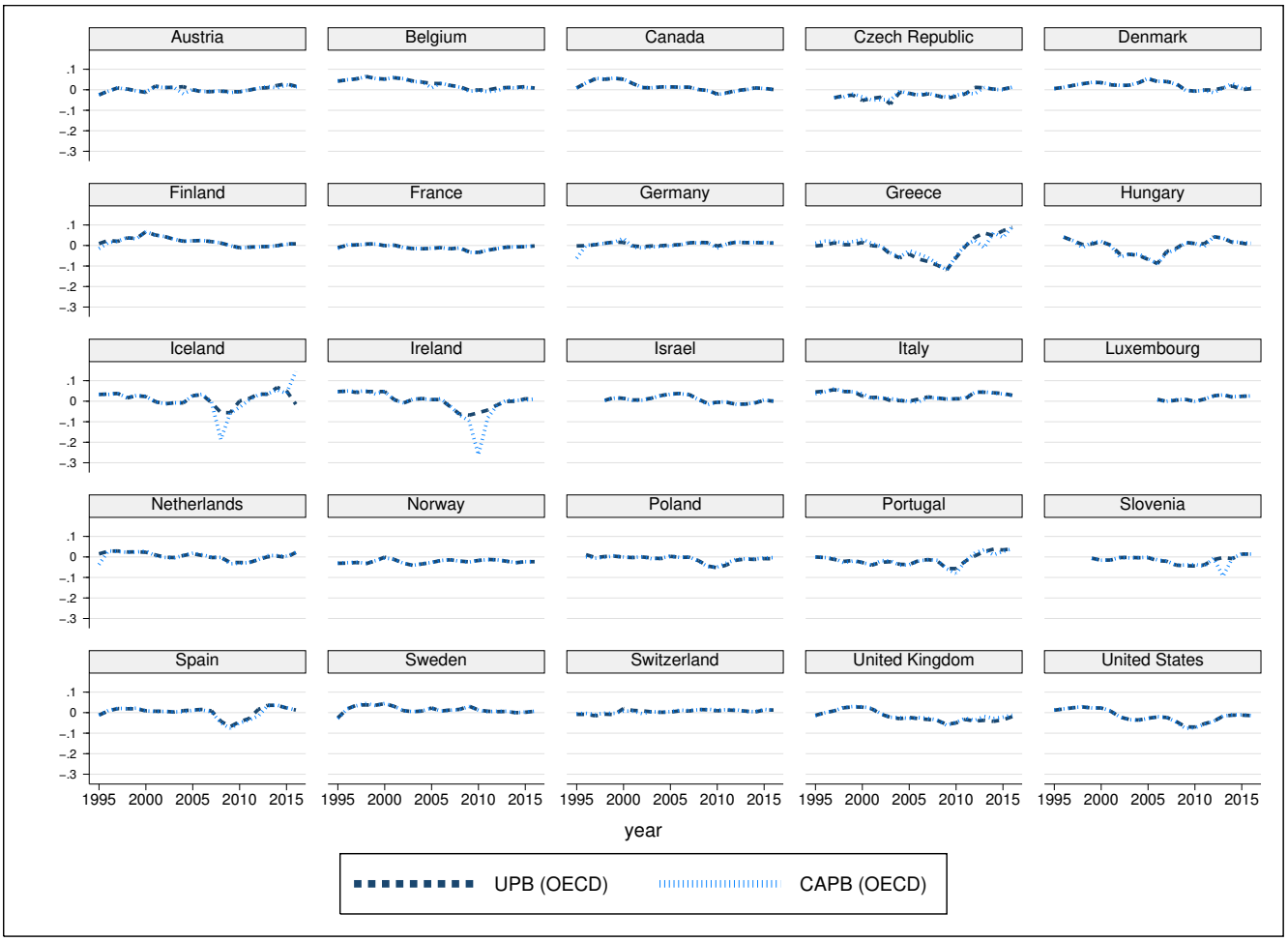

Figure 17: Cyclically-adjusted primary balances (CAPB) and underlying primary balances (UPB) of 25 OECD countries (1995-2016). Fiscal balances can be separated into a cyclical and a non-cyclical component. Cyclical influences are associated with variations of the actual output around its potential level (the output gap). Non-cyclical changes can be seen as a "cause", rather than an effect, of output fluctuations and may be interpreted as indicative of *discretionary* policy adjustments. The CAPB refers to general government cyclically-adjusted balances and exclude net interest payments. UPB eliminate the impact of so called one-off transactions from the CAPB. One-offs transactions include deviations from trend in net capital transfers and special one-offs not related to capital transfers.

ward trend emerges around 2007 across most countries in the sample. This is particularly evident for EMU countries. Conversely, looking at the country paths of the potential debt service (Figure 18), a markedly different picture emerges. A considerable number of countries even experienced gradual decreases in their debt services, even while debt-to-GDP ratios were soaring. As a result of decreasing

long-term interest rates, some EMU countries such as Austria, Belgium, France, Germany, but also Canada and the United States, kept potential debt service levels at historically low levels. Instead countries in the EMU periphery, namely Greece, Ireland, Portugal and Spain, experienced large increases in potential debt services, worsened by abrupt rises in prevailing long-term market interest rates[74]. Yet, a high average debt-to-GDP ratio brings all countries more sensitive to future increases in long-term interest rates. This brings the question of whether one can interpret the dissimilar fiscal responses of OECD and EMU countries, such as Ireland or Luxembourg, to similar debt-to-GDP ratio paths as a result of different credit conditions in sovereign debt markets.

Figure 19 uncovers very different co-movements of fiscal balances and output gaps. In several EMU countries, diverging paths of fiscal balances and the output gap suggest a predominantly pro-cyclical fiscal policy in the past decade. This is not only the case for EMU countries under emergency lending programmes in the aftermath of the financial crisis, such as Greece or Portugal, but also in Austria, Finland, or Luxembourg. Over the entire period however, no consistent co-movements can be identified, and (discretionary) fiscal policy across the OECD can be understood as mainly a-cyclical. Figures E.1 and E.2, in Appendix, show the paths of value-added (VAT), personal income (PIT) and corporate income (CIT) tax rates over the same period.

Turning our attention to Figure 20, we can observe that both the level of expenditure and revenue decentralization are relatively stable over the period for most countries. For some countries a stable upward trend on the level of expenditure decentralization can be seen, namely in Belgium, Canada, Denmark, Finland, or

[74]This can also be seen in Hungary or Slovenia. This phenomenon of financial segregation within the EMU was pointed out by several studies as one of the main consequences of the recent financial crisis and an important cause of concern for EU policymakers.

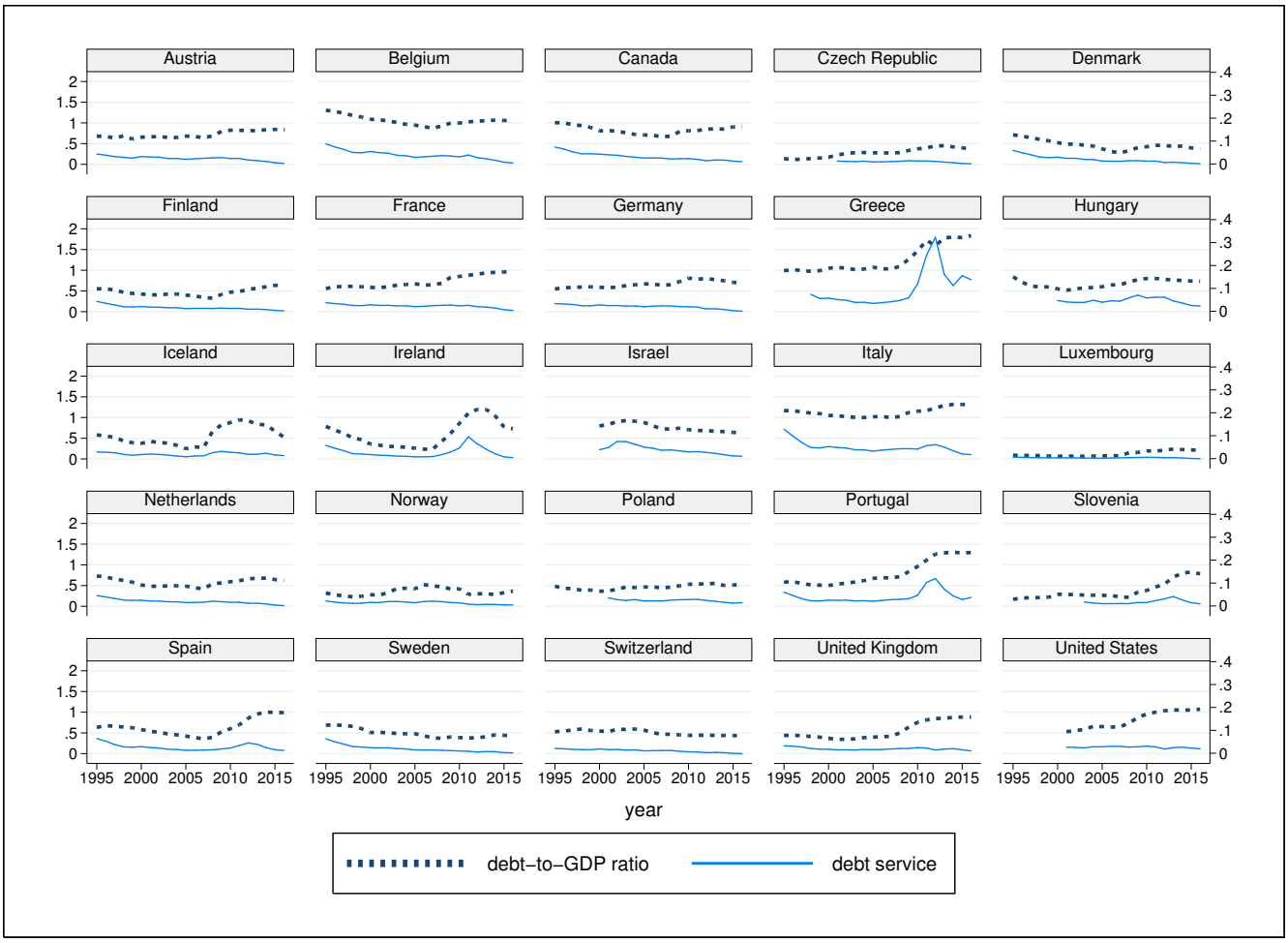

Figure 18: Debt-to-GDP ratios and (potential) debt service of 25 OECD countries (1995-2016). Debt-to-GDP ratios are calculated as total general government debt as a percentage of national GDP. The potential debt service is calculated as the product of the debt-to-GDP ratio with the average 10-year interest yield on government debt. The figure intends to serve as a comparison between the (relative) stocks of debt and the actual pressure these may exert on national government budgets, which depends necessarily on market conditions and the average interest rate charged on the stock of debt. Note: both measures are expresses as percentage of GDP, but shown in a different scale for presentation purposes. The relevant scale for the former measure is shown on the left hand-side, whereas the scale for the latter is shown on the right hand-side of each row of individual country plots.

Sweden, while the large changes in Ireland, Italy, and Spain suggest important fiscal decentralization reforms. All the countries in the sample also present a level of expenditure decentralization consistently higher than that of revenue decentralization. The result is a significant overall degree of vertical fiscal imbalances (VFIs) across most countries, with large underlying intergovernmental transfer

systems. It is also interesting to look at the marked differences across countries. For instance, some unitary countries present high degrees of fiscal decentralization, such as Denmark and Sweden, whereas in federal countries such as Belgium, or in Spain, an apparently low degree of fiscal decentralization emerges, particularly on the revenue side. Some countries also stand out with very low levels of fiscal decentralization, such as Greece, or with very high degrees of vertical fiscal imbalances, such as Belgium and the United Kingdom. On the contrary, Germany, Iceland, or Sweden, appear as prominently different cases of fiscal decentralization, with more balanced equilibria of revenue and spending powers.

Yet, behind these figures may lie substantially different institutional backgrounds, resulting in different levels of *de facto* fiscal decentralization. For instance, where sub-national governments have little or no discretion over the composition and size of their budgets, a high degree of expenditure decentralization may not entail correspondingly high levels of sub-national fiscal autonomy, giving little room for fiscal discretion at local or regional government levels. Bearing this in mind, we explore the Local Authority Index (LAI) and, in particular, disaggregate some of its key measures in order to have a brief look at the heterogeneous institutional frameworks underlying sub-national governments and intergovernmental relations across of OECD countries. This index builds upon a series of questionnaires with local experts assessing a wide array variables related to local autonomy. These variables are then aggregated into different dimensions of local autonomy (European Commission, 2015)[75]. Figure E.3 presents the evolution of three dimensions: policy scope, effective political discretion and financial autonomy. The policy scope dimension considers the range of activi-

[75]The seven identified dimensions of local autonomy are the following: legal autonomy, organizational autonomy, policy scope, effective political discretion, financial autonomy, central or regional control, and vertical influence.

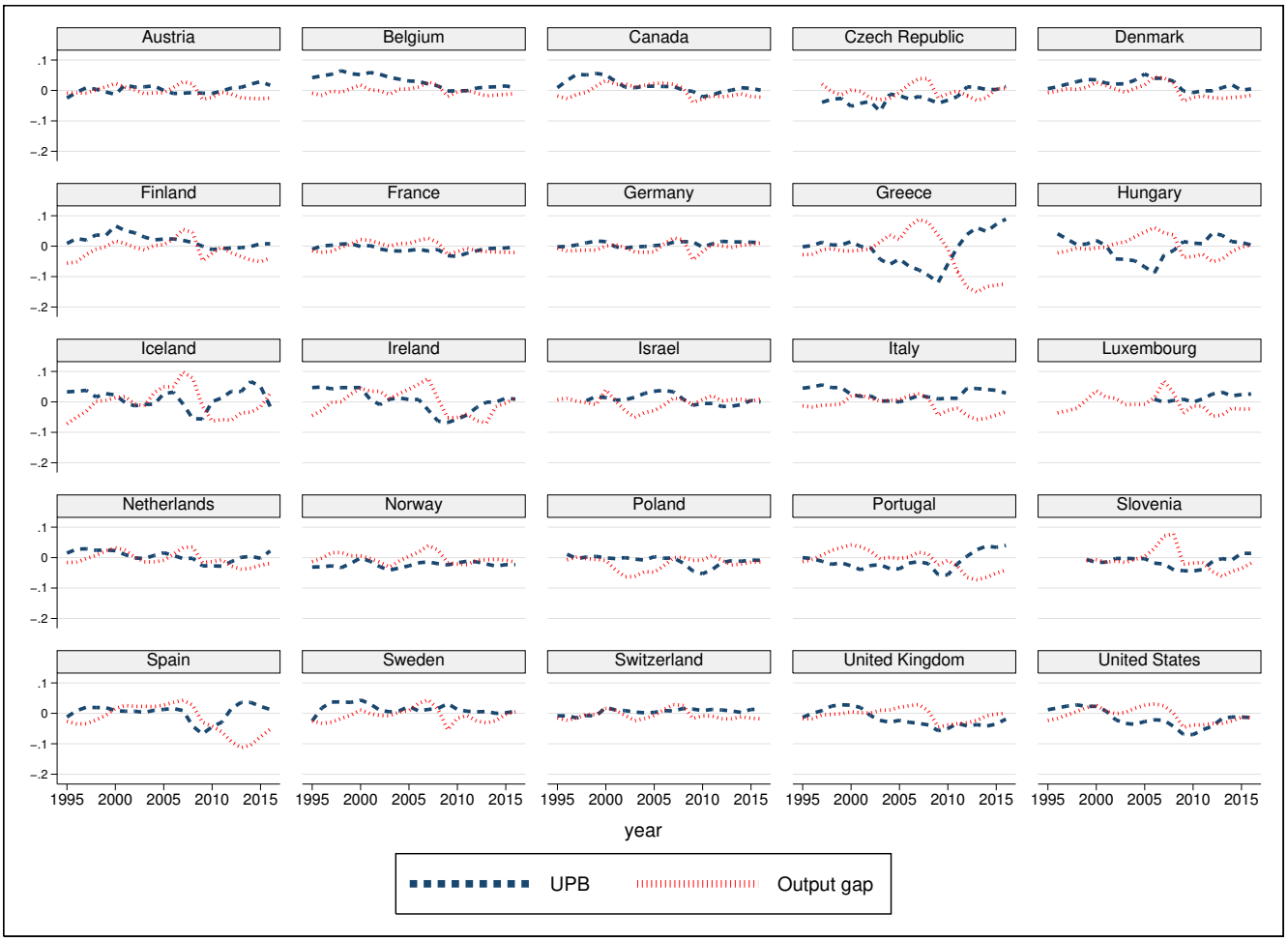

Figure 19: Underlying primary balances (UPB) and output gap of 25 OECD countries (1995-2016). The UPB is a measure of the (general) government cyclically-adjusted budgetary balance, excluding net interest payments and the impact of one-off transactions. A predominantly counter-cyclical (discretionary) fiscal policy is suggested if both fiscal balances and the output gap move consistently in the same direction. On the other hand, if these two tend to move in opposite directions, pro-cyclicality is suggested. If no consistent co-movements are found, (discretionary) fiscal policy can be understood as mainly a-cyclical. Looking at the behaviour of UPB trends across countries, discretionary fiscal policy appears predominantly a-cyclical. The cases of Greece and Hungary are perhaps worth noting as cases of predominantly pro-cyclical discretionary fiscal policies since the early 2000s.

ties in which sub-national governments are effectively involved. This dimension does not distinguish, however, the extent to which sub-national governments are involved in the delivery of those public services. Effective policy discretion measures the range of activities over which sub-national government effectively have discretion and whether they enjoy full responsibilities over the provision of given

public services[76]. Finally, the financial autonomy dimension aims at measuring whether sub-national governments have fiscal and political discretion over their own budgets, by combining variables related to fiscal autonomy, the system of intergovernmental transfers and borrowing autonomy.

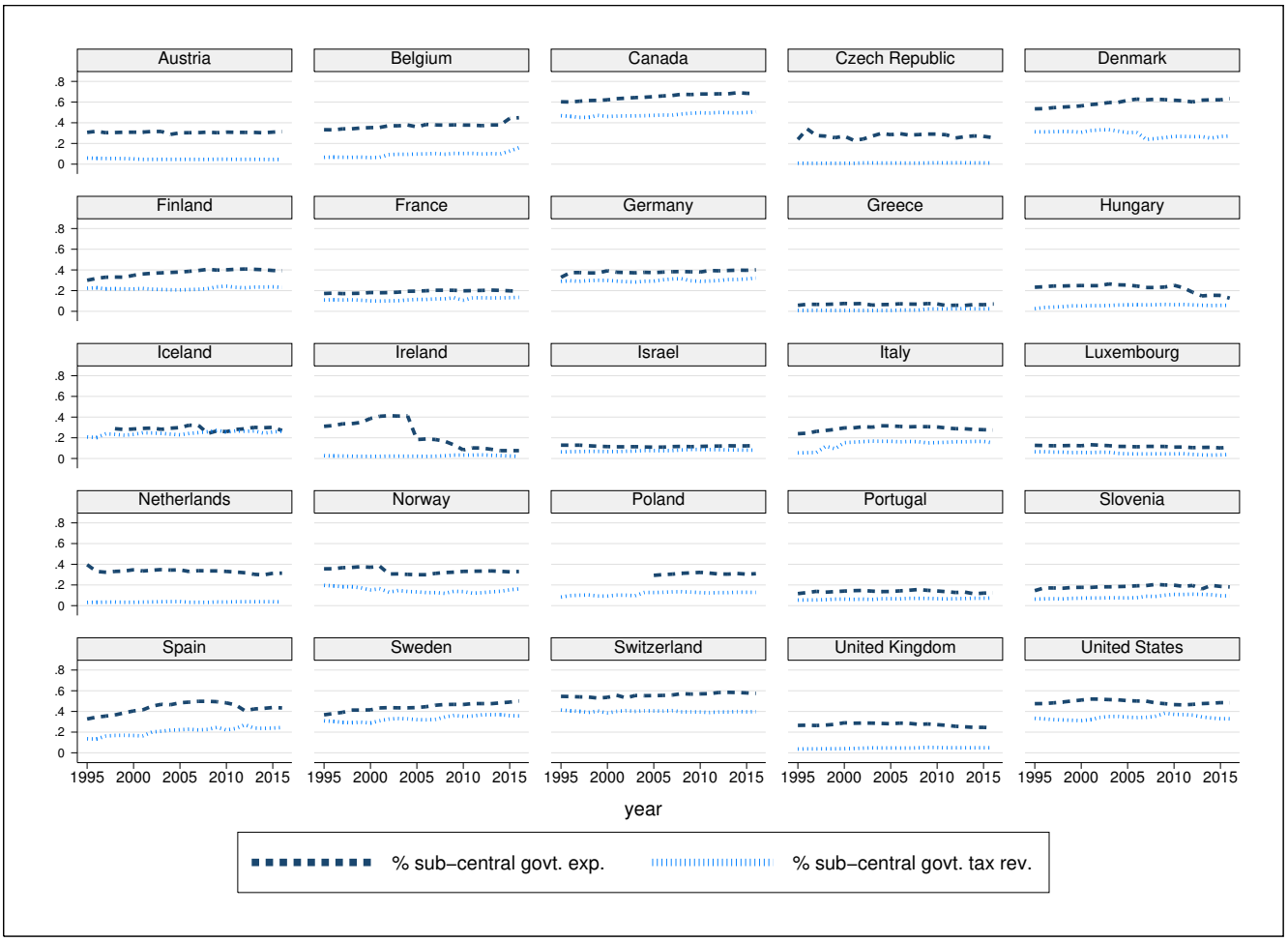

Figure 20: Share of sub-national expenditures and own revenues, as percentage of total general government expenditure and revenue of 25 OECD countries (1995-2016). Sub-national expenditure and revenue measures are considered as the sum of local and, whenever appropriate, regional or state governments. The figure shows a broadly mixed picture of fiscal decentralization across OECD countries over two decades. Countries with shares of sub-national expenditure consistently at or above 40% include Canada, Denmark, Germany, Spain, Sweden, Switzerland, and the United States. Countries where sub-national expenditures represent 20% or less of total government expenditure include France, Greece, Israel, Luxembourg, Portugal and Slovenia. Countries with persistent large (above 20 p.p.) differences between the level of expenditure and revenue decentralization include Austria, Belgium, Czech Republic, Denmark, the Netherlands, Spain, and the United Kingdom.

[76]These include namely education, social assistance, healthcare, public transports or housing, among others.

The first picture that emerges from Figure E.3 is perhaps the very large heterogeneity both between unitary and federal countries. Countries where sub-national governments have a large policy scope include Denmark, Finland, France, Germany, Hungary, and Poland. Yet, countries where sub-national governments have relatively high effective political discretion over the range of public services on which they are involved include Czech Republic, Finland, Germany, Iceland, and Sweden. Finally, countries where sub-national governments enjoy a high level of financial autonomy include Belgium, Finland, France, Germany, Iceland, Norway, Spain, Sweden, and Switzerland. In terms of the overall LAI score, Finland, Iceland, and Switzerland are the highest ranked countries, followed by Denmark, Germany, Norway, Poland, and Sweden. Countries with the lowest overall LAI scores are Greece, Ireland and the United Kingdom, followed by France and Slovenia. Two illustrative cases emerge from this analysis. On the one hand, the three highest ranked countries also enjoy the highest levels of financial autonomy. On the other hand, France emerges as a country where sub-national governments have a large policy scope and enjoy a significant level of financial autonomy, but is one of the lowest ranked countries in terms of overall local autonomy.

4.3.2 Methodology

One underlying assumption of the literature on fiscal reaction functions is that governments ought to be concerned with debt sustainability and macroeconomic stabilization. The concern with long-term debt sustainability can be traced back to the origins of the literature, namely the early contributions of Barro (1979) and Bohn (1998). The main concern is to check whether the short-run behaviour of fiscal balances is in line with the concept of a "Ricardian" fiscal regime, ensuring a sustainable debt path. In this context, a positive response of the fiscal stance

to rising debt-to-GDP ratios should be observed. Regarding the response to the business cycle, this is another "desirable" property of fiscal policy generally identified in the literature on macroeconomic stabilization (Galí et al., 2003). We follow the literature on fiscal reaction functions, estimating a fiscal policy function where the fiscal stance reacts to, or is determined by, the debt-to-GDP ratio and the position of the economy relative to its economic potential, among other determinants. Having emphasized the fundamental identities underlying the estimation of fiscal reaction functions, it is pertinent to set out our econometric strategy.

The use of panel estimation methods is a particularly suitable empirical methodology to obtain careful estimates of fiscal reactions, due to the ability of a panel design to increase the accuracy of econometric estimates, enabling the use of two key components of evidence, embedded in the time-series and cross-section dimensions. This is generally reinforced by specific sample characteristics, which often have a small time dimension and make time-series estimates less reliable. The estimation of individual country regressions thus often becomes unfeasible (Afonso, 2008). The dataset used in this paper is one such example, with yearly data for 25 OECD countries from 1995 until 2016. Another advantage of adopting a panel data approach is the decrease of multi-collinearity problems between regressors. In particular, we develop our analysis in the framework of fixed effect (FE) models, which are generally more suitable than random effect (RE) in the context of multi-country fiscal reactions functions (Afonso, 2008). Under the standard FE framework, a linear regression model is estimated with intercepts allowed to change over the cross-section dimension, while the remaining parameters are assumed homogeneous across the sample. Different econometric specifications are then generally assessed against their potential to produce reliable estimates

of the relevant parameters.

We thus start by recalling the basic econometric specification derived earlier to estimate fiscal reaction functions, based on a simple linear dynamic model:

$$s_{i,t} = \alpha_i + \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \Lambda^{(n)} X^{(n)}_{(i,t)} + \varepsilon_{i,t} \qquad (33')$$

The subscript i in the intercept parameter α_i highlights that country fixed effects are included, whereas the parameters, β, γ and δ, capture respectively the degrees of persistence, long-term sustainability and cyclicality of the fiscal stance. The vector of parameters, $\Lambda^{(n\times 1)}$, includes other variables that may influence the fiscal stance. These can also include interaction terms with the main regressors.

Dynamic panel data specifications bring important additional empirical challenges. Namely, in the context of autoregressive panel data estimations, the problem of inconsistency must be properly tackled. The inclusion of the lagged dependent variable as a regressor leads, by construction, to a correlation between the error term, the unobserved panel effects, and the dependent variable (Harris and Mátyás, 2004). A common solution is the use of an instrumental variables (IV) strategy. In general, other variables, strongly correlated with the original regressor and not correlated with the disturbance term, have to found. One example, in the context of the estimation of fiscal reaction functions, is the use of first-differenced variables as instruments (Afonso, 2008).

Harris and Mátyás (2004) denote that *Within* estimators tend to underestimate the real value of coefficients, while OLS and *Between* estimators overestimate the true value. This "Nickell-Bias" in the estimation of dynamic panel models using OLS methods represents a large asymptotic bias and causes inconsistent estimates (Nickell, 1981). Least squares estimators do not exhibit adequate statistical prop-

erties and, hence, standard econometric approaches become unreliable. In the context of an IV variable approach, the use of Generalized Method of Moments (GMM) techniques is the most common (Harris and Mátyás, 2004).

Even if *Within* estimators become biased under dynamic panel designs, Monte Carlo evidence shows that these estimators still perform relatively well even in small samples, remaining within a narrow interval and showing small variance values, especially bearing in mind the volatile performance of IV or GMM estimators (Kiviet et al. 1995, Bun and Kiviet 2003, Harris and Mátyás 2004, Harris et al. 2008). Against this background, an improved version of the Within or Least-Squares Dummy Variables (LSDV) estimator is proposed (Kiviet et al., 1995). This is achieved by deriving analytically the Nickell-bias and subtracting an approximation of it from the standard LSDV estimator. This modification to the standard LSDV estimator produces a nearly unbiased estimator with a strong econometric performance (Judson and Owen 1999, Bun and Kiviet 2003). Besides showing better econometric performances in finite sample circumstances, LSDV-type estimators are also generally easier to compute (Kiviet et al., 1995). Comparing to performance of GMM estimators, it is generally found that GMM estimation reliability tends to be harmed in small sample conditions, resulting in persistent small-sample biases, in particular when performed in panels with a comparatively small time dimension and a large number of moment conditions is determined (Harris et al., 2008). Bearing this in mind, a framework for implemented a bias-corrected LSDV (LSDVC) estimator (Bun and Kiviet, 2003) is proposed by Bruno (2005), delivering better small sample properties than common GMM estimators (Harris et al., 2008), namely the popular Arellano and Bond (1991) estimator. We thus follow the procedure offered by Bruno (2005) which,

building on the findings of Bun and Kiviet (2003), provides a simple econometric routine to implement LSDVC estimations in unbalanced panels. This allows for a wider use of LSDVC estimators, by bridging the gap formerly identified in Judson and Owen (1999). In the context of the estimation of fiscal reaction functions, this approach has also been used in Afonso and Hauptmeier (2009).

According to the literature on fiscal reaction functions, we now develop the econometric specifications starting from the autoregressive specification outlined in (33'). In the spirit of recent contributions, we include other potential determinants of the fiscal stance, with the aim of exploring the relationship between these variables and the response of the fiscal stance to rising debt levels and to the business cycle. We aim in particular to assess the role of fiscal decentralization and endogenous debt limits on the fiscal stance of OECD and EU economies and assess whether this may have played a role in the fiscal responses before and after the recent European sovereign debt crisis.

We start by considering another variable, with a long tradition in the political economy literature, aiming to capture the effect of elections on fiscal policy (Alesina and Sachs 1988, Rogoff and Sibert 1988, Alesina and Roubini 1992, Persson and Tabellini 2001). Nordhaus et al. (1975) early coined this issue as one of "political business cycles", identifying a "predictable pattern of policy" (p. 187), whereby incumbent parties holding office would attempt to set out more expansionary fiscal policies before elections[77]. There is also evidence that electoral cycles can influence the fiscal stance in EU countries (Afonso, 2008). We use a dummy variable capturing years of parliamentary (or presidential) elections in

[77]This can happen both as a result of postponing more generous expansionary fiscal measures in government programmes towards the end of political mandates or by introducing unannounced expansionary fiscal policies close to election periods.

each country, depending on the political regime[78].

Accordingly, we add the variable D_{it}^{EBC} to the basic model specification, where D_{it}^{EBC} takes the value of 1 for country i when there are parliamentary (or presidential) elections in period t, and 0 otherwise.

$$s_{i,t} = \alpha_i + \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \lambda_1 D_{it}^{ebc} + \varepsilon_{i,t} \tag{34}$$

A negative and statistically significant sign of coefficient λ_1 indicates that the fiscal stance is negatively affected in election years and points towards the relevance of electoral budget cycles.

In this vein, we devote particular attention to the effects of fiscal decentralization on the fiscal stance. In the context of the literature on fiscal reaction functions and fiscal federalism, decentralization is often measured through relative shares of relative expenditure and revenue decentralization. Afonso and Hauptmeier (2009), for instance, find that higher spending decentralization, relative to total general government expenditure, has a negative effect on (cyclically-adjusted) primary balances. Interestingly, greater spending decentralization is also associated with a lower sensitivity of primary balances to the level of debt. Fiscal decentralization can, however, be assessed along several different dimensions and the implications for aggregate fiscal behaviour may vary widely (Boadway and Shah, 2009). Following the literature on fiscal federalism, we aim to consider a broader line of inquiry, in order to capture different features of fiscal decentralization. Benefiting from the availability of detailed data for OECD countries, we start by considering the effect of fiscal decentralization, using measures of sub-national expenditure,

[78]This data was collected from the International Institute for Democracy and Electoral Assistance (IDEA), which holds detailed country-level data on election years and participation rates, among other variables on the quality of democracy and democratic participation.

f_{it}^{exp}, and revenue decentralization, f_{it}^{rev}, as percentage of total general government spending. In addition, we consider the size of vertical fiscal imbalances, f_{it}^{vfi}, in light of the pervasive effects these may exert on long-term fiscal policy sustainability. These are computed as the proportion of revenues of sub-central governments obtained from intergovernmental transfers[79]. We also aim to assess whether fiscal decentalization may have an effect on the responsiveness of the fiscal stance to the debt-to-GDP ratio. We thus specify the following equations:

$$s_{i,t} = \alpha_i + \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \lambda_1 D_{it}^{ebc} + \lambda_2^{exp} f_{it}^{exp} + \varepsilon_{i,t} \tag{3a}$$

$$s_{i,t} = \alpha_i + \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \lambda_1 D_{it}^{ebc} + \lambda_2^{rev} f_{it}^{rev} + \varepsilon_{i,t} \tag{3b}$$

$$s_{i,t} = \alpha_i + \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \lambda_1 D_{it}^{ebc} + \lambda_2^{vfi} f_{it}^{vfi} + \varepsilon_{i,t} \tag{3c}$$

$$s_{i,t} = \alpha_i + \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \lambda_1 D_{it}^{ebc} + \lambda_2^{b*vfi} \left(b_{i,t-1} \times f_{it}^{vfi}\right) + \varepsilon_{i,t} \tag{3d}$$

$$s_{i,t} = \alpha_i + \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \lambda_1 D_{it}^{ebc} + \lambda_2^{\hat{y}*rev} \left(\hat{y}_{i,t-1} \times f_{it}^{rev}\right) + \varepsilon_{i,t} \tag{3e}$$

As mentioned before, as a complex phenomenon, fiscal decentralization must be analyzed along several dimensions. Different institutional arrangements, resulting in different "true" levels of fiscal decentralization may have profoundly different implications for aggregate fiscal behaviour, namely in terms of the response to the business cycle and rising debt-to-GDP levels. One distinctive feature is the degree of sub-national fiscal autonomy. In other words, the extent to which sub-national governments have real fiscal powers, or rather act as agents of the central government, is not always clear only by considering the relative share of the general government budget assigned to sub-national governments. Profiting from the LAI

[79] In countries with two levels of sub-central governments, typically the case of countries with a classical federal structure, with both state/regional and local governments, we use the sum of these two measures.

dataset (European Commission, 2015) - which includes detailed questionnaire-based measures of fiscal and political discretion at the sub-national levels, with comparable data for 39 European countries over the 1990-2014 period - we look further into the link between fiscal decentralization and the fiscal stance. Several measures of decentralization presented in this dataset are used to capture different dimensions of sub-national fiscal autonomy. In our baseline estimates, we use the aggregate LAI score, f_{it}^{lai}, as a regressor. One drawback of this approach is the reduction in our sample size, both at the time series and the cross-section level. We thus restrict the analysis to 22 European countries in the sample over the 1995-2014 period[80]. We use thus refine the empirical specifications (3a)-(3e):

$$s_{i,t} = \alpha_i + \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \lambda_1 D_{it}^{ebc} + \lambda_2'^{exp}\left(f_{it}^{exp} \times f_{it}^{lai}\right) + \varepsilon_{i,t} \quad \text{(3a')}$$

$$s_{i,t} = \alpha_i + \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \lambda_1 D_{it}^{ebc} + \lambda_2'^{rev}\left(f_{it}^{rev} \times f_{it}^{lai}\right) + \varepsilon_{i,t} \quad \text{(3b')}$$

$$s_{i,t} = \alpha_i + \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \lambda_1 D_{it}^{ebc} + \lambda_2'^{vfi}\left(f_{it}^{vfi} \times f_{it}^{lai}\right) + \varepsilon_{i,t} \quad \text{(3c')}$$

$$s_{i,t} = \alpha_i + \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \lambda_1 D_{it}^{ebc} + \lambda_2'^{b*vfi}\left(b_{i,t-1} \times f_{it}^{vfi} \times f_{it}^{lai}\right) + \varepsilon_{i,t} \quad \text{(3d')}$$

$$s_{i,t} = \alpha_i + \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \lambda_1 D_{it}^{ebc} + \lambda_2'^{\hat{y}*rev}\left(\hat{y}_{i,t-1} \times f_{it}^{rev} \times f_{it}^{lai}\right) + \varepsilon_{i,t} \quad \text{(3e')}$$

We thus also aim to compare whether varying degrees of fiscal decentralization, here interacted with the measure of local autonomy, may have a relationship with macroeconomic stabilization. In other words, we aim to disentangle the (joint) effect of fiscal decentralization and sub-national autonomy on the responsiveness of the fiscal stance. Finally, following the recent literature on fiscal reaction functions in EMU countries, we also add dummies for formal fiscal rules and debt thresholds.

[80] We thus exclude Canada, Israel, and the United States from the sample, as well as the data for 2015 and 2016. This makes our sample substantially smaller and extra care has to be taken, in order to ensure that the number of moments estimated do not endanger the reliability of this analysis. Different specifications are used and the stability of parameter estimates in analyzed.

Accounting for the relevant interactive relationships, we can also assess whether different fiscal rules and debt limits influenced the responsiveness of the fiscal stance to other variables in the model. If this is the case, this would highlight the importance of formal fiscal rules in promoting fiscal sustainability -although it may "hamper" the fiscal discretion of governments and fiscal responsiveness along the business cycle - and suggest a non-linear response of fiscal balances to debt-to-GDP ratios, in line with the 'fiscal fatigue' hypothesis (Ghosh et al. 2013, Checherita-Westphal and Žďárek 2017). Let us define the following specifications:

$$s_{i,t} = \alpha_i + \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \lambda_1 D_{it}^{ebc} + \lambda_3 D_{it}^{\bar{b}} + \varepsilon_{i,t} \tag{4a}$$

$$s_{i,t} = \alpha_i + \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \lambda_1 D_{it}^{ebc} + \lambda_3 D_{it}^{\bar{b}} + \lambda_3^{b*\bar{b}} \left(D_{it}^{\bar{b}} \times b_{i,t-1} \right) + \varepsilon_{i,t} \tag{4b}$$

$$s_{i,t} = \alpha_i + \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \lambda_1 D_{it}^{ebc} + \lambda_3 D_{it}^{\bar{b}} + \lambda_3^{\hat{y}*\bar{b}} \left(D_{it}^{\bar{b}} \times \hat{y}_{i,t-1} \right) + \varepsilon_{i,t} \tag{4c}$$

where we include different debt thresholds, $\bar{b}$, at 80, 90, and 100 percent of GDP levels, and combine these with the (lagged) debt-to-GDP ratio and the (lagged) output gap in (4b) and (4c), respectively[81]. We also analyse the effect of fiscal rules on the fiscal stance. The rationale for this follows, on the one hand, from the interest in re-assessing the effectiveness of the fiscal framework in the EMU, namely given the inconclusive evidence found in the literature (Hallerberg et al., 2007). The empirical analysis is analogous to the case of debt thresholds. For instance, one can expect a positive impact of debt rules on the primary balance and on the response to rising debt-to-GDP levels. Similarly, a balanced budget rule

[81] In two seminal papers, Reinhart et al. (2003) and Reinhart and Rogoff (2010) bring forward the hypothesis of a "debt intolerance" level, beyond which growth is negatively affected by the stock of debt. Following these contributions, a large literature has blossomed on the effects of high debt levels in developed economies observed in the post-financial crisis period. Égert (2015) finds that the value of this threshold - initially identified at the 90 percent debt-to-GDP point for developed economies (Reinhart and Rogoff, 2010) - is very sensitive to several sample characteristics, namely country coverage and data frequency. This suggests more research is needed to identify the possibly non-linear effects of debt on the economy. In a series of robustness checks, the existence of debt thresholds at the 50-70% debt-to-GDP levels is also tested.

may have a positive impact on the fiscal stance but may undermine governments' ability to pursue counter-cyclical fiscal policies (Galí et al., 2003). The following additional fiscal reaction function specifications are also estimated:

$$s_{i,t} = \alpha_i + \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \lambda_1 D_{it}^{ebc} + \lambda_4 D_{it}^{\overline{r}} + \varepsilon_{i,t} \tag{5a}$$

$$s_{i,t} = \alpha_i + \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \lambda_1 D_{it}^{ebc} + \lambda_4 D_{it}^{\overline{r}} + \lambda_4^{b*\overline{r}} \left(D_{it}^{\overline{r}} \times b_{i,t-1} \right) + \varepsilon_{i,t} \tag{5b}$$

$$s_{i,t} = \alpha_i + \beta s_{i,t-1} + \gamma b_{i,t-1} + \delta \hat{y}_{i,t-1} + \lambda_1 D_{it}^{ebc} + \lambda_4 D_{it}^{\overline{r}} + \lambda_4^{\hat{y}*\overline{r}} \left(D_{it}^{\overline{r}} \times \hat{y}_{i,t-1} \right) + \varepsilon_{i,t} \tag{5c}$$

Different fiscal rules, $\overline{r}$, such as debt rules or balanced budget rules, are again combined with the (lagged) debt-to-GDP ratio and (lagged) output gap in (5b) and (5c), respectively. Once again, one drawback arises using the fiscal rules indicators. The dummies for country fiscal rules (sub-divided into expenditure, revenue, balanced budget and debt rules) were extracted from the Fiscal Rules Dataset, prepared by the IMF Fiscal Affairs Department. The original dataset however only includes fiscal rules until 2015. This reduces the time series dimension of our panel. Alternatively, we use a dummy for EMU participation, in order to look for possible fixed effects (which include the common fiscal framework).

4.4 Results

A preliminary illustration of the fiscal behaviour of OECD countries can be obtained with the use basic charts, plotting together the dependent variable together with some of the key factors of interest. In this case, one can start for instance by looking at a measure of the cyclically-adjusted fiscal balances plotted against variables that capture the level of indebtedness or the output gap. Thus, when looking at Figure 21, we can foresee the first sign of a fiscal behaviour across OECD coun-

tries consistent with long-term debt sustainability: no evident relationship can be immediately found between (cyclically-adjusted) primary balances and the level of indebtedness. The individual points in the plot represent the fiscal stance of different countries in each year, relative to the (lagged) debt-to-GDP ratio. The five marked outlier observations on the top-right side of the graph are different observations for Greece and point towards the importance of properly taking into account the outliers in the estimation of the dynamic panel regression. Furthermore, by looking at Figure 22, we can observe that, by and large, a negative relationship between underlying primary balances and the (lagged) output gap stands out. This points towards a pro-cyclical behaviour of fiscal policies across OECD countries over the period. The problem of outliers seems less relevant in this case and, importantly, not attributable to one single country. Most negative output gap observations do however arise in the wake of the financial crisis period (as can also be confirmed from Figure 19). Time dummies, as well as debt-to-GDP controls included in some of the estimation procedures presented in this section can capture partially this "outlier effect", linked frequently to countries under stronger fiscal stress.

The dynamic "fixed effects" (or LSDVC) estimator used in the baseline estimation (featuring country-level dummies) is able to partially capture the outlier problem, whenever this attributable to one country, at a given moment in time. Yet, in our robustness checks, a set of estimations is also ran for a sub-set of EMU countries, namely excluding Greece from the sample. The results are shown to be

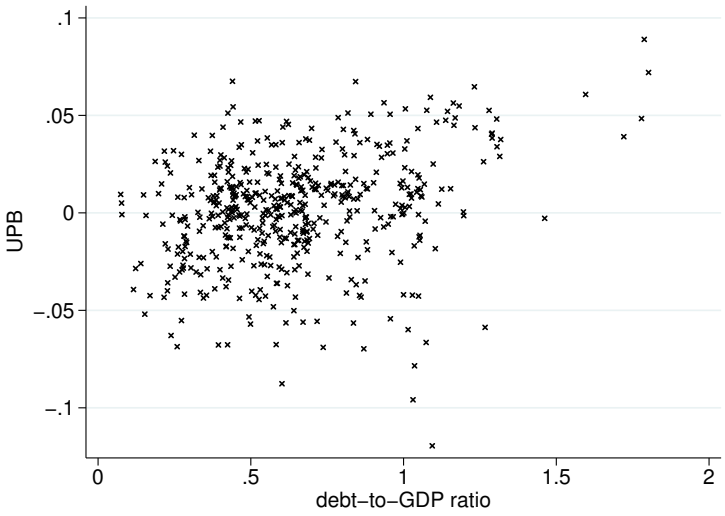

Figure 21: Fiscal policy sustainability across OECD countries (1995-2016). Scatterplot of the (lagged) debt-to-GDP ratio and underlying primary balances (UPB) in OECD countries. The UPB is a measure of the (general) government cyclically-adjusted budgetary balance, excluding net interest payments and the impact of one-off transactions. The figure suggests a mildly positive response of the fiscal stance to rising debt-to-GDP levels, in line with long-term fiscal sustainability concerns. The five marked outlier observations on the top-right side of the graph correspond to yearly observations in Greece after the 2009-10 EMU sovereign crisis episode. This feature points towards the importance of properly dealing with the outlier observations in the estimation stage of the dynamic panel regression. Further robustness checks are performed by removing Greece from the estimation sample.

robust to this exclusion[82].

4.4.1 Dynamic panel regression estimates: baseline results

We now proceed to a detailed analysis of the baseline results from the estimation of a set of fiscal reaction functions for a sample of OECD countries, from 1995 to 2016. In so doing, our objectives are threefold. Firstly, we aim to provide a detailed characterization of the behaviour of the fiscal stance across the OECD over the past two decades. In addition, in a second stage, we focus not only on

[82]The baseline estimations are also re-run for the whole OECD sample with the exception of Greece (Tables F.3 and F.4), and uncover further interesting features. Firstly, a consistent and significant positive response of fiscal balances to the debt-to-GDP ratio is found. Secondly, however, the evidence for a pro-cyclical behaviour of discretionary fiscal policies is now weaker, but still significant at the 10% level. Finally, fiscal balances appear again negatively affected in election years.

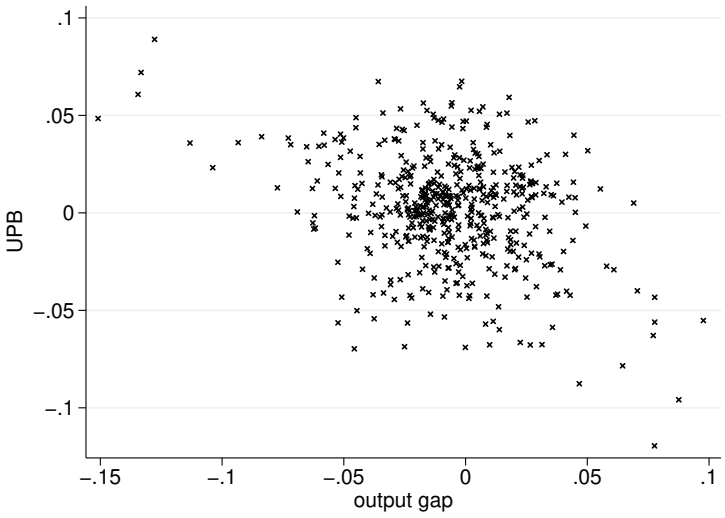

Figure 22: Fiscal policy cyclicality across OECD countries (1995-2016). Scatterplot of the (lagged) output gap and underlying primary balances (UPB) in OECD countries. The UPB is a measure of the (general) government cyclically-adjusted budgetary balance, excluding net interest payments and the impact of one-off transactions. A negative relationship between underlying primary balances and the (lagged) output gap is suggested, pointing towards a pro-cyclical fiscal behaviour across the OECD over the sample period. Some outliers that can be observed in this figure are not attributable to one single country. Most negative output gap observations (on the top-left side of the graph) arise in the wake of the financial crisis period. Output gap observations implying more significant deviations from trend appear again concentrated in the 2004-2007 period. Time dummies, as well as debt-to-GDP thresholds are included in some of the estimation procedures, as part of the (negative) "outlier effect" appears mostly linked to countries with high surges in debt-to-GDP levels.

the fiscal balances, but also on the contribution of revenue-side fiscal reforms, through changes in personal income tax (PIT) rates and corporate income tax (CIT) rates[83]. Secondly, we aim to gain a deeper understanding of the effect and associated magnitudes that several political and institutional factors may have exerted on the observed fiscal behaviour of OECD countries, some of them already previously emphasized in the literature. In this context, we aim to explore in greater detail the role of fiscal decentralization. Thirdly, we aim at exploring further possible non-linearities in fiscal responses, as suggested by recent literature. Namely, we aim to shed more light on the fiscal fatigue hypothesis (Ghosh et al.,

[83]The choice over this two taxes is that they represent two of the main revenue sources for developed economies. Having provided an illustration of how consumption taxes, in particular value added tax (VAT) rates, evolve over time, we observe that these have been relatively more stable than PIT or CIT rates and, hence, less prone to cyclical variations.

2013). This is associated with the idea of an underlying nonlinear relationship between public debt and a country's fiscal and macroeconomic performance, frequently associated with the seminal studies of Reinhart et al. (2003) and Reinhart and Rogoff (2010).

In accordance with the discussion developed in the previous section, the results presented in this section are based on a dynamic panel data estimation method, using the bias-corrected LSDV (LSDVC) estimator (Kiviet et al. 1995, Bun and Kiviet 2003 and Bruno 2005). The bias correction is initialized in this context using a consistent estimator, which is chosen to be the standard Arellano and Bond (1991) GMM estimator. The standard errors reported in each table are thus not standard analytical values, but rather based on numerical simulation techniques. Alongside the tables presented in the context of this section, supplementary regression results are provided in the Appendix and discussed here whenever plausible, for comparison and robustness purposes.

Table 12 presents the results for the LSDVC panel estimates of different fiscal reaction function specifications, using underlying primary balances as the dependent variable. The explanatory variables used in the first specification (column (1)) are meant to provide a benchmark estimate of a simple fiscal reaction function, using the three most commonly used variables, besides the lagged dependent variable: the (lagged) debt-to-GDP ratio, the (lagged) output gap, and a dummy variable capturing election years. Under this framework, the coefficient on the lagged dependent variable captures the persistence of underlying primary balances, which unsurprisingly remains very high across all specifications. In turn, the coefficient on the (lagged) debt-to-GDP ratio provides an estimate of the fiscal responsiveness to indebtedness conditions or, in other words, of the debt

stabilization motive of governments. A positive and significant sign, which remains again broadly stable across the different specifications shown in Table 12, indicates that governments tend to respond with strengthened fiscal discipline to increasing debt levels and points towards a Ricardian fiscal behaviour or, in other words, a sustainable debt path. Note however the relatively low (although persistently significant) coefficient, in the $0.02 - 0.03$ interval. The coefficient on the output gap, in turn, aims at measuring the cyclicality of fiscal policy[84]. Finally, the dummy identifying election years aims to capture the existence of electoral budget cycles. A negative and significant sign across all different specifications strongly indicates that governments tend to systematically loosen fiscal policy, running higher (cyclically-adjusted) primary deficits or lower surpluses, in election years, confirming the findings in the literature on political economy and fiscal policy.

The remaining cases look into the relationship between fiscal decentralization and the fiscal stance. The second specification (column (2)) adds the level of expenditure decentralization, measured as the as the percentage of sub-national over total government expenditure, to the set of explanatory variables. For instance, a negative coefficient would suggest that highly decentralized governments tend to be associated with lower fiscal balances. Instead, the third specification shown in Table 12 (column (3)) adds level of revenue decentralization, also as percentage of total government revenue. A positive coefficient would in this case signal a positive effect on fiscal balances of decentralizing taxation powers towards sub-national governments. The results suggest that the level of expenditure de-

[84]The lag is justified also, but no only, in order to tackle the well-know endogeneity problems of this variable in the estimation of fiscal reaction functions, namely as an alternative to an instrumental variable (IV) approach (Turrini et al., 2008). Another important issue is to deal with the information lags underlying fiscal policy decisions. Assuming policymakers typically cannot respond contemporaneously to short-term macroeconomic fluctuations, a lag on the levels of debt and output gap thus also captures this phenomenon.

centralization has no persistent effect on the fiscal stance, whereas the decentralization of government revenue seems to exert a significantly negative effect on the fiscal stance. This suggests that the level of expenditure decentralization *per se* may not be detrimental for the fiscal stance. In other words, there seem to be clear reasons for more decentralized countries to necessarily run higher or lower (cyclically-adjusted) primary deficits. The main question may thus lie on specific institutional designs, which define the "rules of the game" and how fiscal responsibilities are devolved. The reasons behind a negative sign on the level of revenue decentralization can be twofold. On the one hand, as suggested by the literature on fiscal federalism, fiscal decentralization often originates common pool incentives at the sub-national level, due to the fact that it frequently encompasses a larger level of expenditure rather than revenue decentralization. The results here may thus suggest that, even when sub-national governments have significant fiscal powers to raise own revenues, the fundamental incentive still remains due to the extensive intergovernmental transfer systems that are generally set in place in decentralized systems of government, creating a large vertical fiscal imbalance (VFI). A second argument may suggest that this negative coefficient can be explained by the fact that sub-national governments have weaker revenue-raising powers, in practice, because tax bases are more mobile at this level of government and sub-national tax administration systems may be less developed than federal or central ones. Both arguments can also be seen as complementary explanations of the same phenomenon. The fourth econometric specification (column (4)) aims to further explore the effect of VFIs on the fiscal stance. Although with the expected sign, the coefficient on the VFI, calculated as the percentage of sub-national government revenues obtained from intergovernmental transfers, is not significant. Bearing this in mind, the aim in the remaining baseline econometric

specifications is to explore further the role of fiscal decentralization on the fiscal behaviour of OECD countries. In particular, we aim to explore how different degrees of sub-national autonomy may play a role in this relationship.

The first specification in this subset (column (5)) only includes the aggregate score of the local autonomy index (LAI) as a regressor. No significant relationship between this factor and the level of underlying primary balances is found, although the negative sign is consistent with previous estimates. The three following regression specifications (columns (6)-(9)) interact the aggregate LAI score with the measures of fiscal decentralization used previously. Both the relative levels of expenditure and revenue decentralization now exhibit negative but not significant signs. More interesting is the sign on the level of VFI. The sign now appears much larger than before, in absolute terms, and highly significant. This suggests that the existence of extensive intergovernmental transfer systems coupled with a high degree of sub-national fiscal autonomy can be particularly damaging for a country's aggregate fiscal stance. The two final specifications aim explore whether the degree of sub-national autonomy may have a relationship with the *responsiveness* - rather than the average level - of the fiscal stance, in terms of both cyclicality and long-term sustainability properties. Both coefficients appear with statistically insignificant negative signs, suggesting no (direct) relationship between fiscal decentralization and the short-term responsiveness of fiscal policy to the business cycle and rising debt levels.

4.4.1.1 Non-linear fiscal responses

In Table 13, the existence of non-linear fiscal responses to indebtedness conditions is explored. In the aim of Reinhart and Rogoff (2010) and Égert (2015), among

Table 12: Fiscal reaction functions of 25 OECD countries (1995-2016): baseline results. Dependent variable ($s_{i,t}$): underlying primary balances (UPB). The UPB is a measure of the (general) government cyclically-adjusted budgetary balance, excluding net interest payments and the impact of one-off transactions. Estimates are based on a bias-corrected least squares dummy variable (LSDVC) estimator developed for autoregressive (unbalanced) panel data models, using bias approximations developed in Bruno (2005), based on the standard Arellano and Bond (1991) panel estimator. Bootstrap standard errors are provided in brackets. The regressors in the baseline estimation include: (lagged) debt-to-GDP ratio ($b_{i,t-1}$), (lagged) output gap ($\hat{y}_{i,t-1}$), and a dummy capturing election years (D^{ebc}_{it}). Further regression specification for which results are presented in this table also include different measures of fiscal decentralization (f^{FD}_{it}), as well as interaction terms between those, with measures of expenditure (f^{exp}_{it}) and revenue decentralization (f^{rev}_{it}), vertical fiscal imbalances (f^{vfi}_{it}) and local autonomy (f^{lai}_{it}).

$s_{i,t}$ (UPB)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$s_{i,t-1}$	0.819***	0.816***	0.786***	0.815***	0.839***	0.840***	0.820***	0.817***	0.828***	0.839***
	(0.034)	(0.030)	(0.033)	(0.030)	(0.032)	(0.042)	(0.032)	(0.040)	(0.041)	(0.032)
$b_{i,t-1}$	0.025***	0.026***	0.027***	0.024***	0.028***	0.027***	0.028***	0.023***	0.030***	0.028***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006	(0.006)	(0.006)
$\hat{y}_{i,t-1}$	-0.066**	-0.065**	-0.074***	-0.071***	-0.066**	-0.067**	-0.068***	-0.084***	-0.073**	-0.065*
	(0.029)	(0.026)	(0.029)	(0.027)	(0.027)	(0.033)	(0.026)	(0.032)	(0.033)	(0.037)
D^{ebc}_{it}	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
f^{exp}_{it}		0.007								
		(0.019)								
f^{rev}_{it}			-0.099***							
			(0.039)							
f^{vfi}_{it}				-0.026						
				(0.034)						
f^{lai}_{it}					-0.018					
					(0.043)					
$f^{exp}_{it} \times f^{lai}_{it}$						-0.021				
						(0.042)				
$f^{rev}_{it} \times f^{lai}_{it}$							-0.088			
							(0.064			
$f^{vfi}_{it} \times f^{lai}_{it}$								-0.357**		
								(0.184)		
$b_{i,t-1} \times f^{vfi}_{it} \times f^{lai}_{it}$									-0.433	
									(0.319)	
$\hat{y}_{i,t-1} \times f^{rev}_{it} \times f^{lai}_{it}$										-0.029
										(0.283)

*10% significance level, **5% significance level, ***1% significance level

others, we explore whether the fiscal stance may exhibit different responses to rising debt levels, depending on the relative size of the debt stock. This is related to the idea of a debt intolerance threshold, beyond which the stock of government debt can become an important burden for a country's fiscal and macroeconomic performance. Ghosh et al. (2013) proposes the concept of endogenous debt limits and "fiscal fatigue". Consistent with the previous literature, we first look for the existence of threshold effects around the 90% debt-to-GDP ratio. Against what is found in Reinhart and Rogoff (2010) or Ghosh et al. (2013), we find no evidence of a debt threshold at the 90-100% debt-to-GDP ratio levels. Instead, consistent with Égert (2015), we do find evidence that possible debt thresholds may exist at lower debt-to-GDP ratio levels, around or below 70% debt-to-GDP levels (column (1)). Although this cannot be observed as a direct effect on the responsiveness on fiscal balances to both the debt-to-GDP ratio and the output gap (columns (4)-(9)), these results suggest that the marginal responses of (cyclically-adjusted) primary balances remain positive at moderate debt levels, but start to decline beyond this point. This is consistent with the idea of fiscal fatigue suggested namely in Ghosh et al. (2013). Note also that the persistence, sustainability and cyclicality coefficients remain remarkably stable across different specifications, suggesting again a pro-cyclical fiscal stance set in accordance with long-term debt sustainability concerns. A negative significant sign is again found on the election dummy, pointing towards the relevance of electoral budget cycles.

In order to explore the "fiscal fatigue" or "debt intolerance" phenomenon a bit further, the existence of debt thresholds at lower levels is also tested, between 50 and 70% debt-to-GDP ratios. Again, consistent with the findings of Égert (2015), we find that signs of fiscal fatigue or fiscal intolerance appear to kick in

already at moderate debt levels. The results in Table 17, in the following section, also point towards the existence of relevant debt thresholds, but at lower levels than previously thought, with a negative and significant effect not only on the level of fiscal balances, but crucially on the degree of fiscal responsiveness to indebtedness condition. Although of a relative small magnitude, these estimates point towards a degree of fiscal responsiveness to rising debt-to-GDP ratios that can become severely weakened in cumulative terms. In effect, together with the coefficient on the lagged debt-to-GDP ratio and the estimates obtained in Table 13, these results suggest that the fiscal responsiveness to indebtedness conditions, interpreted frequently as a sustainability criterion, can vary widely across the spectrum of relative debt stocks, which is consistent with the existence of endogenous debt limits (Ghosh et al., 2013). Taken together, the results in Tables 13 and 17 are particularly worrying for the long-term sustainability of fiscal policies in EMU countries and other developed economies, particularly where debt overhang problems appear to be more severe[85]. It is also worth noting that the coefficients on the interactive terms between different debt thresholds and the lagged output gap do not show any significant "fiscal fatigue" effects of high debt-to-GDP levels on the cyclicality of fiscal policies across the OECD.

4.4.1.2 Fiscal rules

The estimates in Table 14 briefly look at the effect of formal fiscal rules on the fiscal stance. As is well-known, much emphasis has recently been given to the existence of sound fiscal frameworks in developed economies, as means of ensuring

[85]These results are also consistent with the large literature that developed recently on debt overhang and sovereign default (Arellano 2008, Cuadra et al. 2010, D'Erasmo and Mendoza 2016, D'Erasmo et al. 2016, Arellano and Bai 2017).

Table 13: Fiscal reaction functions of 25 OECD countries (1995-2016): debt thresholds. Dependent variable: underlying primary balances (UPB). The UPB is a measure of the (general) government cyclically-adjusted budgetary balance, excluding net interest payments and the impact of one-off transactions. Estimates are based on a LSDVC estimator developed for autoregressive (unbalanced) panel data models (Bruno 2005), based on the standard Arellano and Bond (1991) estimator. Bootstrap standard errors are provided in brackets. Besides the regressors also included in the baseline estimation, the regression specifications for which results are presented in this table also include different levels of debt-to-GDP thresholds ($D_{it}^{\bar{b}}$), where $\bar{b} = 80, 90, 100\%$, as well as interaction terms between these and the (lagged) debt-to-GDP ratio and the output gap. These aim to capture possible non-linearities in the response of fiscal balances across different debt levels.

$s_{i,t}$ (UPB)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$s_{i,t-1}$	0.800***	0.815***	0.818***	0.809***	0.818***	0.819***	0.818***	0.816***	0.811***
	(0.033)	(0.034)	(0.034)	(0.033)	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)
$b_{i,t-1}$	0.032***	0.027***	0.025***	0.032***	0.025***	0.024***	0.025***	0.025***	0.024***
	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)
$\hat{y}_{i,t-1}$	-0.070**	-0.067**	-0.066**	-0.070**	-0.067**	-0.067**	-0.061*	-0.061**	-0.057*
	(0.029)	(0.029)	(0.030)	(0.029)	(0.029)	(0.029)	(0.033)	(0.031)	(0.030)
D_{it}^{ebc}	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$D_{it}^{\bar{b}=80\%}$	-0.006**								
	(0.003)								
$D_{it}^{\bar{b}=90\%}$		-0.002							
		(0.003)							
$D_{it}^{\bar{b}=100\%}$			0.000						
			(0.003)						
$b_{i,t-1} \times D_{it}^{80}$				-0.005					
				(0.004)					
$b_{i,t-1} \times D_{it}^{90}$					0.000				
					(0.003)				
$b_{i,t-1} \times D_{it}^{100}$						0.001			
						(0.003)			
$\hat{y}_{i,t-1} \times D_{it}^{80}$							-0.013		
							(0.045)		
$\hat{y}_{i,t-1} \times D_{it}^{90}$								-0.018	
								(0.045)	
$\hat{y}_{i,t-1} \times D_{it}^{100}$									-0.045
									(0.045)

*10% significance level, **5% significance level, ***1% significance level

long-term fiscal sustainability. This has been subject of particular attention in the context of the EMU (Galí et al., 2003), first with the rules established by the Maastricht Treaty and the SGP, and more recently replaced by the Fiscal Compact or TSCG. As with the case of the analysis of debt thresholds, our aim is twofold. First, we aim to assess whether different fiscal rules may have an impact on the average value of fiscal balances. Secondly, going one step further, the aim is to assess whether the level or magnitude of fiscal responsiveness also varies. For instance, a balanced budget rule may restrict a country's capability to respond to business cycle fluctuations. On the other hand, the existence of debt rules may provide an incentive for countries to respond more aggressively to rising debt-to-GDP ratios. Taking advantage of an extensive dataset, the Fiscal Rules Dataset, we can explore the effects of expenditure and revenue rules, as well as of balanced budget and debt rules. We focus in particular on the latter two, as these are also the more discussed options in the context of the EMU fiscal framework.

The first specification presented in Table 14 looks at the effects of fiscal rules on the average value of the underlying primary balances (column (1)). Only debt rules appear with the expected positive sign, found significant at the 10% level. The remaining four econometric specifications (columns (2)-(5)) aim to explore whether, rather than having an impact on the average level of fiscal balances, fiscal rules may affect the responsiveness of the fiscal stance. On the one hand, neither balanced budget rules nor debt rules appear to affect significantly the responsiveness of fiscal balances to indebtedness conditions (columns (2) and (3)). In the framework of the fiscal reaction functions literature, one can thus interpret this as evidence against the view that the existence of formal fiscal rules has beneficial effects on long-term fiscal sustainability. It is also worth noting that, although

not significant, the coefficient on the interaction term between debt rules and the lagged debt-to-GDP ratio appears with the expected positive sign. Finally, the two last econometric specifications (columns (4) and (5)) aim to explore whether the existence of such rules may somehow restrict the ability of governments to respond to the business cycle (Galí et al., 2003). Although both coefficients do not appear statistically significant, a positive sign suggests such rules may gear fiscal policy interventions towards a more counter-cyclical pattern. In addition, the coefficients on the (lagged) output gap now also appear not significant in the regression, suggesting that the discretionary element of fiscal policy is mainly a-cyclical. These results thus appear to mildly support the view that fiscal rules can promote more "prudent" fiscal behaviour, in line with Galí et al. (2003).

4.4.1.3 Tax reaction functions

So far, we have focused on the reactions of cyclically-adjusted (or underlying) primary balances to diverse factors, such as the debt-to-GDP ratio and the output gap, or the level of fiscal decentralization and formal fiscal rules. By and large, we can conclude that fiscal balances appear mildly pro-cyclical over the period and responsive to indebtedness conditions, in line with long-term fiscal sustainability concerns. We have also found a consistent negative effect of election years, as suggested in the literature, and of intergovernmental transfers, particularly when coupled with high degrees of sub-national fiscal autonomy. The existence of threshold effects also seems to suggest that there might exist underlying non-linear effects of the debt stock on fiscal performance, a phenomenon coined in the literature as "debt intolerance" or "fiscal fatigue". The estimates now presented in Tables 15 and 16 aim to provide more insights on the behaviour of fiscal vari-

Table 14: Fiscal reaction functions of 25 OECD countries (1995-2016): fiscal rules. Dependent variable: underlying primary balances (UPB). The UPB is a measure of the (general) government cyclically-adjusted budgetary balance, excluding net interest payments and the impact of one-off transactions. Estimates are based on a LSDVC estimator developed for autoregressive (unbalanced) panel data models (Bruno 2005), based on the standard Arellano and Bond (1991) estimator. Bootstrap standard errors are provided in brackets. Besides the regressors also included in the baseline estimation, the regression specifications for which results are presented in this table also include dummies capturing different fiscal rules ($D_{it}^{\overline{r}}$), where $\overline{r} = er, rr, bbr, dr$, as well as interaction terms between these and the (lagged) debt-to-GDP ratio and the output gap. These aim to capture the effect of formal fiscal rules on the fiscal stance, such as expenditure ($\overline{r} = er$), revenue ($\overline{r} = rr$), balanced budget ($\overline{r} = bbr$) and debt rules ($\overline{r} = dr$).

$s_{i,t}$ (UPB)	(1)	(2)	(3)	(4)	(5)
$s_{i,t-1}$	0.830***	0.833***	0.831***	0.832***	0.832***
	(0.033)	(0.034)	(0.034)	(0.034)	(0.034)
$b_{i,t-1}$	0.028***	0.028***	0.026***	0.028***	0.028***
	(0.006)	(0.007)	(0.007)	(0.006)	(0.006)
$\hat{y}_{i,t-1}$	-0.066***	-0.063***	-0.065***	-0.065	-0.069
	(0.025)	(0.025)	(0.024)	(0.048)	(0.049)
D_{it}^{ebc}	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$D_{it}^{\overline{r}=er}$	-0.001				
	(0.002)				
$D_{it}^{\overline{r}=rr}$	-0.001				
	(0.004)				
$D_{it}^{\overline{r}=bbr}$	-0.003				
	(0.004)				
$D_{it}^{\overline{r}=dr}$	0.008*				
	(0.005)				
$b_{i,t-1} \times D_{it}^{bbr}$		-0.001			
		(0.004)			
$b_{i,t-1} \times D_{it}^{dr}$			0.002		
			(0.004)		
$\hat{y}_{i,t-1} \times D_{it}^{bbr}$				0.002	
				(0.050)	
$\hat{y}_{i,t-1} \times D_{it}^{dr}$					0.007
					(0.052)

*10% significance level, **5% significance level, ***1% significance level

ables. How do tax rates, rather than tax revenues or aggregate fiscal measures, respond to these factors? Do governments tend to vary tax rates over the business cycle or in accordance with long-term debt sustainability concerns? Are tax rates also affected by electoral budget cycles? And, finally, are tax rates affected by the relative levels of fiscal decentralization in different countries? We focus in particular on the behaviour of top statutory CIT (Table 15) and PIT rates (Table 16).

Table 15 replicates the econometric specifications presented in Table 12, but now considering exclusively the behaviour of CIT rates. Again, as expected, CIT rates appear highly persistent, with the autoregressive parameter appearing consistently in the 0.9-0.95 range. Besides the high persistence, three main patterns emerge, at a first glance. Firstly, it is interesting to find that CIT rates do not appear to respond to long-term fiscal sustainability concerns, as the parameters on the (lagged) debt-to-GDP ratio appear consistently not significant and, although very close to zero, with varying signs. Secondly, CIT rates appear to move acyclically or in a mildly counter-cyclical fashion. Although the coefficients on the (lagged) output gap appear consistently with a negative value, these are not always significant, and frequently only significant at the 10% level. Thirdly, CIT rates do not appear to respond to political cycles, showing no significantly positive or negative bias in election years. Taken together these three patterns suggest that CIT rates in OECD countries have been relatively persistent over the past decades and do not seem to exhibit strong cyclical patterns. The mild counter-cyclical behaviour, together with the observed downward trend in the data (Table E.2), rather than pointing towards a "response" of CIT rates to the business cycle (as in the case of aggregate fiscal balances), may instead suggest that CIT rate cuts may happen mostly during economic upswings, perhaps consistently with the fact that higher aggregate tax revenues leave more fiscal space for tax cuts. On the other hand, the fact that CIT rates do not appear to respond to the debt-to-GDP ratio may also not be surprising. Being generally a minor source of tax revenues in developed economies (as compared, for instance, to PIT or VAT revenues) and implying a more distortionary tax, CIT rate increases are frequently forestalled. In addition, in an environment of fierce international fiscal competition, any expectation of CIT rate increases can deter investments and

have a detrimental effect on a country's fiscal and macroeconomic performance.

In order to further delve into this fiscal competition argument, we also aim to explore whether fiscal decentralization may have a relationship with CIT rates. Interestingly, negative relationship is observed between the average CIT rate and the level of expenditure decentralization (column (2)), as well as with the magnitude of VFIs (column (4)). The level of revenue decentralization, although with a negative sign, does not show a significant relationship with the average CIT rate. A similar pattern emerges when these factors are interacted with the level of sub-national autonomy. On the one hand, more decentralized expenditure powers may imply stronger fiscal competition between sub-national jurisdictions, with a negative spillover on average CIT rates. This explanation can also be consistent with the idea that fiscal decentralization can foster yardstick competition, as policymakers of neighbouring jurisdictions would indirectly compete with each other for reelection. These "peer effects" generated at the sub-national level can thus generate lower overall level of corporate taxation. Yet, the negative relationship between the level of VFIs and average level of CIT rates can also suggest a different explanation. As sub-national governments tend to rely predominantly on intergovernmental transfers as a source of revenue, this may endanger fiscal sustainability in the long-term and have a general negative effect on tax rates, not only on CIT rates. This explanation is more consistent with the common pool problems and soft budget constraints that can be generated by decentralized systems of government with large intergovernmental transfer systems. We can explore this argument further by looking at the behaviour of PIT rates.

Table 16 provides a similar analysis of the behaviour of PIT rates. In this tax reaction function, PIT rates are regressed against the same set of determinants

used to analyse the behaviour of fiscal balances and CIT rates (Tables 12 and 15). Once again, PIT rates exhibit a high degree of persistence, along the same range of CIT rates. Yet, the behaviour of these along the business cycle appears to be dramatically different from that of CIT rates. PIT rates appear to respond mildly to the debt-to-GDP ratio. Hence, it appears that personal income taxation is used as a revenue source to ensure long-term fiscal sustainability. The positive and significant coefficients on the (lagged) debt-to-GDP ratio suggest that governments tend to respond to rising debt levels with higher (top statutory) PIT rates. Assuming that these tend to be on the "right" side of the Laffer curve, PIT revenues can then be used to rapidly increase government revenues and strengthen aggregate fiscal balances. On the other hand, PIT rates do not seem to behave in a cyclical way. Another interesting issue emerges however: PIT rates do seem to respond to electoral cycles. A positive and significant coefficient in election years indicates that governments tend to increase PIT rates in election years (even while running lower fiscal balances, as suggested from Table 12). These results can be interpreted as evidence of reelection concerns of incumbent governments. In response to median voter preferences, governments tend to increase average PIT rates, while increasing public expenditures.

Turning our attention to the effect of fiscal decentralization on PIT rates, the results in Table 16 point again towards a different picture from those seen before for CIT rates (columns (2)-(4)). Although no relationship is found between expenditure decentralization or the relative size of VFIs and the average level of PIT rates, revenue decentralization does seem to have a positive significant relationship with the level of PIT rates. When interacted with the degree of sub-national autonomy, similar conclusions arise, with a larger coefficient on the

level of revenue decentralization (column (7)) and no significant effects on the explanatory power of the other two factors (columns (6) and (8)). Once again, this apparent relationship can be explained by different underlying mechanisms.

On the one hand, a higher level of fiscal decentralization coupled with the devolution of taxation powers may cause aggregate PIT rates to rise on average, because these may be used by sub-national governments to raise tax revenues, if decentralized. Generally, VAT rates are decided at the central level - both the standard and reduced rates -, with little or no room for discretion at the sub-national level. Similarly, corporate income taxation is generally not deemed appropriate to be set at the sub-national level, namely because of race to the bottom concerns and fears of negative externalities. Hence, PIT rates seem, besides other sources of local revenue, such as property taxes and user fees, the most likely candidates to allow for some degree of sub-national tax discretion. The questions then emerges of why should PIT rates be higher, and not lower, in more decentralized countries. One explanation is that sub-national governments may tend on average to raise higher PIT taxes in order to provide a higher level of local public goods. On the other hand, fiscal decentralization may imply that the central government may now also compete with sub-national governments to raise tax revenues. Fiscal decentralization may generate, in this context, not only "horizontal" tax competition, between sub-national governments, but also "vertical" tax competition, between the central and sub-national governments. Hence, the central government may choose to raise the aggregate PIT rates strategically, as a "first mover" or an incumbent, ahead of fiscal decentralization reforms.

Table 15: Fiscal reaction functions of 21 OECD countries (1995-2016): tax rates. Dependent variable: top statutory corporate income tax (CIT) rate. Estimates are based on a LSDVC estimator developed for autoregressive (unbalanced) panel data models (Bruno 2005), based on the standard Arellano and Bond (1991) estimator. Bootstrap standard errors in brackets. The same regressors also included in the baseline estimation table are used. Further details can be found in Table 12. The aim using a different dependent variable is to capture further determinants of changes in tax rates and, in so doing, better characterize the evolution of the fiscal stance in the OECD across the sample period.

$\tau_{i,t}$ (CIT)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\tau_{i,t-1}$	0.922***	0.920***	0.906***	0.923***	0.924***	0.916***	0.914***	0.913***	0.924***	0.924***
	(0.021)	(0.022)	(0.022)	(0.022)	(0.021)	(0.024)	(0.023)	(0.024)	(0.024)	(0.021)
$b_{i,t-1}$	0.002	-0.007	0.001	-0.006	0.005	-0.004	0.004	-0.004	0.005	0.006
	(0.007)	(0.008)	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)	(0.008)
$\hat{y}_{i,t-1}$	-0.054	-0.067*	-0.061*	-0.078**	-0.060	-0.066*	-0.062	-0.086**	-0.070*	-0.018
	(0.036)	(0.037)	(0.037)	(0.037)	(0.045)	(0.039)	(0.045)	(0.040)	(0.041)	(0.056)
D_{it}^{ebc}	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
f_{it}^{exp}		-0.070***								
		(0.028)								
f_{it}^{rev}			-0.087							
			(0.055)							
f_{it}^{vfi}				-0.098**						
				(0.049)						
f_{it}^{lai}					0.002					
					(0.059)					
$f_{it}^{exp} \times f_{it}^{lai}$						-0.136***				
						(0.053)				
$f_{it}^{rev} \times f_{it}^{lai}$							-0.084			
							(0.078)			
$f_{it}^{vfi} \times f_{it}^{lai}$								-0.496**		
								(0.243)		
$b_{i,t-1} \times f_{it}^{vfi} \times f_{it}^{lai}$									-0.301	
									(0.453)	
$\hat{y}_{i,t-1} \times f_{it}^{rev} \times f_{it}^{lai}$										-0.489
										(0.421)

*10% significance level, **5% significance level, ***1% significance level

Table 16: Fiscal reaction functions of 21 OECD countries (1995-2016): tax rates. Dependent variable: top statutory personal income tax (PIT) rate. Estimates are based on a LSDVC estimator developed for autoregressive (unbalanced) panel data models (Bruno 2005), based on the standard Arellano and Bond (1991) estimator. Bootstrap standard errors in brackets. The same regressors also included in the baseline estimation table are used. Further details can be found in Table 12. The aim using a different dependent variable is to capture further determinants of changes in tax rates and, in so doing, better characterize the evolution of the fiscal stance in the OECD across the sample period.

$\tau_{i,t}$ (PIT)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\tau_{i,t-1}$	0.938***	0.937***	0.947***	0.938***	0.938***	0.933***	0.946***	0.941***	0.939***	0.939***
	(0.029)	(0.035)	(0.029)	(0.035)	(0.029)	(0.034)	(0.029)	(0.033)	(0.033)	(0.029)
$b_{i,t-1}$	0.013*	0.014	0.011	0.017*	0.018*	0.017*	0.015	0.022**	0.018*	0.016
	(0.008)	(0.010)	(0.008)	(0.010)	(0.010)	(0.010)	(0.010)	(0.011)	(0.010)	(0.010)
$\hat{y}_{i,t-1}$	-0.010	-0.004	-0.008	0.004	-0.012	-0.013	-0.020	-0.004	-0.005	-0.063
	(0.044)	(0.047)	(0.045)	(0.046)	(0.056)	(0.051)	(0.054)	(0.051)	(0.051)	(0.067)
D_{it}^{ebc}	0.005**	0.005**	0.005**	0.005**	0.006**	0.006**	0.006**	0.006**	0.006**	0.006**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
f_{it}^{exp}		0.004								
		(0.035)								
f_{it}^{rev}			0.114*							
			(0.064)							
f_{it}^{vfi}				0.043						
				(0.063)						
f_{it}^{lai}					-0.043					
					(0.072)					
$f_{it}^{exp} \times f_{it}^{lai}$						0.009				
						(0.069)				
$f_{it}^{rev} \times f_{it}^{lai}$							0.171*			
							(0.091)			
$f_{it}^{vfi} \times f_{it}^{lai}$								0.371		
								(0.310)		
$b_{i,t-1} \times f_{it}^{vfi} \times f_{it}^{lai}$									0.190	
									(0.572)	
$\hat{y}_{i,t-1} \times f_{it}^{rev} \times f_{it}^{lai}$										0.542
										(0.512)

*10% significance level, **5% significance level, ***1% significance level

4.4.2 Robustness checks

From our previous analysis, various policy patterns have emerged. Firstly, we have seen that fiscal balances tend to respond to debt-to-GDP ratio in a way consistent with long-term fiscal sustainability concerns. Yet, it appears that fiscal policy has tend to become pro-cyclical across OECD economies. Also CIT rates appear to move in a counter-cyclical fashion, suggesting that governments may use a larger "fiscal space" generally available during economic upswings to reduce corporate taxation. Secondly, electoral budget cycles seem to play a role in the way fiscal policy is conducted across the OECD. Not only election years tend to be associated with weaker fiscal balances, but also with higher PIT rates, suggesting a "strategic" behaviour of incumbent governments with reelection prospects.

The evidence on the existence of debt thresholds and on the effect of fiscal rules is mixed. Debt thresholds seem to exist, according to recent literature, but start to appear at relatively low levels, which imply that "fiscal fatigue" (Ghosh et al., 2013) may indeed be an important feature of fiscal policy responses across the business cycle. Debt rules are associated with higher fiscal balances, on average, and thus seem to play a mild role in promoting long-term fiscal sustainability. Finally, the evidence on the effect of fiscal decentralization is more complex. Fiscal decentralization tends to be associated with weaker fiscal balances and lower CIT rates. In particular, the effect of the relative magnitude of intergovernmental transfers also appears to play a role in this relationship. At the same time, revenue decentralization appears associated with higher PIT rates.

In this section, we aim to further explore the relationships highlighted above. To this end, we design a series of robustness checks, in order to assess whether the results found so far hold across a wider range of econometric specifications. First,

we re-assess the idea of a non-linear response of fiscal balances using different debt thresholds. Secondly, we use the US output gap as a measure of the business cycle. Finally, we re-run the previous for a sample of EMU countries only and, in a second stage, remove Greece from the sample.

4.4.2.1 Debt thresholds

The results obtained so far have suggested that the fiscal responsiveness to indebtedness conditions can vary widely across different debt levels. This is consistent with the recent literature, suggesting the existence of endogenous debt limits (Ghosh et al., 2013). Table 17 confirms and reinforces the idea of a varying responsiveness of (cyclically-adjusted) primary balances across different debt-to-GDP levels. Having tested several different debt thresholds, it appears that a negative effect of debt on the fiscal stance is perceivable already after the 50% debt-to-GDP ratio. Furthermore, this affects not only the average level of fiscal balances past this level, but also the degree of responsiveness to rising debt-to-GDP levels. The existence of endogenous debt limits (Ghosh et al., 2013) suggests that long-term fiscal sustainability can be endangered in environments of high public debt. Not only the "fiscal space" for future fiscal adjustments becomes shorter, as higher debt-to-GDP ratios are associated with lower structural fiscal balances, but also the varying responsiveness across the distribution of relative debt stocks suggests that "fiscal fatigue" can be an important feature of fiscal policy in the current debt overhang environment across most developed economies.

Acknowledging the dissimilar paths of debt-to-GDP ratios and debt services at the country level, we also aim to identify whether different fiscal responses can also be observed across the distribution of debt service thresholds. Table F.2 shows the

results using different potential debt service thresholds, as measured by the debt-to-GDP ratio multiplied by the yearly average of long-term interest rates for each country. The average (potential) debt service across OECD countries over the period was around 3%. Hence, different debt service thresholds are calculated at the 2-5% levels. Two interesting patterns emerge: while the responsiveness of the fiscal stance to rising debt-to-GDP ratio increases across different (potential) debt service thresholds, the responsiveness to the business cycle also become more pro-cyclical. These results are also robust to the removal of Greece from the sample.

4.4.2.2 US output gap

In Table 18 we provide alternative estimates for our baseline fiscal reaction function specifications (Table 12), using the US output gap as an alternative for the EU output gap. In so doing, we aim to re-assess in particular the cyclical properties of fiscal reactions across the OECD. In addition, we also look at the stability of the remaining parameters, both across the different specifications shown in Table 18 and comparing with previous estimates. Both the sign and magnitude of the coefficients on the (lagged) debt-to-GDP ratio, the output gap measure and the election dummy are broadly constant over the different specifications, and similar to those found previously. In addition, not surprisingly, the estimated persistence of fiscal balance lies within the same range. However, looking at the cyclicality parameter it is interesting to note that, although persistently negative, as in Table 12, most of the coefficients are not significant using the US output gap as a proxy of the business cycle. This points towards a predominantly a-cyclical discretionary fiscal policy response, although again with a slight pro-cyclical tendency.

Regarding the fiscal decentralization coefficients, these appear again with the

Table 17: Fiscal reaction functions of 25 OECD countries (1995-2016): alternative debt thresholds. Dependent variable: underlying primary balances (UPB). The UPB is a measure of the (general) government cyclically-adjusted budgetary balance, excluding net interest payments and the impact of one-off transactions. Estimates are based on a LSDVC estimator developed for autoregressive (unbalanced) panel data models (Bruno 2005), based on the standard Arellano and Bond (1991) estimator. Bootstrap standard errors in brackets. This table reports estimates as a robustness check to the results presented in Table 13. Besides the regressors also included in the baseline estimation, the regression specifications for which results are presented in this table include different levels of debt-to-GDP thresholds ($D_{it}^{\bar{b}}$), where $\bar{b} = 50, 60, 70\%$, as well as interaction terms between these and the (lagged) debt-to-GDP ratio and the output gap. These aim to capture possible non-linearities in the response of fiscal balances across different debt levels.

$s_{i,t}$ (UPB)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$s_{i,t-1}$	0.801***	0.811***	0.808***	0.804***	0.817***	0.814***	0.814***	0.815***	0.819***
	(0.035)	(0.035)	(0.031)	(0.035)	(0.035)	(0.031)	(0.034)	(0.034)	(0.032)
$b_{i,t-1}$	0.031***	0.028***	0.033***	0.039***	0.026***	0.034***	0.024***	0.024***	0.025***
	(0.005)	(0.006)	(0.006)	(0.007)	(0.008)	(0.007)	(0.005)	(0.005)	(0.006)
$\hat{y}_{i,t-1}$	-0.065**	-0.066**	-0.063***	-0.065**	-0.067**	-0.065***	-0.046	-0.050	-0.065**
	(0.028)	(0.029)	(0.026)	(0.029)	(0.029)	(0.026)	(0.044)	(0.037)	(0.031)
D_{it}^{ebc}	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$D_{it}^{\bar{b}=50\%}$	-0.005**								
	(0.002)								
$D_{it}^{\bar{b}=60\%}$		-0.002							
		(0.002)							
$D_{it}^{\bar{b}=70\%}$			-0.005**						
			(0.002)						
$b_{i,t-1} \times D_{it}^{50}$				-0.010**					
				(0.004)					
$b_{i,t-1} \times D_{it}^{60}$					-0.001				
					(0.004)				
$b_{i,t-1} \times D_{it}^{70}$						-0.006*			
						(0.003)			
$\hat{y}_{i,t-1} \times D_{it}^{50}$							-0.033		
							(0.048)		
$\hat{y}_{i,t-1} \times D_{it}^{60}$								-0.031	
								(0.042)	
$\hat{y}_{i,t-1} \times D_{it}^{70}$									-0.003
									(0.046)

*10% significance level, **5% significance level, ***1% significance level

same signs, magnitudes and significance. It is again worth noting that revenue decentralization does seem to be associated with lower fiscal balances, while large intergovernmental transfers are also detrimental to the fiscal stance, particularly when coupled with a large degree of sub-national fiscal autonomy.

4.4.2.3 EMU countries

Restricting the initial analysis to EMU countries significantly restricts our sample size[86] and reinforces the preference for the use of LSDVC rather than GMM estimation methods. Tables 19 and 20 show the results for the sample of 13 EMU countries. In addition, Tables F.3 and F.4 (in Appendix) consider the results for the complete sample of OECD countries, excluding Greece.

The results for our EMU sample show broadly similar results. Fiscal balances respond positively to the debt-to-GDP ratio and show a markedly pro-cyclical behaviour. Electoral budget cycles also appear to be an important feature, as fiscal balances are consistently lower in election years. These trends are also very stable across different econometric specifications and the estimated relationships hold consistently at the 5% significance level, and at the 1% level (Tables 19 and 20). The relationship between fiscal decentralization and the aggregate fiscal stance seems again more complex. Only revenue decentralization appears with a significantly negative coefficient. The role of sub-national autonomy in this relationship is not apparent from the results obtained for the sample of EMU countries (Table 19). On the contrary, we find evidence of the existence of debt thresholds (Table 20), again at relatively lower debt levels than previous studies have suggested

[86]The new sample consists only of the following 13 countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Slovenia, and Spain. We also include a dummy for EMU participation.

Table 18: Fiscal reaction functions of 25 OECD countries (1995-2016): US output gap. Dependent variable: underlying primary balances (UPB). The UPB is a measure of the (general) government cyclically-adjusted budgetary balance, excluding net interest payments and the impact of one-off transactions. Estimates are based on a LSDVC estimator developed for autoregressive (unbalanced) panel data models (Bruno 2005), based on the standard Arellano and Bond (1991) estimator. Bootstrap standard errors in brackets. This table reports estimates as a robustness check to the results presented in previous Tables 12-17, using the (lagged) output gap as a regressor. Besides the remaining regressors included in the baseline estimation, the regression specifications for which results are presented in this table include use the (lagged) US output gap as a measure of the business cycle. This aim to assess whether the responsiveness or the measured cyclicality of fiscal balances is robust to different measures of the output gap.

$s_{i,t}$ (UPB)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$s_{i,t-1}$	0.841***	0.837***	0.813***	0.841***	0.864***	0.868***	0.848***	0.855***	0.860***	0.865***
	(0.034)	(0.031)	(0.033)	(0.031)	(0.031)	(0.041)	(0.031)	(0.039)	(0.039)	(0.030)
$b_{i,t-1}$	0.031***	0.031***	0.032***	0.029***	0.033***	0.030***	0.033***	0.026***	0.034***	0.031***
	(0.004)	(0.005)	(0.004)	(0.005)	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)
$\hat{y}^{\mathrm{US}}_{i,t-1}$	-0.032	-0.031	-0.039	-0.042	-0.038	-0.047	-0.043	-0.077**	-0.055	-0.073
	(0.029)	(0.033)	(0.030)	(0.035)	(0.033)	(0.032)	(0.031)	(0.033)	(0.032)	(0.052)
D^{ebc}_{it}	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
f^{exp}_{it}		0.005								
		(0.020)								
f^{rev}_{it}			-0.096***							
			(0.039)							
f^{vfi}_{it}				-0.025						
				(0.037)						
f^{lai}_{it}					-0.022					
					(0.043)					
$f^{exp}_{it} \times f^{lai}_{it}$						-0.036				
						(0.042)				
$f^{rev}_{it} \times f^{lai}_{it}$							-0.094			
							(0.063)			
$f^{vfi}_{it} \times f^{lai}_{it}$								-0.424**		
								(0.193)		
$b_{i,t-1} \times f^{vfi}_{it} \times f^{lai}_{it}$									-0.470	
									(0.323)	
$\hat{y}^{\mathrm{US}}_{i,t-1} \times f^{rev}_{it} \times f^{lai}_{it}$										0.283
										(0.378)

*10% significance level, **5% significance level, ***1% significance level

(Égert, 2015). Evidence is found of non-linearities of fiscal responses around the 70-80% thresholds. Furthermore, this does not only affect the level of fiscal balances, but the responsiveness of the fiscal stance to rising debt ratios (column (10)). The results found for the sub-sample of EMU countries is thus consistent with the existence of endogenous debt limits and of fiscal fatigue at high debt-to-GDP ratios (Ghosh et al., 2013), which can endanger fiscal adjustments in the EMU.

Finally, looking at our OECD sample, excluding Greece, uncovers further interesting features. On the one hand, a consistent significant positive response of fiscal balances to the debt-to-GDP ratio is found. In addition, fiscal balances appear again to be negatively affected in election years. Both relationships hold at the 1% level. On the other hand, the evidence for a pro-cyclical behaviour of discretionary fiscal policies is now much weaker. Although a negative sign is persistently found, this relationship is now only found significant at the 10% level, or even not significant at all in several cases (Tables F.3 and F.4). This suggests that pro-cyclicality of fiscal policies was triggered in EMU countries under fiscal stress and only recently became a feature of fiscal policy within the EMU. Yet, this also underlines one important "shortcoming" of the EMU fiscal design: countries under fiscal stress were forced to persistently run pro-cyclical (contractionary) fiscal policies, in order to respond to sustainability concerns, or even to guarantee membership of the EMU in extreme cases. Although this may have been partly driven by lax fiscal behaviour at the national level in the build-up to the EMU sovereign debt crisis, it is now widely recognised that the EMU needs to move forward to achieve a common fiscal framework, namely able to "insure" member countries against asymmetric macroeconomic shocks.

Table F.3 uncovers further interesting features. By removing only one "outlier" of the sample, both in terms of aggregate fiscal behaviour over recent years and of the relative level of fiscal decentralization, we are able to re-assess the relationship between fiscal decentralization and the aggregate fiscal stance. Similar patterns arise here from those found in Table 12, for the full sample of OECD countries. The relationships found are now slightly stronger. Interestingly, the coefficient on the interaction term between the level of revenue decentralization and the level of sub-national autonomy becomes significant. The relationship between the interaction term between the level of VFIs and the level of sub-national autonomy also becomes stronger and significant at the 5% level. This points again towards the directions identified earlier. Firstly, fiscal decentralization may lead to common pool incentives, as it frequently implies larger levels of expenditure than revenue decentralization. In addition, even extensive own revenues decentralized to sub-national government levels, the latter may have weaker revenue-raising powers, either because tax bases are more mobile or because local tax administration systems may be less developed than federal or central ones. Both explanations lead to a negative relationship between fiscal decentralization and aggregate fiscal balances. Secondly, the existence of extensive intergovernmental transfer systems coupled with a high degree of sub-national fiscal autonomy can be particularly damaging for the general government fiscal stance and long-term fiscal sustainability. Not only it may create the type of common pool problems just highlighted, but it can also make them permanent. By bringing both more fiscal powers and more bargaining power to sub-national governments levels, the scope for renegotiation of intergovernmental transfers becomes greater and this can "institutionalize" soft budget constraint incentives in federal systems.

In turn, the results in Table F.4 confirm and reinforce the results previously found on debt thresholds. If these exist, suggesting that the fiscal stance response can exhibit a non-linear pattern across different indebtedness conditions, they appear at lower levels than previously found. Evidence is found here of endogenous debt limits around or below the 80% debt threshold, with an effect on the responsiveness of fiscal balances to the debt-to-GDP ratio found already at the 50% debt-to-GDP ratio. Similarly to Égert (2015), the volatility of debt thresholds across different samples also suggests that these may vary according to country characteristics or macroeconomic and institutional environments.

4.4.2.4 Sub-national autonomy

In order to further explore the sub-national autonomy measures contained in the LAI dataset, we identify three key dimensions which can have a direct effect on the effective degree of fiscal autonomy and run further regressions on the whole OECD sample. Table F.5 shows the results for this exercise.

The dimensions of sub-national autonomy included is this set of regressions are the following: financial autonomy, $f_{it}^{lai(fa)}$, effective political discretion, $f_{it}^{lai(epd)}$, and policy scope, $f_{it}^{lai(ps)}$, the three factors identified and analyzed earlier (Table E.3). The first interesting result that immediately emerges is that the three factors now appear with different signs (columns (1)-(3)). While the estimated coefficients on policy scope and effective political discretion suggest a positive relationship between these factors and the fiscal stance, financial autonomy appears to exert a negative effect on the fiscal stance. Only financial autonomy, however, appears with a significant (negative) effect.

We thus interact this measure with the levels of expenditure and revenue de-

Table 19: Fiscal reaction functions of 13 EMU countries (1995-2016): baseline results. Dependent variable: underlying primary balances (UPB). The UPB is a measure of the (general) government cyclically-adjusted budgetary balance, excluding net interest payments and the impact of one-off transactions. Estimates are based on a LSDVC estimator developed for autoregressive (unbalanced) panel data models (Bruno 2005), based on the standard Arellano and Bond (1991) estimator. Bootstrap standard errors in brackets. This table reports estimates for similar specifications to those presented in Table 12, using a sub-sample of OECD countries inside the EMU.

$s_{i,t}$ (UPB)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$s_{i,t-1}$	0.847***	0.842***	0.817***	0.844***	0.861***	0.864***	0.838***	0.854***	0.861***	0.857***
	(0.043)	(0.043)	(0.044)	(0.043)	(0.040)	(0.041)	(0.041)	(0.041)	(0.041)	(0.042)
$b_{i,t-1}$	0.021***	0.022***	0.022***	0.022***	0.026***	0.025***	0.025***	0.023***	0.026***	0.025***
	(0.006)	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
$\hat{y}_{i,t-1}$	-0.085***	-0.085***	-0.097***	-0.083***	-0.083**	-0.081**	-0.091***	-0.086**	-0.087**	-0.095**
	(0.033)	(0.033)	(0.033)	(0.033)	(0.037)	(0.037)	(0.036)	(0.036)	(0.038)	(0.049)
D_{it}^{ebc}	-0.004**	-0.004**	-0.004**	-0.004**	-0.004**	-0.004**	-0.004**	-0.004**	-0.004**	-0.004**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
f_{it}^{exp}		0.007								
		(0.020)								
f_{it}^{rev}			-0.083*							
			(0.043)							
f_{it}^{vfi}				0.015						
				(0.040)						
f_{it}^{lai}					-0.013					
					(0.039)					
$f_{it}^{exp} \times f_{it}^{lai}$						-0.025				
						(0.042)				
$f_{it}^{rev} \times f_{it}^{lai}$							-0.087			
							(0.072)			
$f_{it}^{vfi} \times f_{it}^{lai}$								-0.363		
								(0.245)		
$b_{i,t-1} \times f_{it}^{vfi} \times f_{it}^{lai}$									-0.197	
									(0.479)	
$\hat{y}_{i,t-1} \times f_{it}^{rev} \times f_{it}^{lai}$										0.157
										(0.422)

*10% significance level, **5% significance level, ***1% significance level

Table 20: Fiscal reaction functions of 13 EMU countries (1995-2016): debt thresholds. Dependent variable: underlying primary balances (UPB). The UPB is a measure of the (general) government cyclically-adjusted budgetary balance, excluding net interest payments and the impact of one-off transactions. Estimates are based on a LSDVC estimator developed for autoregressive (unbalanced) panel data models (Bruno 2005), based on the standard Arellano and Bond (1991) estimator. Bootstrap standard errors in brackets. This table reports estimates for similar specifications to those presented in Table 13, using a sub-sample of OECD countries inside the EMU.

$s_{i,t}$ (UPB)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$s_{i,t-1}$	0.815***	0.835***	0.846***	0.831***	0.845***	0.848***	0.828***	0.831***	0.822***	0.831***
	(0.045)	(0.045)	(0.043)	(0.044)	(0.045)	(0.043)	(0.044)	(0.044)	(0.041)	(0.041)
$b_{i,t-1}$	0.031***	0.027***	0.023***	0.035***	0.027***	0.020**	0.023***	0.025***	0.033***	0.041***
	(0.008)	(0.008)	(0.008)	(0.010)	(0.009)	(0.008)	(0.006)	(0.006)	(0.008)	(0.010)
$\hat{y}_{i,t-1}$	-0.089***	-0.081***	-0.082***	-0.087***	-0.083***	-0.086***	-0.093***	-0.088***	-0.072**	-0.069**
	(0.032)	(0.033)	(0.033)	(0.032)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)
D_{it}^{ebc}	-0.004**	-0.004**	-0.004**	-0.004**	-0.004**	-0.004**	-0.004***	-0.004**	-0.004**	-0.004**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$D_{it}^{\bar{b}=80\%}$	-0.009**									
	(0.004)									
$D_{it}^{\bar{b}=90\%}$		-0.006								
		(0.004)								
$D_{it}^{\bar{b}=100\%}$			-0.002							
			(0.004)							
$b_{i,t-1} \times D_{it}^{80}$				-0.010**						
				(0.005)						
$b_{i,t-1} \times D_{it}^{90}$					-0.004					
					(0.005)					
$b_{i,t-1} \times D_{it}^{100}$						0.001				
						(0.003)				
$D_{it}^{\bar{b}=50\%}$							-0.003			
							(0.003)			
$D_{it}^{\bar{b}=60\%}$								-0.003		
								(0.003)		
$D_{it}^{\bar{b}=70\%}$									-0.008**	
									(0.003)	
$b_{i,t-1} \times D_{it}^{70}$										-0.011**
										(0.005)

*10% significance level, **5% significance level, ***1% significance level

centralization, as well as with the relative size of VFIs, as before. Yet this time no significant relationship emerges from the analysis. Using the same interaction terms for the other two measures of sub-national fiscal autonomy does however uncover another interesting issue. A negative significant relationship emerges when the policy scope factor is interacted with the relative size of VFIs. This suggests that, although a large policy scope at the sub-national level may not in itself be harmful for the aggregate fiscal stance (although not significant, this factor even appears with a positive sign in our regression results), it may become harmful if coupled with large VFIs. In other words, extensive intergovernmental transfer systems can become particularly damaging for aggregate fiscal performance, if and when sub-national governments are involved in the provision of a wide array of public services. This reinforces the idea that measuring fiscal decentralization is a particularly difficult task as, especially in this case, the devil lies in the details.

4.5 Concluding remarks

Governments can be understood to have two main fiscal policy objectives over the short-term: macroeconomic and debt stabilization. However countercyclicality and fiscal sustainability can be thought as two desirable properties of fiscal policy, there can often be a trade-off between both. In this context, fiscal policy across OECD countries has become pro-cyclical over recent decades. While this phenomenon is not new (viz. Turrini et al. 2008, Fatás and Mihov 2010), this paper suggests that it appears to have become even stronger in EMU countries and aims to shed more light on some of its causes. Namely, we aim to emphasize the role of two institutional features that may undermine the capacity of governments to respond both to macroeconomic and to debt stabilization concerns:

endogenous debt limits and fiscal decentralization.

The existence of dissimilar fiscal responses across different debt-to-GDP levels suggests the relevance of endogenous debt limits (Ghosh et al., 2013). Indeed, the results presented in this paper highlight two related issues: both the average level the responsiveness of structural fiscal balances to rising debt levels is persistently weaker beyond the 70 percent debt-to-GDP limit. Consistent with recent literature (Égert, 2015), the level of this threshold varies, however, between the 50 and 80 percent debt-to-GDP ratio, suggesting once again the importance of different country characteristics in determining endogenous debt limits. Irrespective of the exact threshold values, this points towards the relevance of fiscal fatigue in debt overhang environments. Hence, the capacity of governments to sustain a fiscal stance in line with both macroeconomic and debt stabilization properties can be undermined when debt-to-GDP ratios are at historically high levels.

The results in this paper point towards a fact that may have become particularly relevant to describe the post-2008 financial crisis fiscal policy environment in developed economies: in order to sustain a fiscal stance in line with long-term fiscal sustainability concerns, OECD countries, particularly EMU countries, have often had to "switch-off" automatic stabilizers, by running pro-cyclical policies in economic downturns. Similarly, if and when this would imply unsustainable pro-cyclical policies, the responsiveness to debt may have become weaker. Fiscal fatigue can thus be understood to arise when the "fiscal space" for countries to simultaneously respond to macroeconomic and debt stabilization concerns is limited. This is even reinforced by considering the results obtained with different potential debt service levels. Having become an important feature of fiscal policy in the current fiscal policy environment, as countries face historically high debt

burdens, fiscal fatigue is thus one symptom of fiscal policy in countries facing debt overhang problems. The existence of formal fiscal rules seems, in this context, to have done little to avoid this phenomenon and promote long-term fiscal sustainability, with only mild evidence for the effectiveness of debt rules.

In turn, another aim in this paper was to shed more light into the relationship between fiscal decentralization and aggregate fiscal performance. The first conclusion that emerges from this paper is that sub-national autonomy is a key "hidden" link to understand this relationship. Revenue decentralization appears, at first sight, persistently linked with a weaker fiscal stance. Yet, sub-national governments across OECD countries have, on average, 30% of total general government expenditure responsibilities, while only 20% of own-revenues are collected at the sub-national level. These figures also hide important differences in fiscal decentralization across OECD countries and, in particular, about the level of effective sub-national fiscal autonomy. Having explored various different dimensions of sub-national autonomy, offered by the extensive LAI dataset (European Commission, 2015), vertical fiscal imbalances appear to play an important role in the relationship between fiscal decentralization and the fiscal stance. Both when the aggregate index of sub-national autonomy and the index of sub-national policy scope are considered, vertical fiscal imbalances are shown to affect negatively the average level of fiscal balances, as well as the responsiveness to rising debt-to-GDP ratios. At the same time, a higher level of expenditure decentralization is associated with lower average corporate income tax rates, while revenue decentralization is associated with higher average personal income tax rates. Financial autonomy appears associated with weaker fiscal balances, but the results do not hold when interacting this variable with measures of fiscal decentralization. Fiscal decentral-

ization does not appear to affect aggregate fiscal performance, neither through its effect on the average level of structural fiscal balances nor through its effect on macroeconomic or debt stabilization. It does however generally imply large intergovernmental transfer systems, often arising as a result of an optimal organization of tax and spending responsibilities. One issue thus arises from our analysis: as ambitious fiscal decentralization reforms often involve large intergovernmental transfer systems, namely as a result of the limited scope for decentralization of taxation powers, these ought to be accompanied by administrative reforms aiming at reinforcing accountability at the sub-national level.

Fiscal policy has become pro-cyclical across the OECD and the results in this paper suggest that pro-cyclicality can be here to stay. An environment of debt overhang, together with the likely rise of interest rates over the medium term, can bring further pressures to the conduct of fiscal policy, particularly in EMU countries with limited fiscal space. Its main syndrome, fiscal fatigue, is likely to make the short-term trade-off between macroeconomic and debt stabilization ever more visible. In turn, the different experiences of fiscal decentralization across OECD countries and the important institutional heterogeneities suggest that large intergovernmental transfer systems tend to be a consequence of an optimal fiscal design, where sub-national have extensive spending powers but limited revenue-raising capacity. If not adequately designed, these can however have consequences for long-term fiscal sustainability and eventually bring further fiscal pressure in countries facing high debt burdens.

What are the policy implications? Fiscal policy should respond both to macroeconomic and debt stabilization. Policymakers should thus aim to create the necessary conditions to ensure this is indeed the case. In the EMU, the current

policy proposals on a common European unemployment insurance system are an example of a step in this direction. The scope for counter-cyclical structural balances should also be reinforced. Yet, in an environment where countries are facing historically high debt-to-GDP ratios, this can prove a particularly difficult task. Moves into the direction of common debt issuance, backed by a common fiscal framework, can be an important factor ensuring governments, through the management of national fiscal policies, have enough discretion - and fiscal space - to respond adequately to both the business cycle and long-term fiscal sustainability. The discussion on a European Stability Fund has already taken off, and its design should, first and foremost, ensure enough fiscal discretion is kept at the national level, while improving fiscal sustainability across the EU. At the same time as a common fiscal framework is being implemented at the European level, there is also frequently a large scope for fiscal discretion at the sub-national level. Two issues stand out from our analysis: a very large heterogeneity in the levels of fiscal decentralization as well as in the effective levels of sub-national autonomy, and the general negative effect of large intergovernmental transfer systems on fiscal sustainability. This suggests a large room for improvement in national institutionsm governing intergovernmental fiscal relations. At the European level, this process can be promoted through national cooperation aiming at sharing best practices and promoting the role of regional and local governments, without compromising fiscal sustainability in the long-term. In short, ensuring a multi-layered integreated European fiscal framework is paramount to promote the overall quality of fiscal policies.

V

Conclusion

V Conclusion

The European sovereign debt crisis has sparked a large debate on the fiscal architecture of the European Monetary Union. A new wave of academic contributions has rapidly blossomed, after the Presidents' Reports (Van Rompuy et al. 2012 and Juncker et al. 2015). Policymakers have also taken on board some of the recommendations highlighted as essential pillars of a reformed European Monetary Union. Hence, the change in paradigm on the scope of intervention of the European Central Bank, the rapid creation of the European Stability Mechanism, the approval of a new European fiscal framework - known as the Fiscal Compact -, and the move towards a Banking Union, with the Single Supervisory Mechanism and a potential common deposit insurance.

Yet, much remains to be done. The European Union still lacks a common fiscal capacity, namely in order to equip member countries with better mechanisms to respond to asymmetric macroeconomic shocks and a large burden of debt. The literature has provided numerous solutions, such as the creation of a European unemployment insurance scheme (Abraham et al. 2018a) or the development of a European Stability Fund (Abraham et al. 2018b). While these reforms can go a long way in forming a common fiscal capacity to complete the European Monetary Union, making it more resilient to financial crises and large macroeconomic fluctuations, they are also likely to fall short in terms of endowing the European Union with a comprehensive fiscal framework capable of responding to the long-term challenges of developed economies in the twenty-first century, such as widening wealth inequality and the automation of a large share of traditionally labour-intensive tasks in the productive chain. In this context, one clear trend over the past decades has been the changing structure of taxation across developed

economies, with a secular decrease in corporate income taxation and a progressive shift towards indirect taxes and less progressive labour income taxes.

Departing from the classical literature on fiscal federalism, this thesis aims to provide a new perspective on the development of a European fiscal framework. In a nutshell, the main question that it aims to answer is: how to design a fiscal framework for the European Union consistent both with the forces of globalization and the protection of the European Welfare State? Focusing in particular on the pressures brought by increasing capital mobility and interjurisdictional fiscal competition, this thesis brings some answers to this problem and offers new questions for future research.

5.1 Lessons from *Essays on Fiscal Federalism*

This thesis contributes to the literature in several ways. Firstly, it provides a detailed picture of the evolution of taxation over the past decades across EU and OECD countries, which also constitutes one important motivation behind the first two chapters. In this context, the downward trend in corporate income tax rates stands out as a marked characteristic of tax reforms in recent decades across the EU. The results obtained in Chapter Four also suggest another interesting characteristic of corporate tax rates trends over recent decades: governments appear to have persistently used a larger fiscal space available in periods of economic expansion to introduce tax cuts, thus making fiscal policy more pro-cyclical. The recent corporate tax cuts across developed economies, most notably in the United States, seem to confirm this pattern of policy and clearly suggest that the secular decrease in corporate tax cuts has not yet come to a halt. Other common trends in taxation across developed economies are a steady decrease in labour income tax

progressivity and a higher reliance of governments on indirect forms of taxation, namely on VAT revenues.

Secondly, it re-assesses the relationship between fiscal federalism and economic growth. In an environment of tax competition between jurisdictions, either at the national or at the regional and local level, fiscal federalism brings growth-maximizing policies. In a race to attract mobile factors of production, governments attempt to maximise the after-tax rate of return by providing higher levels of public goods and services with a productive character. This also involves a potential large shift in tax bases, from more mobile and distortive towards less mobile and least distortive tax bases. In an environment of fixed labour supply and perfectly mobile capital, this implies a race to bottom in capital taxes and a race to the top in taxes that fall on the immobile fixed factor. This is a fully efficient outcome and implies the highest growth dividend.

Thirdly, acknowledging the additional constraints brought by an environment of international tax competition to the trade-off between growth and redistribution, or efficiency and equity, it analyzes the room for and the consequences of different tax harmonization scenarios. Chapter Two provides a framework where simple tax harmonization scenarios can be designed and understood, by and large, as the main options at the disposal of policymakers. The consequences of harmonization of tax rates on mobile and immobile factors are explored. The first clear result that emerges from this theoretical exercise is that the harmonization of taxes on mobile factors, frequently advocated in an attempt to deter a race to the bottom in capital income taxation, may in fact lead to a race to the top in taxes on immobile factors. This happens as governments face the perfect mobility of productive factors and thus engage in a Bertrand competition to attract these

to their jurisdiction. When the taxation of mobile factors is fixed - or (binding) minimum thresholds are imposed -, the competition occurs solely over the (gross) rate of return on these factors, which implies that governments raise taxes on immobile factors to finance higher levels of productive public good provision. In an environment with perfectly mobile capital and a fixed supply of labour, this implies that all labour income accruing to households is taxed away to maximise the rate of return on capital. Only the harmonization of labour income taxes can avoid this outcome, while leaving room for competition over tax rates on mobile factors and non-zero capital income taxes, in equilibrium.

Fourthly, building on this intuition and on the theoretical results obtained in Chapter Two, Chapter Three develops an endogenous growth model with flexible labour supply calibrated to an average EU economy. Detailed policy simulations are performed and different fiscal harmonization scenarios are considered. Capital income tax harmonization proves once again to be no panacea. A race to the top is again observed on the least mobile and distortive tax base. This also leads to an over-investment on the productive public good, relative to the optimum. In this context, indirect taxes, such as VAT, should become priority targets of fiscal reforms proposals in the European Monetary Union. Expenditure side reforms are also needed. Even limited increases in the EU budget, such as the introduction of a common European unemployment insurance system can go a long way in preventing significant welfare losses from interjurisdictional fiscal competition.

Finally, Chapter Four provides a novel characterization of the evolution of fiscal policy across OECD countries. In particular, the cyclical behaviour of discretionary fiscal policy is explored, both as a response to short-term macroeconomic stabilization and long-term fiscal sustainability concerns. Although a consistent

response of structural balances is found to higher debt levels, in line with long-term fiscal sustainability concerns, fiscal policy across OECD countries has become pro-cyclical over recent decades, particularly within the European Monetary Union. Furthermore, in line with recent literature, the existence of endogenous debt limits and the channels through which these might have affected the fiscal stance in OECD countries is explored. Both the average level of structural fiscal balances and their responsiveness to the level of debt are found persistently weaker beyond the 70 percent debt-to-GDP threshold, or even below, pointing towards the relevance of fiscal fatigue phenomena. Looking at the average level and responsiveness of fiscal balances across different potential debt service thresholds, uncovers another interesting result: beyond the 3 percent debt service limit a higher average level of fiscal balances is found, as well as a stronger response to indebtedness conditions. However, this is also accompanied by a more pro-cyclical response to the business cycle. This suggests that, not only fiscal fatigue episodes can be thought as a new feature of fiscal policy across OECD countries over recent years, but also that countries under greater fiscal stress – as measured by potential debt service levels – may have had to completely switch off automatic stabilizers during economic downturns in order to respond to short-term fiscal pressures. In the terminology of recent literature on fiscal policy, this also suggests that many countries have long exhausted the available fiscal space, implying that future fiscal adjustments in the context of economic recessions can become ever more painful, particularly for countries within the European Monetary Union. The role of fiscal decentralization is also assessed, with the aim of learning from the past experience of OECD countries and draw lessons both for future fiscal decentralization reforms at the national level and fiscal reforms at the European level. The effect of fiscal decentralization on the fiscal stance appears to be more complex, not least

because of the significant heterogeneity in political and legal arrangements behind fiscal decentralization reforms across OECD countries. Two issues however seem to remain clear. On the one hand, fiscal decentralization is not necessarily harmful for fiscal performance and does not appear to affect the aggregate responsiveness to macroeconomic and debt cycles. On the other hand, large intergovernmental transfer systems, which frequently accompany ambitious decentralization reforms, show a persistent negative relation with fiscal performance. This phenomenon is reinforced when sub-national governments keep wide responsibilities over the provision of local public services. Large levels of sub-national financial autonomy are also related with weaker aggregate fiscal performance.

5.2 Policy proposals and future work

The lessons from this thesis have wide implications for the current discussion on the fiscal architecture of the European Union and for the future design and implementation of such reforms. Firstly, any future fiscal reforms that involve only partial harmonization of corporate taxes, or the mere consolidation of tax bases (like in the CCCTB project), are unlikely to produce significant results in terms of limiting the potentially damaging effects of capital mobility and tax competition. Instead, by constraining the discretion of governments to set corporate tax rates and rules, it is instead likely to intensify fiscal competition over other tax bases and the provision of productive public goods, to the detriment of equitable tax structures and welfaristic or merit goods. In other words, any tax reforms that are limited to corporate taxation are likely to generate more regressive income tax structures and produce a heavier reliance on indirect forms of taxation.

Secondly, indirect taxes, such as value-added taxes, rather than income taxes,

appear as the obvious candidates for future tax harmonization reforms. Both in terms of scope, given the relative importance in terms of government revenue, and of effectiveness in restraining fiscal competition incentives, the harmonization of consumption taxes can become a prime candidate for future fiscal reform. Such an instrument can not only provide the European Union with a common fiscal framework able to finance a larger common budget, but also equip member countries as a whole with a partially harmonized tax system that is able to overcome potentially future intense fiscal competition pressures.

Thirdly, tax reforms ought to be accompanied by expenditure side reforms. Although this thesis does not directly tackle this issue and does not aim to propose specific reforms on this side, it contributes to understand current proposals in a wider context. Recent proposals that include a European unemployment scheme are therefore particularly welcome in light of these results, as a means to improve the response of national economies to short-run macroeconomic fluctuations, but also in a context where national governments become more constrained to set out more ambitious welfaristic programmes. This thesis also hints that such proposals can be extended at a later stage to a wider set of government programmes and spending areas, from the development of a common European defence budget to a direct involvement in the financing of certain areas of healthcare and education spending across the European Union.

Fourthly, any fiscal reforms undertook at the European level must also learn from the past. Besides a common feasibility or participation constraint, implying that any future fiscal reforms in the European Union ought to rule out permanent transfers between member countries, these also need to be able to overcome other potential issues. On the one hand, fiscal reforms ought to ensure that the

quality of fiscal policy over the business cycle is improved. In particular, recent years have witnessed a pro-cyclical discretionary component of fiscal policy, arguably related to the need to respond to soaring debt levels during economic downturns. This phenomenon has become more intense in countries under greater fiscal stress, namely in those under greater scrutiny from financial markets. Hence, fiscal reforms within the European Monetary Union, having already moved forward towards a more credible fiscal framework, also have to ensure that a debt overhang environment is compatible with an adequate response to business cycle fluctuations. Proposals for a European Stability Fund, or an extended European Stability Mechanism, go in this direction. On the other hand, the future fiscal architecture of the European Union, can also learn from individual country fiscal decentralization experiences. Namely, as both revenue and expenditure side reforms can lead to extensive fiscal transfer systems, both of cyclical and permanent nature, these ought to be carefully designed so as to ensure an alignment of fiscal incentives across different member countries. In so doing, extensive room for fiscal discretion at the national level must also be kept.

This thesis also opens new lines of research. The first is a natural development of the current work to consider the proposed policy reforms in the context of more complete macroeconomic models. The second places emphasis on the need to place any fiscal harmonization reforms in a wider context. In particular, studying the effect of tax harmonization reforms in a partial equilibrium setting or in the context of models with a limited role for governments can lead to misleading results and endanger the validity of proposed policy reforms. The third explores in detail the blurry link between fiscal federalism and fiscal performance. As more data becomes available and new datasets are developed, more promising results

can shed light on the wider effects of fiscal decentralization reform and contribute to better inform policymakers.

5.3 Closing remark

This section has highlighted that the lessons and policy recommendations that can be drawn from this thesis open many new questions relevant for the design of future fiscal reforms in the European Union, but also across the globe. As recent work in this field has shown, there is plenty of room for significant improvements in the design of the European Monetary Union and an exciting prospect is the progressive development of ambitious policy proposals with a subsequent detailed analysis with the help of modern macroeconomic models. Namely, recent work in macroeconomics has helped to include labour market frictions and different types of heterogeneities into traditional models, thereby contributing to move the field into an unprecedented level of detail. Independently of other work, like this thesis, it seems ever more promising for future work to profit from this body of knowledge and from the growing availability of detailed data to understand how current institutions are likely to respond to the challenges of the twenty-first century. Automation and the changing structure of the global supply chain are only two examples that are likely to radically change current economic structures and the role of governments in the economy, and thereby an important role for economic research is to enable a well-informed policy debate and propose policy reforms that can help shape a global economy that is able to generate the highest ever levels of economic prosperity and living standards for all.

"Globalization, the information revolution, and regional and ethnic conflicts have made it imperative for a large and growing number of countries around the globe to reexamine the roles of various orders of government to secure peace, order, and good government and to reposition their roles in improving social and economic outcomes and retaining relevance in the lives of their citizens. This reexamination has resulted in a silent revolution sweeping the globe, which is slowly but gradually bringing about rearrangements that embody diverse features of supranationalization, confederalization, centralization, provincialization, and localization. The vision of a governance structure that is slowly taking hold through this silent revolution indicates either a gradual shift from unitary constitutional structures to federal or confederal governance for a large majority of people or a strengthening of local governance under a unitary form of government. This new vision of governance has also led to a resurgence of interest in fiscal federalism principles and practices as federal systems are seen to provide safeguards against the threat of centralized exploitation as well as decentralized opportunistic behavior while bringing decision making closer to the people."

Robin Boadway and Anwar Shah (2009)

VI Bibliography and Data Sources

References

Arpad Abraham, João Brogueira de Sousa, Ramon Marimon, and Lukas Mayr. On the Design of a European Unemployment Insurance System, 2018a.

Arpad Abraham, Eva Carceles-Poveda, Yan Liu, and Ramon Marimon. On the Optimal Design of a Financial Stability Fund, 2018b.

Daron Acemoglu. *Introduction to modern economic growth*. Princeton University Press, 2008.

Antonis Adam, Pantelis Kammas, and Athina Lagou. The effect of globalization on capital taxation: What have we learned after 20years of empirical studies? *Journal of Macroeconomics*, 35:199–209, 2013.

António Afonso. Ricardian fiscal regimes in the European Union. *Empirica*, 35(3):313–334, 2008.

Antonio Afonso and Sebastian Hauptmeier. Fiscal behaviour in the European Union: rules, fiscal decentralization and government indebtedness. Working Paper Series 1054, European Central Bank, 2009.

Antonio Afonso, Luca Agnello, and Davide Furceri. Fiscal policy responsiveness, persistence, and discretion. *Public Choice*, 145(3-4):503–530, 2010.

Philippe Aghion and Peter Howitt. *Endogenous Growth Theory*. MIT Press, 1998.

Alberto Alesina and Dani Rodrik. Distributive Politics and Economic Growth. *The Quarterly Journal of Economics*, pages 465–490, 1994.

Alberto Alesina and Nouriel Roubini. Political cycles in OECD economies. *Review of Economic Studies*, 59(4):663–688, 1992.

Alberto Alesina and Jeffrey Sachs. Political Parties and the Business Cycle in the United States, 1948-1984. *Journal of Money, Credit and Banking*, 20(1):63–82, 1988.

Céline Allard, Petya Koeva Brooks, John C. Bluedorn, Fabian Bornhorst, Katharine Christopherson, Franziska Ohnsorge, and Tigran Poghosyan. Toward a Fiscal Union for the Euro Area, 2013.

Facundo Alvaredo, Anthony Atkinson, Thomas Piketty, and Emmanuel Saez. The top 1 percent in international and historical perspective. *Journal of Economic Perspectives*, 27(3):3–20, 2013.

Robert A Amano and Tony S Wirjanto. Government expenditures and the permanent-income model. *Review of Economic Dynamics*, 1(3):719–730, 1998.

Cristina Arellano. Default risk and income fluctuations in emerging economies. *American Economic Review*, 98(3):690–712, 2008.

Cristina Arellano and Yan Bai. Fiscal austerity during debt crises. *Economic Theory*, 64(4): 657–673, 2017.

Manuel Arellano and Stephen Bond. Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *Review of Economic Studies*, pages 277–297, 1991.

Zareh Asatryan, Lars P Feld, and Benny Geys. Partial fiscal decentralization and sub-national government fiscal discipline: empirical evidence from OECD countries. *Public Choice*, 163 (3-4):307–320, 2015.

David Alan Aschauer. Fiscal policy and aggregate demand. *American Economic Review*, 75(1): 117–127, 1985.

Alan J Auerbach and Kevin Hassett. Capital taxation in the twenty-first century. *American Economic Review*, 105(5):38–42, 2015.

Olivier Bargain, Mathias Dolls, Clemens Fuest, Dirk Neumann, Andreas Peichl, Nico Pestel, and Sebastian Siegloch. Fiscal union in Europe? Redistributive and stabilizing effects of a European tax-benefit system and fiscal equalization mechanism. *Economic Policy*, 28(75): 375–422, 2013.

Robert J Barro. On the Determination of the Public Debt. *Journal of Political Economy*, pages 940–971, 1979.

Robert J Barro. Output effects of government purchases. *Journal of Political Economy*, 89(6): 1086–1121, 1981.

Robert J Barro. Government Spending in a Simple Model of Endogeneous Growth. *Journal of Political Economy*, pages S103–S125, 1990.

Thushyanthan Baskaran. On the link between fiscal decentralization and public debt in OECD countries. *Public Choice*, 145(3-4):351–378, 2010.

Stefano Battilossi, Regina Escario, and James Foreman-Peck. Fiscal policy response to cycles under two regimes: Spain 1950–1998. *Cliometrica*, 7(3):267–294, 2013.

Miroslav Beblavý and Ilaria Maselli. An Unemployment Insurance Scheme for the Euro Area: A Simulation Exercise of Two Options, 2014.

Elizabeth Becker. The illusion of fiscal illusion: Unsticking the flypaper effect. *Public Choice*, 86(1-2):85–102, 1996.

A Bénassy-Quéré, M Brunnermeier, H Enderlein, E Farhi, M Fratzscher, C Fuest, PO Gourinchas, P Martin, J Pisani-Ferry, H Rey, et al. *Reconciling Risk Sharing with Market Discipline: A Constructive Approach to Euro Area Reform*. CEPR Policy Insight No. 91 - London: Centre for Economic Policy Research, 2018.

Jess Benhabib and Roberto Perli. Uniqueness and indeterminacy: on the dynamics of endogenous growth. *Journal of Economic Theory*, 63(1):113–142, 1994.

Martin Besfamille and Ben Lockwood. Bailouts in federations: is a hard budget constraint always best? *International Economic Review*, 49(2):577–593, 2008.

Leon Bettendorf, Michael P Devereux, Albert Van der Horst, Simon Loretz, and Ruud A De Mooij. Corporate tax harmonization in the EU. *Economic Policy*, 25(63):537–590, 2010.

Robin Boadway and Anwar Shah. *Fiscal federalism: principles and practice of multiorder governance*. Cambridge University Press, 2009.

Henning Bohn. The Behavior of US Public Debt and Deficits. *Quarterly Journal of Economics*, pages 949–963, 1998.

Henning Bohn. The sustainability of fiscal policy in the United States. Technical report, CESifo Working Paper, 2005.

Michele Boldrin and David K Levine. Perfectly competitive innovation. *Journal of Monetary Economics*, 55(3):435–453, 2008.

Hafedh Bouakez and Nooman Rebei. Why does private consumption rise after a government spending shock? *Canadian Journal of Economics*, 40(3):954–979, 2007.

Laurent Bouton, Marjorie Gassner, and Vincenzo Verardi. Redistributing income under fiscal vertical imbalance. *European Journal of Political Economy*, 24(2):317–328, 2008.

Jan K Brueckner. Fiscal federalism and economic growth. *Journal of Public Economics*, 90(10): 2107–2120, 2006.

Giovanni SF Bruno. Approximating the bias of the LSDV estimator for dynamic unbalanced panel data models. *Economics Letters*, 87(3):361–366, 2005.

Sam Bucovetsky. Insurance and incentive effects of transfers among regions: equity and efficiency. *International Tax and Public Finance*, 4(4):463–483, 1997.

Maurice JG Bun and Jan F Kiviet. On the diminishing returns of higher-order terms in asymptotic expansions of bias. *Economics Letters*, 79(2):145–152, 2003.

John Y Campbell and N Gregory Mankiw. Permanent income, current income, and consumption. *Journal of Business & Economic Statistics*, 8(3):265–279, 1990.

D. Cass. Optimum growth in an aggregative model of capital accumulation. *Review of Economic Studies*, 32(3):233–240, 1965.

Cristina Checherita-Westphal and Václav Žďárek. Fiscal reaction function and fiscal fatigue: evidence for the euro area. Technical report, ECB Working Paper, 2017.

Jacopo Cimadomo. Real-time data and fiscal policy analysis: A survey of the literature. *Journal of Economic Surveys*, 30(2):302–326, 2016.

Paola Conconi, Carlo Perroni, and Raymond Riezman. Is partial tax harmonization desirable? *Journal of Public Economics*, 92(1-2):254–267, 2008.

Gabriel Cuadra, Juan M Sanchez, and Horacio Sapriza. Fiscal policy and default risk in emerging markets. *Review of Economic Dynamics*, 2(13):452–469, 2010.

Betty C Daniel and Christos Shiamptanis. Pushing the limit? Fiscal policy in the European Monetary Union. *Journal of Economic Dynamics and Control*, 37(11):2307–2321, 2013.

Ronald B Davies, Julien Martin, Mathieu Parenti, and Farid Toubal. Knocking on tax haven's door: multinational firms and transfer pricing. *Review of Economics and Statistics*, (0), 2014.

Hamid Davoodi and Heng-Fu Zou. Fiscal decentralization and economic growth: A cross-country study. *Journal of Urban Economics*, 43(2):244–257, 1998.

Luiz De Mello. Fiscal Decentralization and Intergovernmental Fiscal Relations: A Cross-Country Analysis. *World Development*, 28(2):365–380, 2000.

Luiz De Mello. Estimating a fiscal reaction function: the case of debt sustainability in Brazil. *Applied Economics*, 40(3):271–284, 2008.

Pablo D'Erasmo and Enrique G Mendoza. Distributional incentives in an equilibrium model of domestic sovereign default. *Journal of the European Economic Association*, 14(1):7–44, 2016.

Michael P Devereux. Taxation of outbound direct investment: economic principles and tax policy considerations. *Oxford Review of Economic Policy*, 24(4):698–719, 2008.

Michael P Devereux and Rachel Griffith. The Taxation of Discrete Investment Choices. *Institute for Fiscal Studies*, 1999.

Michael P Devereux, Rachel Griffith, and Alexander Klemm. Corporate income tax reforms and international tax competition. *Economic Policy*, 17(35):449–495, 2002.

Michael P Devereux, Ben Lockwood, and Michela Redoano. Do countries compete over corporate tax rates? *Journal of Public Economics*, 92(5):1210–1235, 2008.

Peter Diamond and Emmanuel Saez. The case for a progressive tax: from basic research to policy recommendations. *Journal of Economic Perspectives*, 25(4):165–90, 2011.

Mathias Dolls, Clemens Fuest, Dirk Neumann, and Andreas Peichl. An unemployment insurance scheme for the euro area? A comparison of different alternatives using microdata. *International Tax and Public Finance*, 25(1):273–309, 2018.

Pablo D'Erasmo, Enrique G Mendoza, and Jing Zhang. What is a sustainable public debt? In *Handbook of Macroeconomics*, volume 2, pages 2493–2597. Elsevier, 2016.

Balázs Égert. Fiscal policy reaction to the cycle in the OECD: pro-or counter-cyclical? *Mondes en développement*, (3):35–52, 2014.

Balázs Égert. Public debt, economic growth and nonlinear effects: Myth or reality? *Journal of Macroeconomics*, 43:226–238, 2015.

Valerio Ercolani and João Valle e Azevedo. The effects of public spending externalities. *Journal of Economic Dynamics and Control*, 46:173–199, 2014.

European Commission. Self-rule Index for Local Authorities. Technical report, Directorate-General for Regional and Urban Policy - European Commission, 2015.

European Commission. *Taxation trends in the European Union*. Luxembourg: Publications Office of the European Union, 2016. doi: 10.2785/751842.

European Commission. Reflection Paper on the Deepening of Economic and Monetary Union, 2017a.

European Commission. Taxation Trends in the European Union - Data for the EU Member States, Iceland and Norway. 2017b.

European Commission. White Paper on the Future of Europe: Reflections and scenarios for the EU27 by 2025, 2017c.

Luc Eyraud, Lusine Lusinyan, et al. Decentralizing Spending More Than Revenue; Does it Hurt Fiscal Performance? Technical report, International Monetary Fund, 2011.

Luc Eyraud, Anita Tuladhar, Julio Escolano, Marialuz Moreno Badia, and Juliane Sarnes. Fiscal Performance, Institutional Design and Decentralization in European Union Countries. Technical report, International Monetary Fund, 2012.

Emmanuel Farhi and Iván Werning. Fiscal Unions. *American Economic Review*, 107(12):3788–3834, 2017.

Antonio Fatás and Ilian Mihov. The euro and fiscal policy. In *Europe and the Euro*, pages 287–324. University of Chicago Press, 2010.

Riccardo Fiorito and Tryphon Kollintzas. Public goods, merit goods, and the relation between private and government consumption. *European Economic Review*, 48(6):1367–1398, 2004.

Dirk Foremny and Juergen von Hagen. Fiscal Federalism in Times of Crisis. Technical report, CEPR Discussion Papers, 2012.

Jeffrey A Frankel, Carlos A Vegh, and Guillermo Vuletin. On graduation from fiscal procyclicality. *Journal of Development Economics*, 100(1):32–47, 2013.

Don Fullerton, John B Shoven, and John Whalley. Replacing the US income tax with a progressive consumption tax: A sequenced general equilibrium approach. *Journal of Public Economics*, 20(1):3–23, 1983.

Jordi Galí, Roberto Perotti, Philip R Lane, and Wolfram F Richter. Fiscal Policy and Monetary Integration in Europe. *Economic Policy*, pages 535–572, 2003.

Jordi Galí, J David López-Salido, and Javier Vallés. Understanding the effects of government spending on consumption. *Journal of the European Economic Association*, 5(1):227–270, 2007.

Atish R Ghosh, Jun I Kim, Enrique G Mendoza, Jonathan D Ostry, and Mahvash S Qureshi. Fiscal fatigue, fiscal space and debt sustainability in advanced economies. *The Economic Journal*, 123(566):F4–F30, 2013.

Roberto Golinelli and Sandro Momigliano. The cyclical reaction of fiscal policies in the euro area: the role of modelling choices and data vintages. *Fiscal Studies*, 30(1):39–72, 2009.

Timothy J Goodspeed. Bailouts in a Federation. *International Tax and Public Finance*, 9(4): 409–421, 2002.

Fred C Graham. Fiscal policy and aggregate demand: comment. *American Economic Review*, 83(3):659–666, 1993.

João Guerreiro, Sérgio Rebelo, and Pedro Teles. *Should Robots be Taxed?* NBER Working Paper No. 23806, 2018.

Mark Hallerberg, Rolf Strauch, and Jürgen Von Hagen. The design of fiscal rules and forms of governance in European Union countries. *European Journal of Political Economy*, 23(2): 338–359, 2007.

Mark N Harris and László Mátyás. A comparative analysis of different IV and GMM estimators of dynamic panel data models. *International Statistical Review*, 72(3):397–408, 2004.

Mark N Harris, Laszlo Matyas, and Patrick Sevestre. Dynamic Models for Short Panels. In *The Econometrics of Panel Data: Fundamentals and Recent Developments in Theory and Practice*, volume 46, page 249. Springer, 2008.

John William Hatfield. Federalism, taxation, and economic growth. *Journal of Urban Economics*, 87:114–125, 2015.

Andreas Haufler and Christoph Lülfesmann. Reforming an asymmetric union: On the virtues of dual tier capital taxation. *Journal of Public Economics*, 125:116–127, 2015.

James R Hines Jr and Richard H Thaler. The Flypaper Effect. *Journal of Economic Perspectives*, 9(4):217–226, 1995.

Atsushi Iimi. Decentralization and economic growth revisited: an empirical note. *Journal of Urban Economics*, 57(3):449–461, 2005.

Ethan Ilzetzki and Carlos A Végh. *Procyclical fiscal policy in developing countries: Truth or fiction?* NBER Working Papers 14191. National Bureau of Economic Research, 2008.

Robert P Inman. The flypaper effect. Technical report, National Bureau of Economic Research, 2008.

Larry E Jones and Rodolfo E Manuelli. Neoclassical models of endogenous growth: The effects of fiscal policy, innovation and fluctuations. *Handbook of Economic Growth*, 1:13–65, 2005.

Larry E Jones, Rodolfo E Manuelli, and Peter E Rossi. Optimal taxation in models of endogenous growth. *Journal of Political Economy*, 101(3):485–517, 1993.

Mark P Jones, Pablo Sanguinetti, and Mariano Tommasi. Politics, institutions, and fiscal performance in a federal system: an analysis of the Argentine provinces. *Journal of Development Economics*, 61(2):305–333, 2000.

Ruth A Judson and Ann L Owen. Estimating dynamic panel data models: a guide for macroeconomists. *Economics Letters*, 65(1):9–15, 1999.

Jean Claude Juncker, Donald Tusk, Jeroen Dijsselbloem, Mario Draghi, and Martin Schulz. The Five Presidents' Report: Completing Europe's Economic and Monetary Union. Technical report, 2015.

Graciela L. Kaminsky, Carmen M. Reinhart, and Carlos A. Végh. When It Rains, It Pours: Procyclical Capital Flows and Macroeconomic Policies. In *NBER Macroeconomics Annual 2004, Volume 19*, pages 11–82. National Bureau of Economic Research, Inc, 2005.

Michael Keen and Kai A Konrad. The Theory of International Tax Competition and Coordination. In *Handbook of Public Economics, volume=5, pages=257-328, year=2013, publisher=Elsevier*.

Jan F Kiviet et al. On bias, inconsistency, and efficiency of various estimators in dynamic panel data models. *Journal of Econometrics*, 68(1):53–78, 1995.

T.C. Koopmans. On the Concept of Optimal Economic Growth. In Pontif. Acad. Sc. Scripta Varia 28, editor, *The Econometric Approach to Development Planning*, pages 225–300. reissued North-Holland Publ. (1966), 1965.

Andreas P Kyriacou, Leonel Muinelo-Gallo, and Oriol Roca-Sagalés. Fiscal decentralization and regional disparities: The importance of good governance. *Papers in Regional Science*, 94(1): 89–107, 2015.

Antonio Ladrón-de Guevara, Salvador Ortigueira, and Manuel S Santos. Equilibrium dynamics in two-sector models of endogenous growth. *Journal of Economic Dynamics and Control*, 21 (1):115–143, 1997.

Philip R Lane. The cyclical behaviour of fiscal policy: evidence from the OECD. *Journal of Public Economics*, 87(12):2661–2675, 2003.

Etienne Lehmann, Laurent Simula, and Alain Trannoy. Tax me if you can! Optimal nonlinear income tax between competing governments. *The Quarterly Journal of Economics*, 129(4): 1995–2030, 2014.

Wenli Li and P. Sarte. Growth effects of progressive taxes. Working paper, Federal Reserve Bank of Philadelphia, 2001.

Assar Lindbeck. Stabilization policy in open economies with endogenous politicians. *American Economic Review*, 66(2):1–19, 1976.

Simon Loretz. Corporate taxation in the OECD in a wider context. *Oxford Review of Economic Policy*, 24(4):639–660, 2008.

Robert Lucas. On the mechanics of economic development. *Journal of Monetary Economics*, 22(1):3–42, 1988.

Gregory Mankiw. Yes, $r > g$. So what? *American Economic Review*, 105(5):43–47, 2015.

Jorge Martinez-Vazquez and Robert M McNab. Fiscal decentralization and economic growth. *World Development*, 31(9):1597–1616, 2003.

Enrique G Mendoza and Jonathan D Ostry. International evidence on fiscal solvency: Is fiscal policy "responsible"? *Journal of Monetary Economics*, 55(6):1081–1093, 2008.

Enrique G Mendoza and Linda L Tesar. Why hasn't tax competition triggered a race to the bottom? Some quantitative lessons from the EU. *Journal of Monetary Economics*, 52(1): 163–204, 2005.

Shawn Ni. An empirical analysis on the substitutability between private consumption and government purchases. *Journal of Monetary Economics*, 36(3):593–605, 1995.

Stephen Nickell. Biases in dynamic models with fixed effects. *Econometrica: Journal of the Econometric Society*, pages 1417–1426, 1981.

William D Nordhaus et al. The Political Business Cycle. *Review of Economic Studies*, 42(2): 169–190, 1975.

Wallace E Oates. Fiscal decentralization and economic development. *National Tax Journal*, pages 237–243, 1993.

Wallace E Oates. An essay on fiscal federalism. *Journal of Economic Literature*, pages 1120–1149, 1999.

Wallace E Oates. Toward a second-generation theory of fiscal federalism. *International Tax and Public Finance*, 12(4):349–373, 2005.

Wallace E Oates. On the evolution of fiscal federalism: theory and institutions. *National Tax Journal*, pages 313–334, 2008.

Maurice Obstfeld and Alan M Taylor. The Great Depression as a Watershed: International Capital Mobility over the Long Run. Technical report, National Bureau of Economic Research, 1997.

OECD. *Fundamental Reform of Corporate Income Tax*. OECD Publishing, 2007. doi: http://dx.doi.org/10.1787/9789264038127-en.

OECD. *Revenue Statistics 2016*. OECD Publishing, 2016.

OECD. *Tax Policy Reforms 2017: OECD and Selected Partner Economies*. OECD Publishing, 2017.

Masakatsu Okubo. Intratemporal substitution between private and government consumption: the case of Japan. *Economics Letters*, 79(1):75–81, 2003.

Ozlem Onaran, Valerie Boesch, and Markus Leibrecht. How does globalization affect the implicit tax rates on labor income, capital income, and consumption in the European Union? *Economic Inquiry*, 50(4):880–904, 2012.

Gianmarco IP Ottaviano and Tanguy Van Ypersele. Market size and tax competition. *Journal of International Economics*, 67(1):25–46, 2005.

Michael Overesch and Johannes Rincke. What drives corporate tax rates down? A reassessment of globalization, tax competition, and dynamic adjustment to shocks. *The Scandinavian Journal of Economics*, 113(3):579–602, 2011.

Francesco Pappadà and Yanos Zylberberg. Hanging off a cliff: fiscal consolidations and default risk. Technical report, Working Paper, 2018.

Torsten Persson and Guido Tabellini. The politics of 1992: Fiscal policy and European integration. *Review of Economic Studies*, 59(4):689–701, 1992.

Torsten Persson and Guido Tabellini. Federal fiscal constitutions: Risk sharing and moral hazard. *Econometrica: Journal of the Econometric Society*, pages 623–646, 1996.

Torsten Persson and Guido Tabellini. Political Institutions and Policy Outcomes: What Are the Stylized Facts? CESifo Working Paper Series 459, CESifo Group Munich, 2001.

Per Pettersson-Lidbom. Dynamic commitment and the soft budget constraint: An empirical test. *American Economic Journal: Economic Policy*, pages 154–179, 2010.

Thomas Piketty. About capital in the twenty-first century. *American Economic Review*, 105 (5):48–53, 2015.

Thomas Piketty and Gabriel Zucman. Capital is back: Wealth-income ratios in rich countries 1700–2010. *The Quarterly Journal of Economics*, 129(3):1255–1310, 2014.

Frank P Ramsey. A Contribution to the Theory of Taxation. *The Economic Journal*, 37(145): 47–61, 1927.

Sergio Rebelo. Long-run policy analysis and long-run growth. *Journal of Political Economy*, 99 (3):500–521, 1991.

Carmen M Reinhart and Kenneth S Rogoff. Growth in a Time of Debt. *American Economic Review*, 100(2):573–78, 2010.

Carmen M Reinhart, Kenneth S Rogoff, and Miguel A Savastano. Debt Intolerance. *Brookings Papers on Economic Activity*, 2003(1):1–62, 2003.

Jonathan Rodden, Gunnar S Eskeland, and Jennie Ilene Litvack. *Fiscal decentralization and the challenge of hard budget constraints*. MIT press, 2003.

Andrés Rodríguez-Pose and Roberto Ezcurra. Is fiscal decentralization harmful for economic growth? Evidence from the OECD countries.

Dani Rodrik. How far will international economic integration go? *Journal of Economic Perspectives*, 14(1):177–186, 2000.

Kenneth Rogoff and Anne Sibert. Elections and Macroeconomic Policy Cycles. *Review of Economic Studies*, pages 1–16, 1988.

Paul M Romer. Increasing returns and long-run growth. *Journal of Political Economy*, pages 1002–1037, 1986.

Onno. Ruding. *Report of the Committee of Independent Experts on Company Taxation*. 1992. URL `http://aei.pitt.edu/8702/`.

Christoph A Schaltegger and Lars P Feld. Are fiscal adjustments less successful in decentralized governments? *European Journal of Political Economy*, 25(1):115–123, 2009.

Robert Solow. A contribution to the theory of economic growth. *The Quarterly Journal of Economics*, 70(1):65–94, 1956.

Peter Birch Sørensen. The case for international tax co-ordination reconsidered. *Economic Policy*, 15(31):430–472, 2000.

Peter Birch Sørensen. International tax coordination: regionalism versus globalism. *Journal of Public Economics*, 88(6):1187–1214, 2004.

Nancy L Stokey and Sergio Rebelo. Growth effects of flat-rate taxes. *Journal of Political Economy*, 103(3):519–550, 1995.

Teresa Ter-Minassian and Annalisa Fedelino. Impact of the global crisis on sub-national government finances. In *Fiscal Policy: Lessons from the Crisis, publisher=Banca d'Italia, address=Rome, pages=595-612, year=2010*.

John Thornton. Fiscal decentralization and economic growth reconsidered. *Journal of Urban Economics*, 61(1):64–70, 2007.

Charles M Tiebout. A pure theory of local expenditures. *Journal of Political Economy*, pages 416–424, 1956.

Aaron Tornell and Philip R Lane. The Voracity Effect. *American Economic Review*, pages 22–46, 1999.

Stephen J Turnovsky. Fiscal policy, elastic labor supply, and endogenous growth. *Journal of Monetary Economics*, 45(1):185–210, 2000.

Alessandro Turrini et al. Fiscal policy and the cycle in the Euro Area: The role of government revenue and expenditure. Technical report, Directorate General Economic and Financial Affairs (DG ECFIN), European Commission, 2008.

Herman Van Rompuy, José Manuel Barroso, Jean-Claude Juncker, and Mario Draghi. The Four Presidents' Report: Towards a genuine economic and monetary union. Technical report, 2012.

Carlos A Vegh and Guillermo Vuletin. How is tax policy conducted over the business cycle? *American Economic Journal: Economic Policy*, 7(3):327–70, 2015.

Alfons J Weichenrieder and Jochen Zimmer. Euro membership and fiscal reaction functions. *International Tax and Public Finance*, 21(4):598–613, 2014.

Barry Weingast. The economic role of political institutions: market-preserving federalism and economic development. *Journal of Law, Economics, & Organization*, pages 1–31, 1995.

Barry R Weingast. The performance and stability of federalism: an institutional perspective. In *Handbook of New Institutional Economics, pages=149–172, year=2008, publisher=Springer.*

John Douglas Wilson and Eckhard Janeba. Decentralization and international tax competition. *Journal of Public Economics*, 89(7):1211–1229, 2005.

Hannes Winner. Has tax competition emerged in OECD countries? Evidence from panel data. *International Tax and Public Finance*, 12(5):667–687, 2005.

World Bank. Decentralization: Rethinking Government. In World Bank, editor, *World Development Report 1999/2000*, pages 107–124. Washington DC, 1998.

George R Zodrow. Tax competition and tax coordination in the European Union. *International Tax and Public Finance*, 10(6):651–671, 2003.

George R Zodrow and Peter Mieszkowski. Pigou, Tiebout, property taxation, and the underprovision of local public goods. *Journal of Urban Economics*, 19(3):356–370, 1986.

Data Sources

European Commission (EC)

Institute for Fiscal Studies (IFS)

International Institute for Democracy and Electoral Assistance (IDEA)

International Monetary Fund (IMF) - Fiscal Affairs Department

Organization for Economic Co-operation and Development (OECD)

Self-Rule Index for Local Authorities

World Bank

VII Appendices

Appendix A Figures (Chapter II)

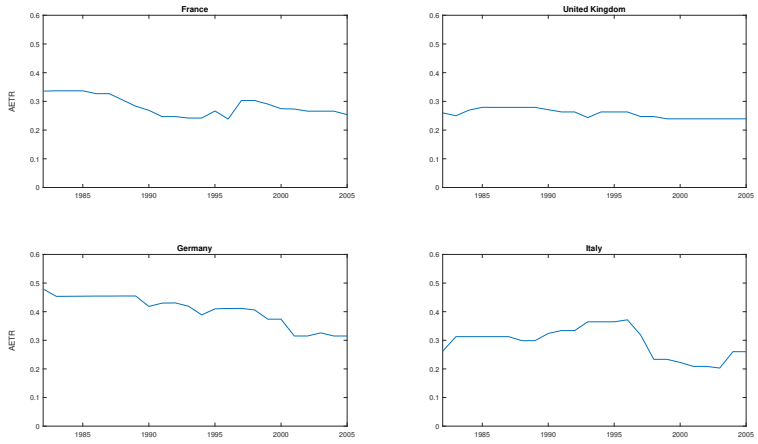

Figure A.1: Average effective tax rates of 4 large EU countries (1982-2005).

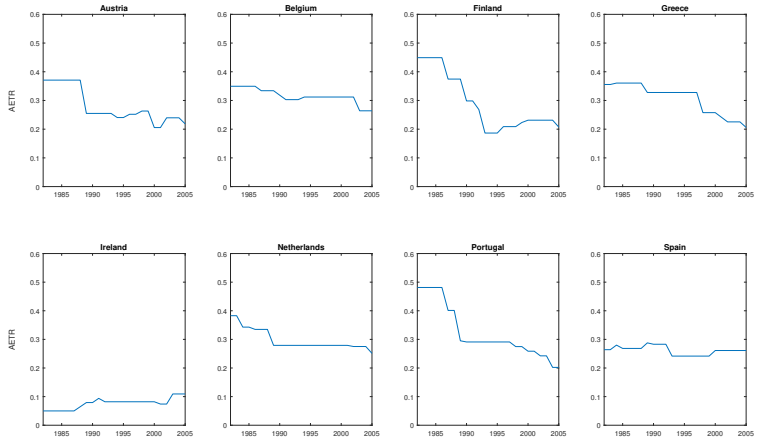

Figure A.2: Average effective tax rates of 8 small EU countries (1982-2005).

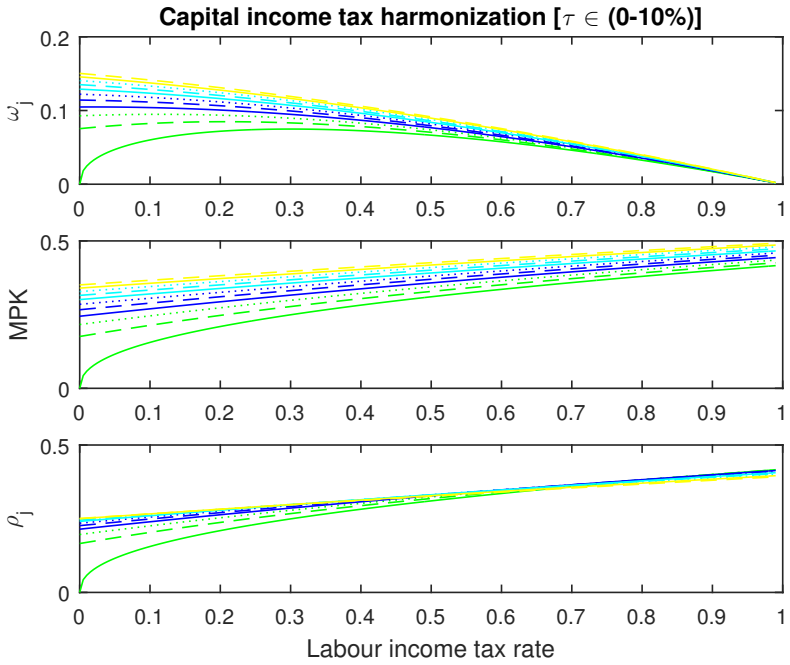

Figure A.3: Capital tax harmonization (τ_j - capital tax, ϕ_j - labour income tax)

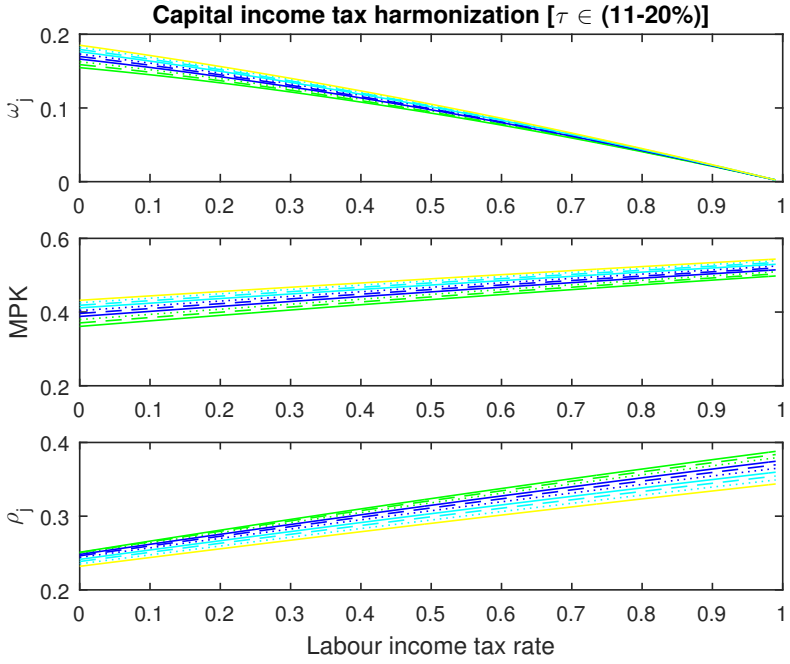

Figure A.4: Capital tax harmonization (τ_j - capital tax, ϕ_j - labour income tax)

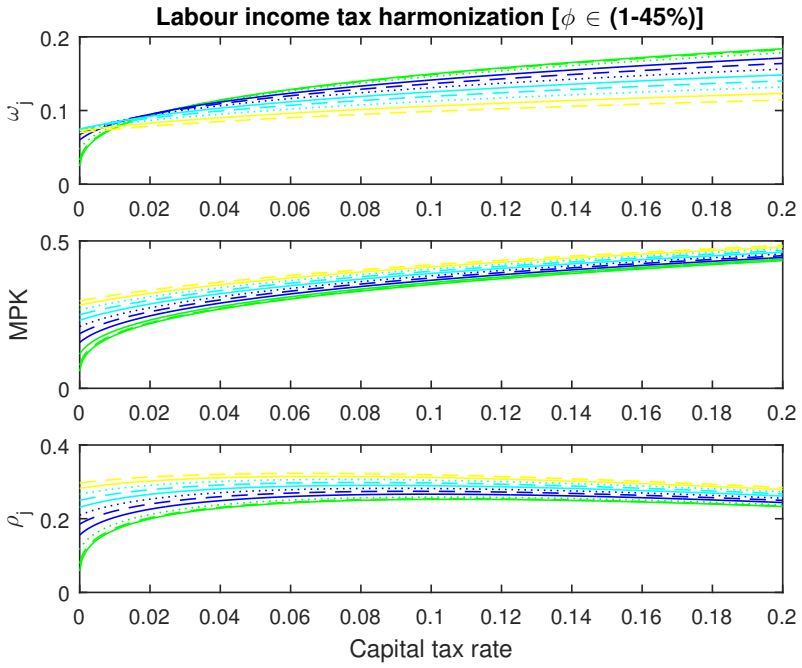

Figure A.5: Labour income tax harmonization (τ_j - capital tax, ϕ_j - labour income tax)

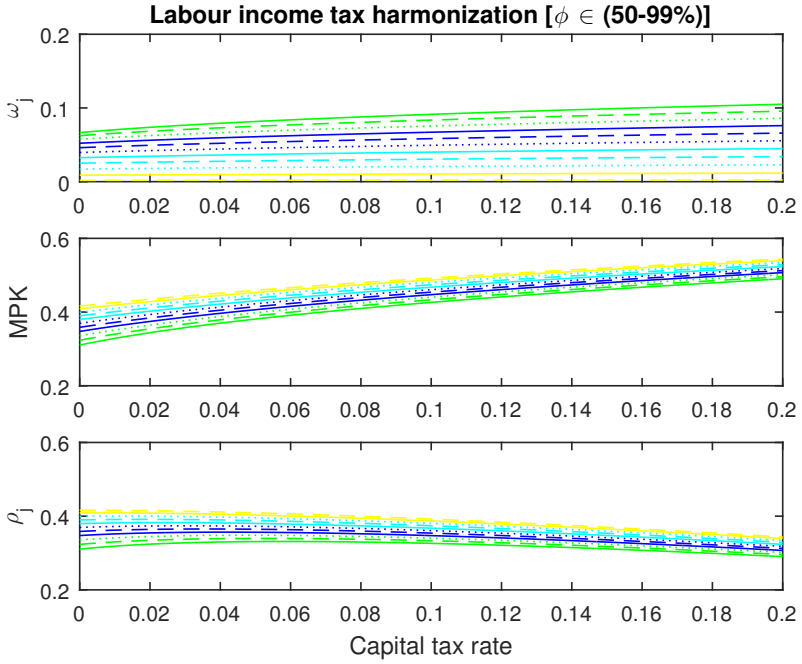

Figure A.6: Labour income tax harmonization (τ_j - capital tax, ϕ_j - labour income tax)

Appendix B Mathematical Appendix (Chapter II)

The standard neo-classical growth model:

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

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

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

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

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

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

Agents face the following budget constraint:

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

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:

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

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:

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

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:

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

where $\varrho = r_j(t) - \delta$ is rate of growth of the economy, $\kappa^i = \frac{k_j^i(0)}{k_j(0)}$ 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 neo-classical growth model.

Neo-classical growth 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:

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

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:

$$\dot{k}_j^i(t) = (r_{d_j^i(t)}(t) - \theta_j)k_j^i(t) + w_j(t)l_j^i - c_j^i(t) \tag{B.8}$$

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

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

We can thus write the following Hamiltonian:

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

and obtain the following Euler equation:

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

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:

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

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:

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

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.

Neo-classical growth model with capital taxes and a *productive* public good:

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

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

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

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

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

Agents face the following budget constraint:

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

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

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

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:

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

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:

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

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.

Neo-classical growth model with capital taxes and both types of public good:

We can represent utility of the representative household similarly to (B.7) and the production function of the economy is similar to (B.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 (B.14) and (B.15), respectively.

Agents face the following budget constraint:

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

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

We can write the current-value Hamiltonian:

$$\hat{H}(c^i_j(t), k^i_j(t), \mu(t)) \equiv e^{-\delta t}\Big\{ \log\Big(\Big[\eta_c^{\frac{1}{\sigma}} c^i_j(t)^{\frac{\sigma-1}{\sigma}} + \eta_h^{\frac{1}{\sigma}} h_j(t)^{\frac{\sigma-1}{\sigma}}\Big]^{\frac{\sigma}{\sigma-1}}\Big) + \mu(t)\Big[\big(r_{d^i_j(t)}(t) - \theta_j - \tau_j\big)k^i_j(t) + w_j(t)l^i_j - c^i_j(t)\Big]\Big\}$$

and obtain the following Euler equation:

$$c^i_j(t) = c^i_j(0)e^{(r_j(t) - \theta_j - \tau_j - \delta)t} \tag{B.21}$$

Consumption can be expressed as:

$$c^i_j(t) = \Big(\delta k^i_j(0) + w_j(0)l^i_j\Big)e^{(r_j(t) - \theta_j - \tau_j - \delta)t}.$$

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

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

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:

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

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.

Model derivations:

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...

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

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

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

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

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

Let us consider:

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

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

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

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

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

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

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

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

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

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

or...

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

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

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

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:

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

where $\xi = \psi - \delta$ 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:

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

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

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

We thus reach our final form:

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

Centralization equilibrium:

In a proof similar to Hatfield (2015), we use the median voter theorem to obtain the policy chosen by the central government:

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

Consider any other policy set $(\tau^{K\prime}, \tau^{L\prime}, \beta')$ with the implied growth rate $\xi(\tau^{K\prime}, \tau^{L\prime}, \beta')$ and after-tax wage-capital ratio $\omega(\tau^{K\prime}, \tau^{L\prime}, \beta')$. If the policy set $(\tau^{K\prime}, \tau^{L\prime}, \beta')$ is not efficient, then there exists another policy set with the same implied growth rate $(\eta(\overline{\tau}^K, \overline{\tau}^L, \overline{\beta}) = \eta(\tau^{K\prime}, \tau^{L\prime}, \beta'))$ and a strictly higher after-tax wage-capital ratio $(\omega(\overline{\tau}^K, \overline{\tau}^L, \overline{\beta}) \geq \omega(\tau^{K\prime}, \tau^{L\prime}, \beta'))$. Every agent thus prefers $(\overline{\tau}^K, \overline{\tau}^L, \overline{\beta})$ to $(\tau^{K\prime}, \tau^{L\prime}, \beta')$. By the same token, there exists a policy set $(\tau^{K^{\text{med}}}, \tau^{L^{\text{med}}}, \beta^{\text{med}})$ that is preferred by half of the agents to $(\overline{\tau}^K, \overline{\tau}^L, \overline{\beta})$; if this policy set $(\tau^{K^{\text{med}}}, \tau^{L^{\text{med}}}, \beta^{\text{med}})$ features a higher growth rate than $(\overline{\tau}^K, \overline{\tau}^L, \overline{\beta})$, then every agent with a (weakly) higher initial capital endowment than the median voter will prefer $(\tau^{K^{\text{med}}}, \tau^{L^{\text{med}}}, \beta^{\text{med}})$ to $(\overline{\tau}^K, \overline{\tau}^L, \overline{\beta})$. Otherwise, if the policy set $(\tau^{K^{\text{med}}}, \tau^{L^{\text{med}}}, \beta^{\text{med}})$ features a lower growth rate than $(\overline{\tau}^K, \overline{\tau}^L, \overline{\beta})$, then the after-tax wage-capital ratio will be higher and every agent with a (weakly) lower initial capital endowment than the median voter will prefer $(\tau^{K^{\text{med}}}, \tau^{L^{\text{med}}}, \beta^{\text{med}})$ to $(\overline{\tau}^K, \overline{\tau}^L, \overline{\beta})$. Therefore, by preference transitivity, at least half of the voters will prefer $(\tau^{K^{\text{med}}}, \tau^{L^{\text{med}}}, \beta^{\text{med}})$ to $(\overline{\tau}^K, \overline{\tau}^L, \overline{\beta})$ and $(\tau^{K^{\text{med}}}, \tau^{L^{\text{med}}}, \beta^{\text{med}})$ is the equilibrium Condorcet winner.

Proposition 1. In the centralization equilibrium, the equilibrium policy set is $(\tau^{K^{\text{med}}}, \tau^{L^{\text{med}}}, \beta^{\text{med}})$. This policy set will not, in general maximize economic growth.

Decentralization equilibrium:

The policy set chosen by the government in jurisdiction j under decentralization is such that:

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

Again, the proof follows Hatfield (2015). Yet, this is now requires a different procedure. With jurisdictions competing for capital and no transaction or adjustment costs, a Bertrand-type competition arises. In other words, to attract any capital, jurisdictions must offer the most attractive rate of return (alternatively, the most attractive price for capital). Households - both capital-rich and capital-poor - within each jurisdiction want to attract capital, as otherwise the wage rate will be 0 in the economy. In such winner-takes-all environment, competition between jurisdictions leads to a "race to the top" to maximize the return on capital. Each jurisdiction, in order to attract any capital, must use its policy set $(\tau_j^K, \tau_j^L, \beta_j)$ to maximize the (net) private rate of return. In equilibrium, all capital will be invested only in those jurisdictions that choose the tax policy $(\tau^{K^*}, \tau^{L^*}, \beta^*)$ that maximizes this function. Finally, note that the rate of return on capital is independent of the amount of capital in the economy; thus each government sets the rate of return on capital in their own jurisdiction by choosing the policy set $(\tau_j^K, \tau_j^L, \beta_j)$. In addition, since the growth rate is an affine function of the rate of return on capital, each government also sets the growth rate of the economy and all capital will be invested only in jurisdictions that choose the growth-maximizing tax policy $(\tau^{K^*}, \tau^{L^*}, \beta^*)$.

Proposition 2. Under decentralization, in every equilibrium at least one government will choose the

growth-maximizing policy set $(\tau^{K^*}, \tau^{L^*}, \beta^*)$ and all capital will be invested in jurisdictions with this tax policy.

This proposition does not state, however, that every government in each jurisdiction j will set their fiscal policy to satisfy the above condition. Indeed, there may exist asymmetric equilibria, under which one or more jurisdictions set their tax rates to $(\tau^{K^*}, \tau^{L^*}, \beta^*)$ and these are the only jurisdictions in which capital is invested, while other governments of different jurisdictions set another policy, receiving no capital. In this case, even if a jurisdiction with no capital were to change its policy set to $(\tau^{K^*}, \tau^{L^*}, \beta^*)$, no agent would necessarily move her capital there. However, by introducing a slight home bias, where households facing equal (net) private rates of return prefer to invest their capital stock in the home jurisdictions, the following can be obtained:

Proposition 3. Under decentralization with the presence of a non-negligible home bias, the equilibrium will imply that all jurisdictions will implement the policy set to become the growth-maximizing policy set, $(\tau^{K^*}, \tau^{L^*}, \beta^*)$, and all capital will be invested by households in their own jurisdictions.

Appendix C Figures and Mathematical Appendix (Chapter III)

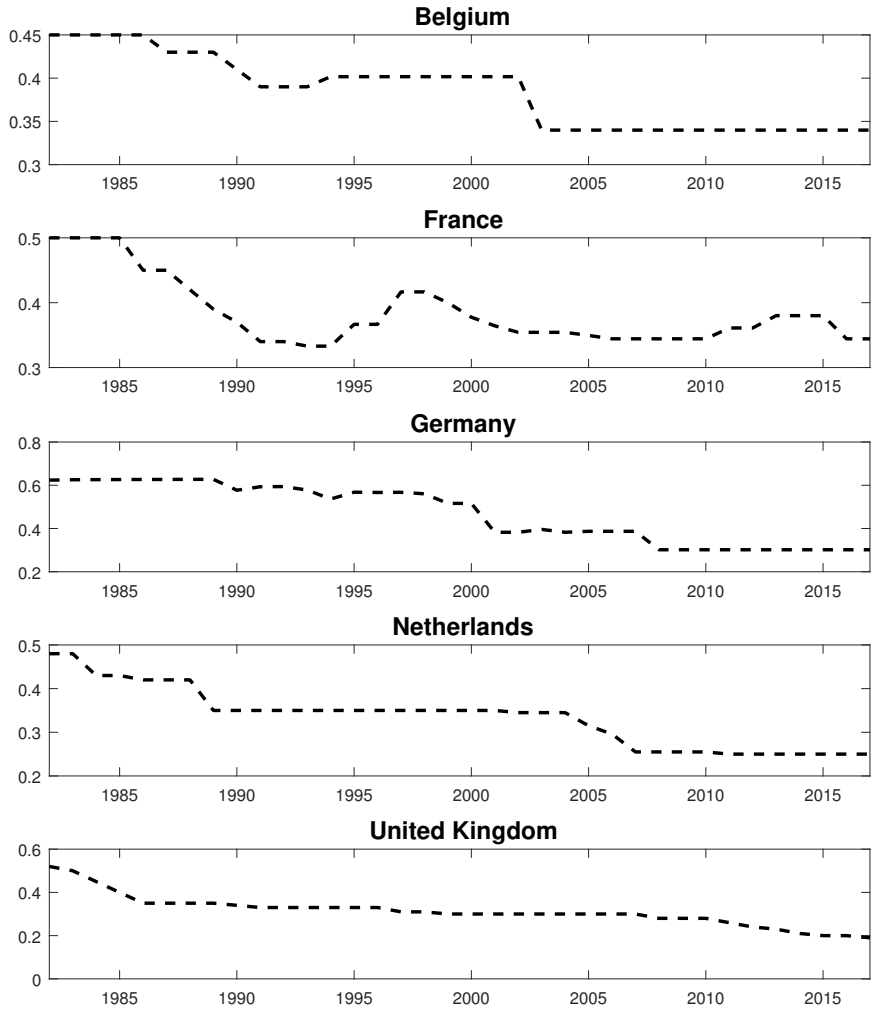

Figure C.1: Top statutory corporate income tax (CIT) rates in the EU-28 (1982-2017): Belgium, France, Germany, Netherlands, United Kingdom

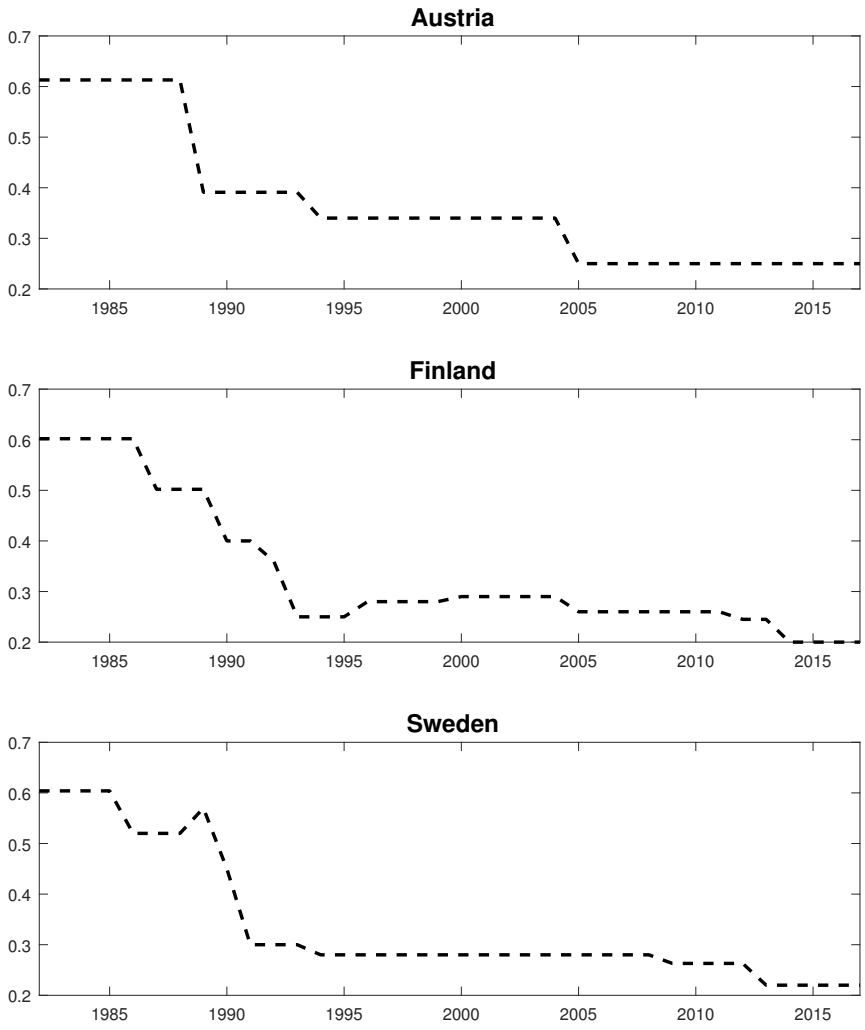

Figure C.2: Top statutory corporate income tax (CIT) rates in the EU-28 (1982-2017): Austria, Finland, Sweden

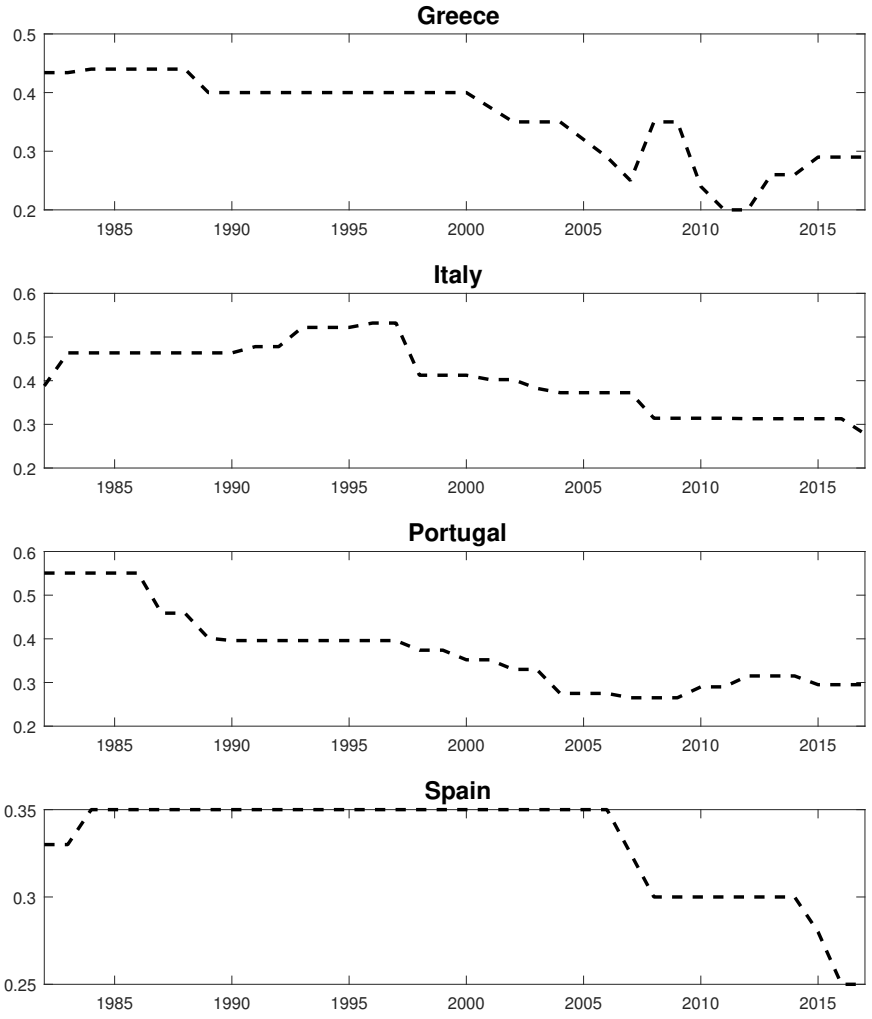

Figure C.3: Top statutory corporate income tax (CIT) rates in the EU-28 (1982-2017): Greece, Italy, Portugal, Spain

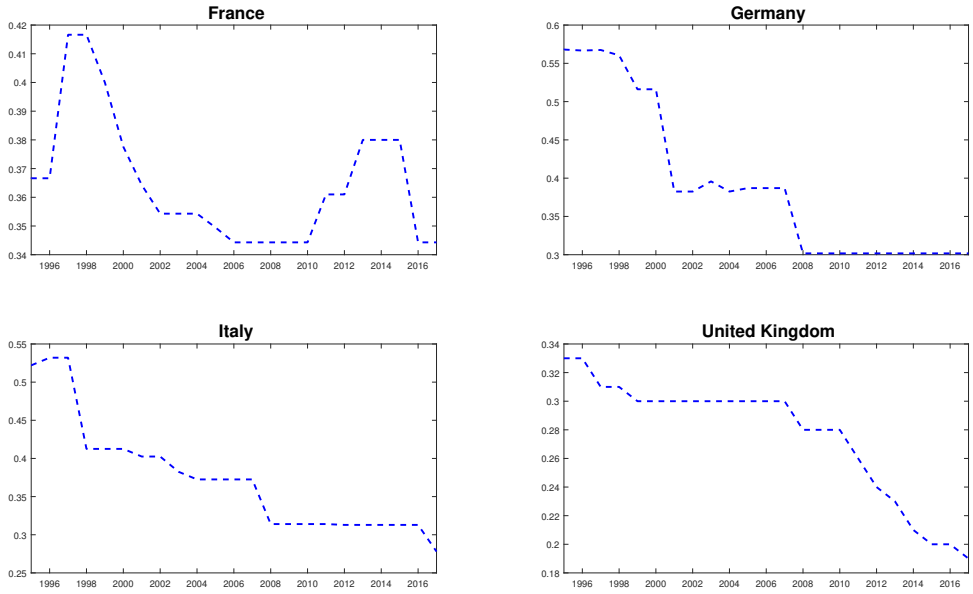

Figure C.4: Top statutory corporate income tax (CIT) rates in the EU-28 (1995-2017): four largest economies

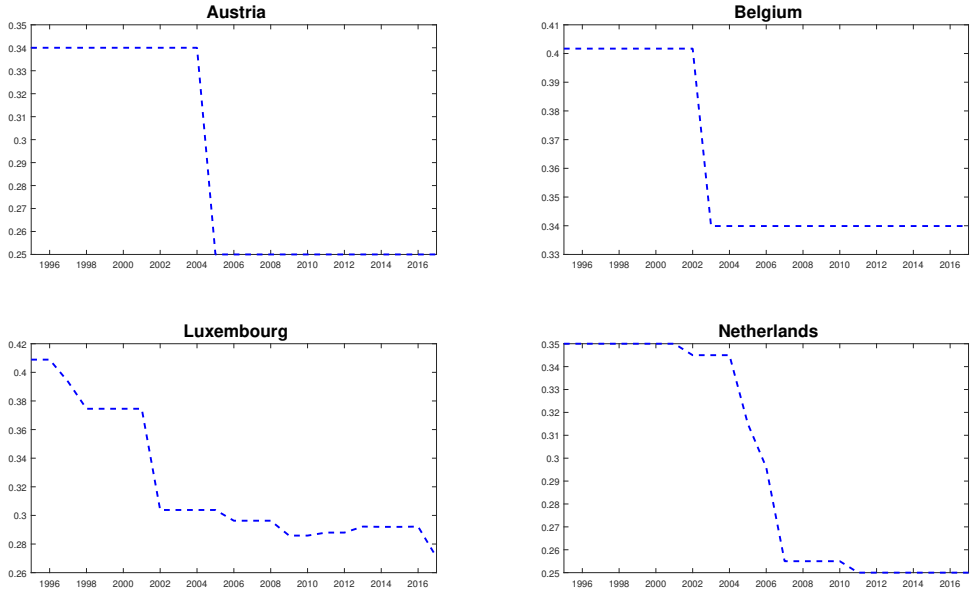

Figure C.5: Top statutory corporate income tax (CIT) rates in the EU-28 (1995-2017): Benelux and Austria

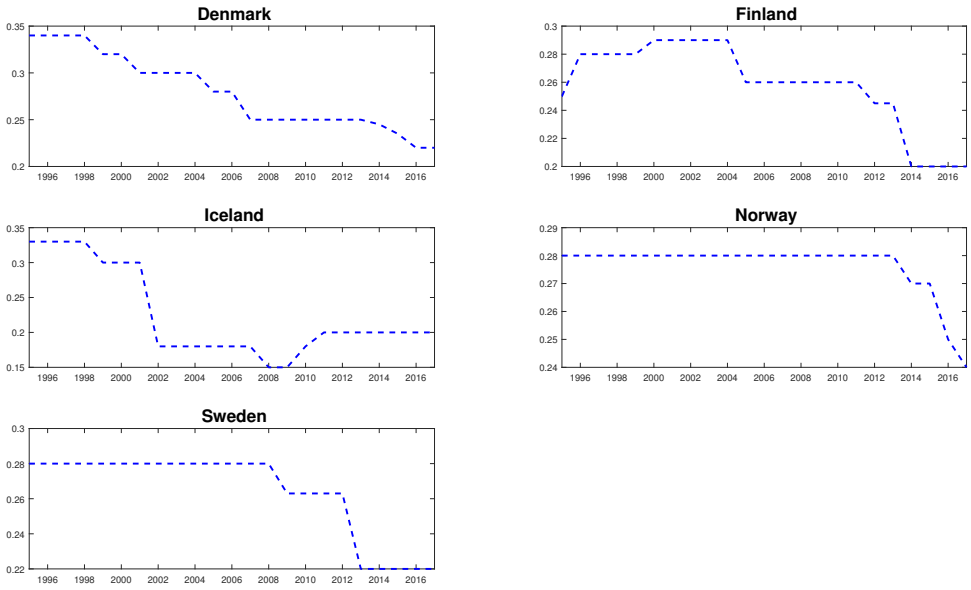

Figure C.6: Top statutory corporate income tax (CIT) rates in the EU-28 (1995-2017): Nordic countries

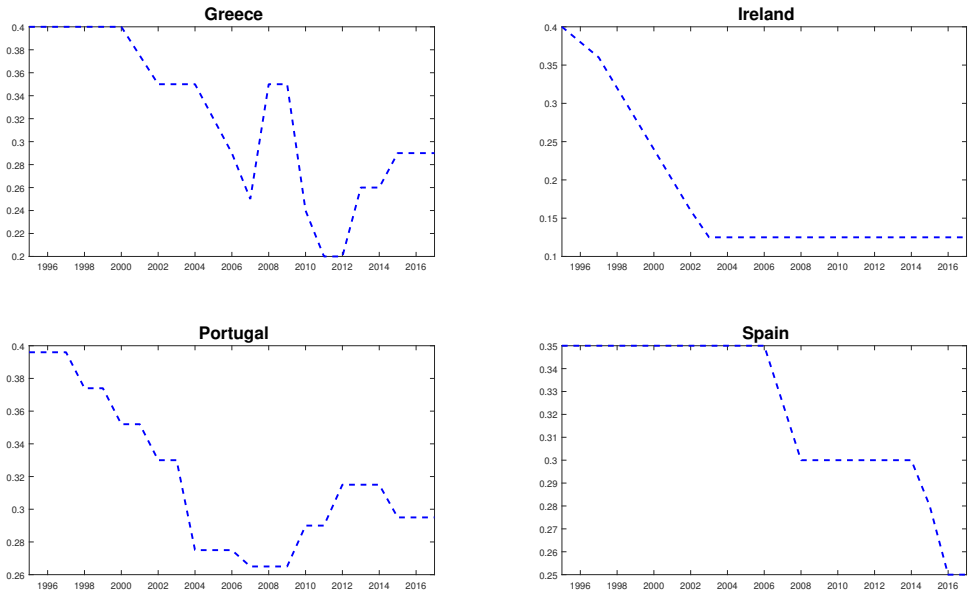

Figure C.7: Top statutory corporate income tax (CIT) rates in the EU-28 (1995-2017): Greece, Italy, Portugal and Spain

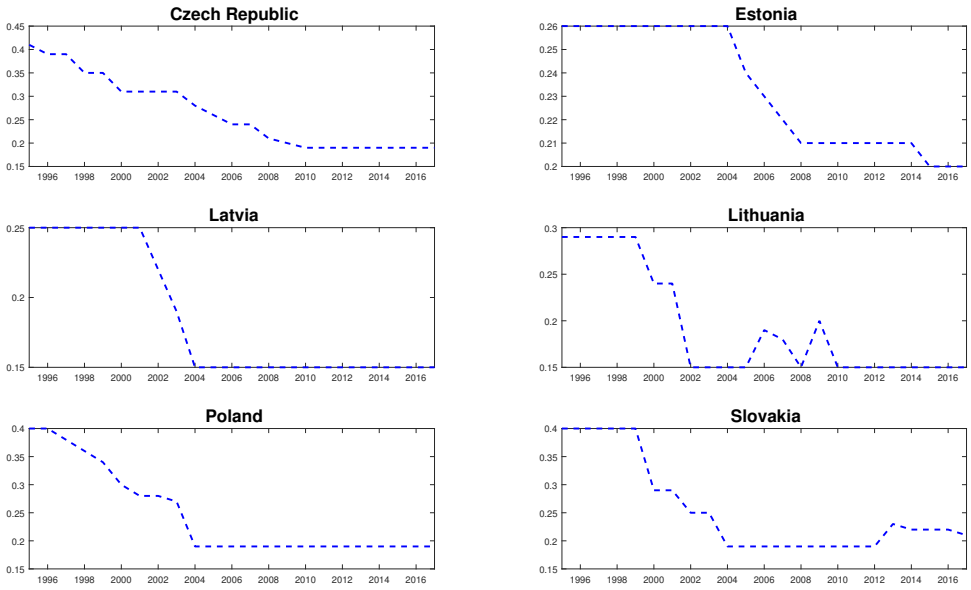

Figure C.8: Top statutory corporate income tax (CIT) rates in the EU-28 (1995-2017): North-Eastern European countries

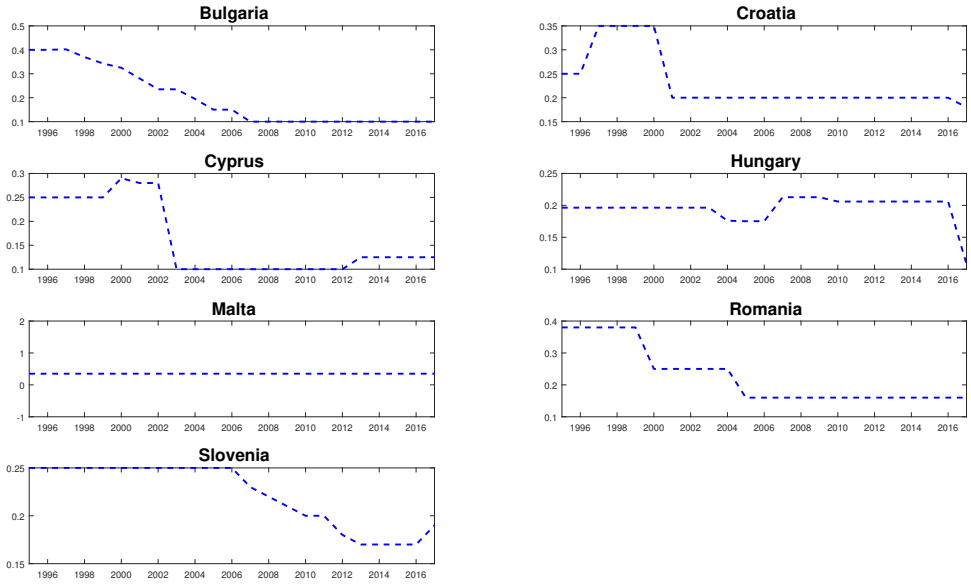

Figure C.9: Top statutory corporate income tax (CIT) rates in the EU-28 (1995-2017): South-Eastern European countries

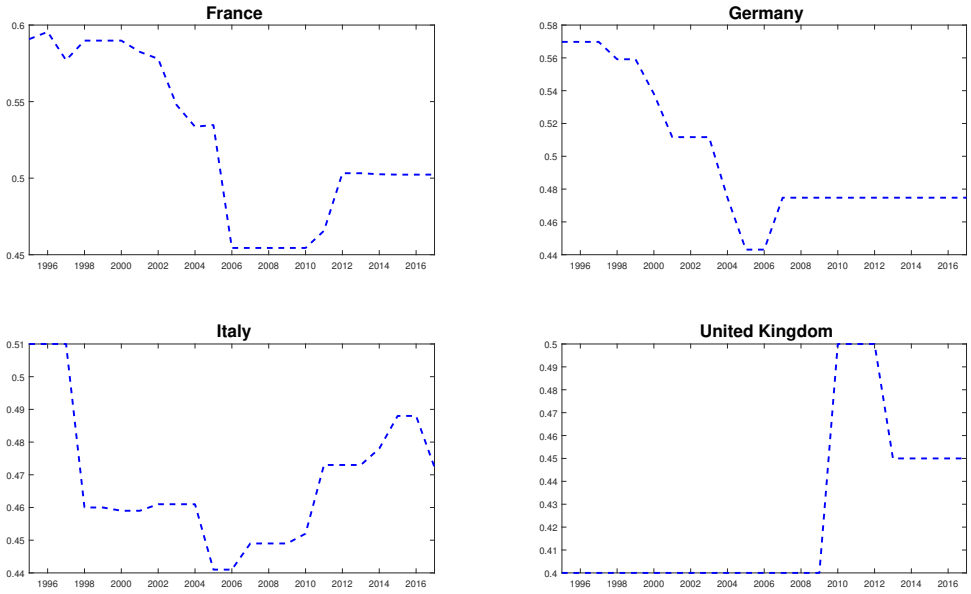

Figure C.10: Top statutory personal income tax (PIT) rates in the EU-28 (1995-2017): four largest economies

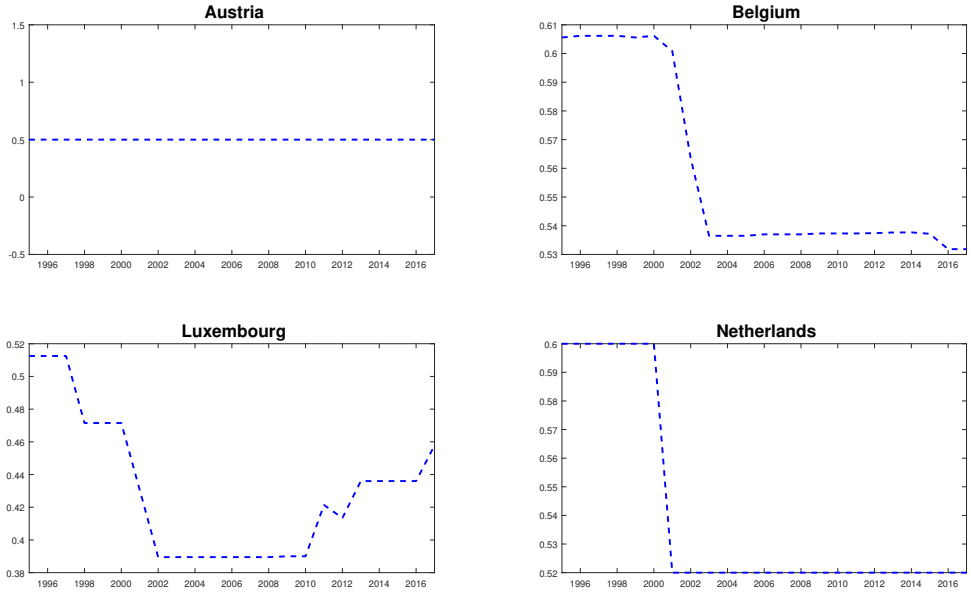

Figure C.11: Top statutory personal income tax (PIT) rates in the EU-28 (1995-2017): Benelux and Austria

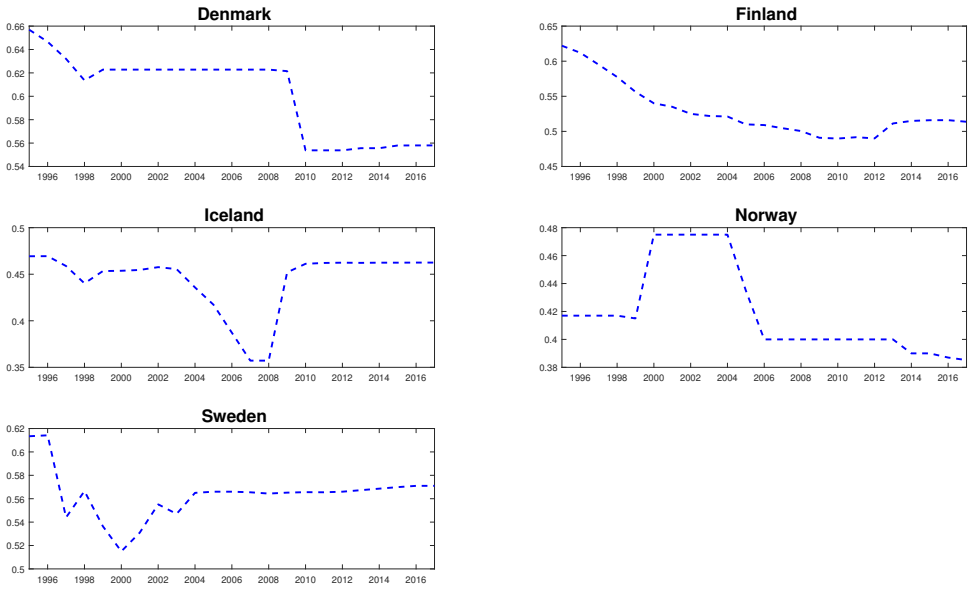

Figure C.12: Top statutory personal income tax (PIT) rates in the EU-28 (1995-2017): Nordic countries

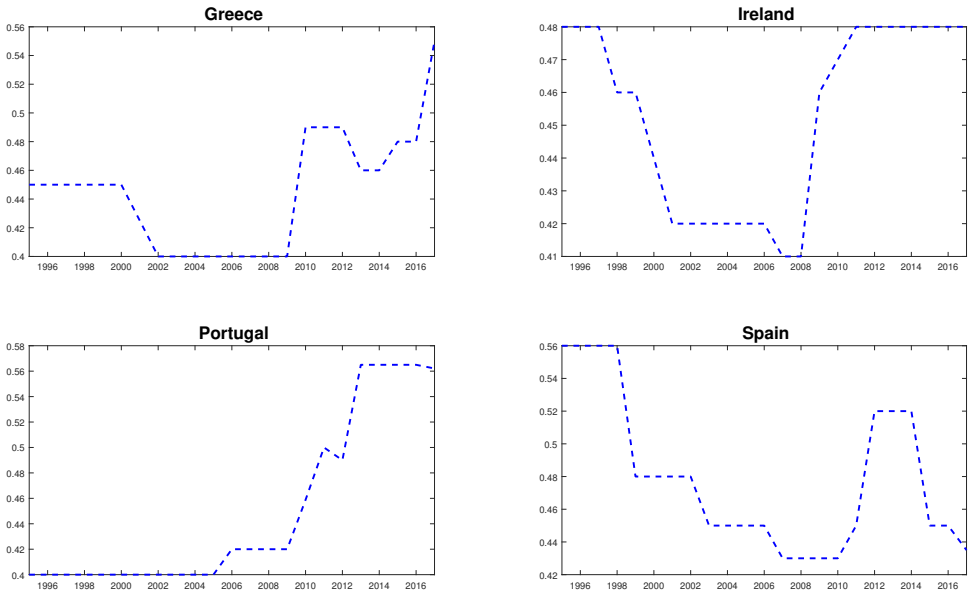

Figure C.13: Top statutory personal income tax (PIT) rates in the EU-28 (1995-2017): Greece, Italy, Portugal and Spain

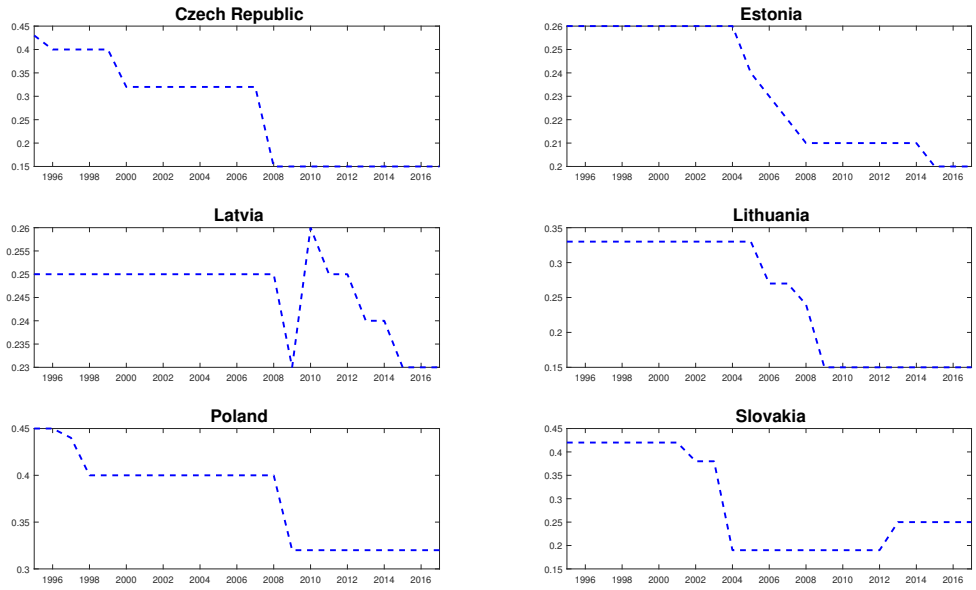

Figure C.14: Top statutory personal income tax (PIT) rates in the EU-28 (1995-2017): North-Eastern European countries

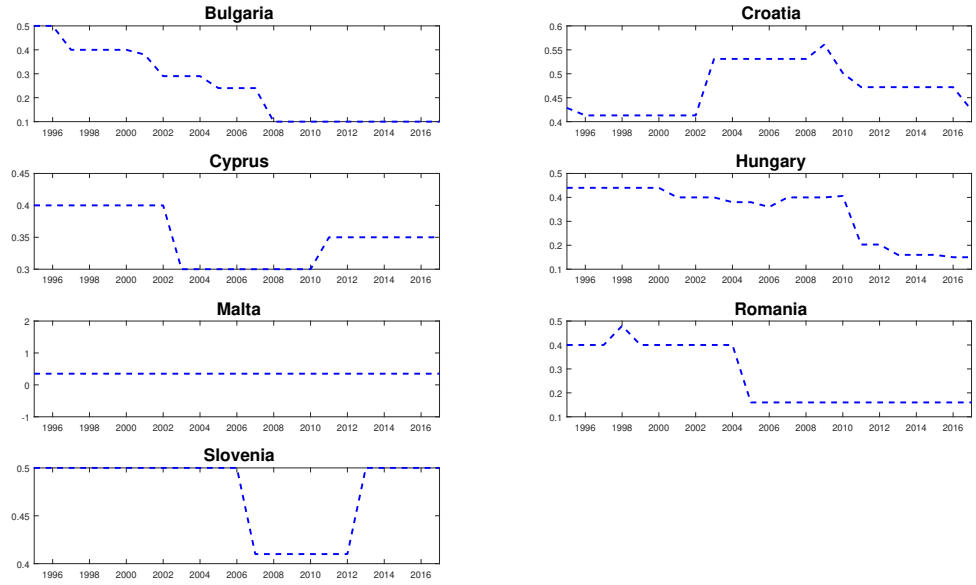

Figure C.15: Top statutory personal income tax (PIT) rates in the EU-28 (1995-2017): South-Eastern European countries

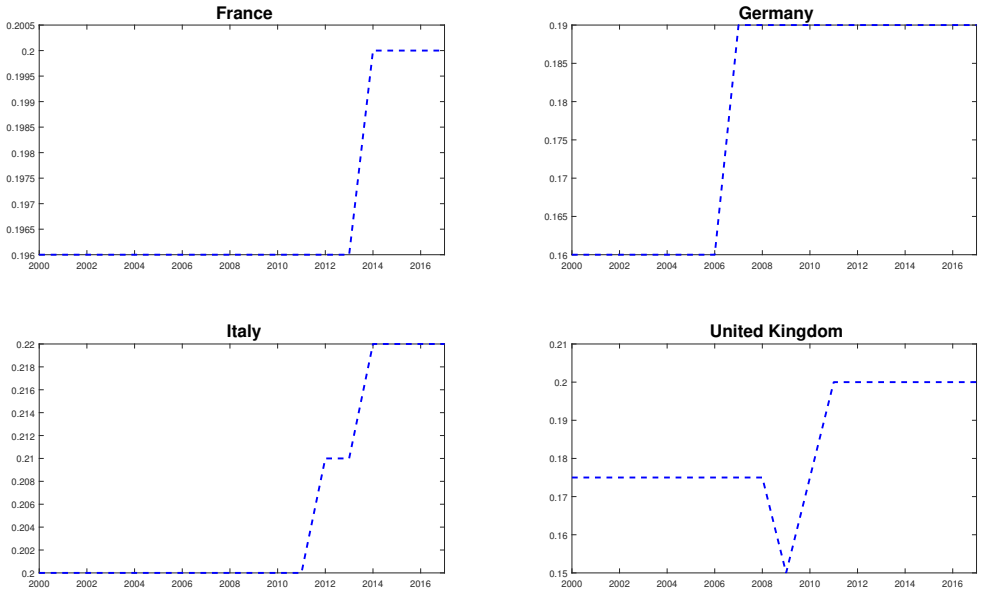

Figure C.16: Value-added tax (VAT) rates in the EU-28 (2000-2017): four largest economies

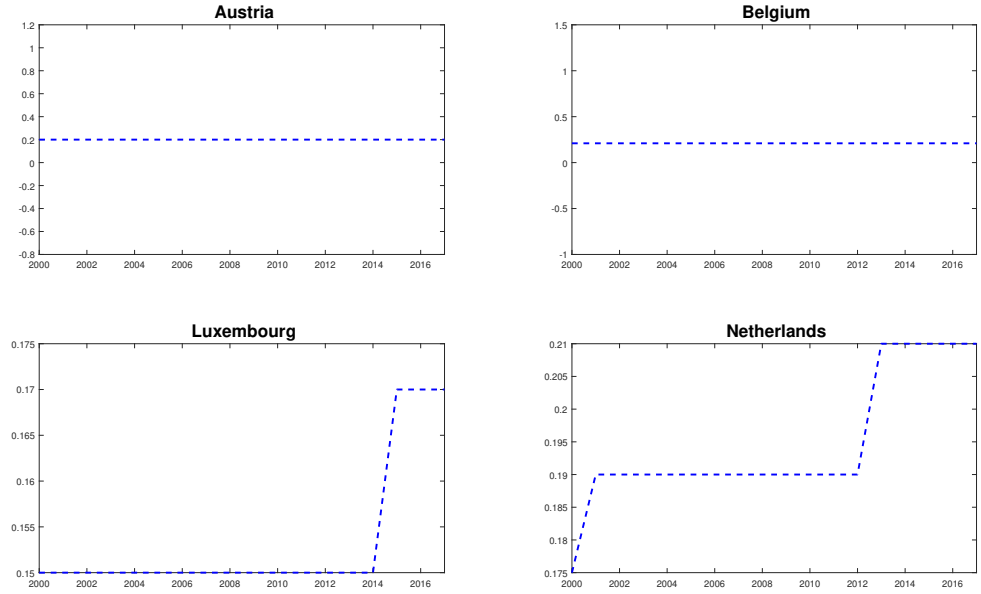

Figure C.17: Value-added tax (VAT) rates in the EU-28 (2000-2017): Benelux and Austria

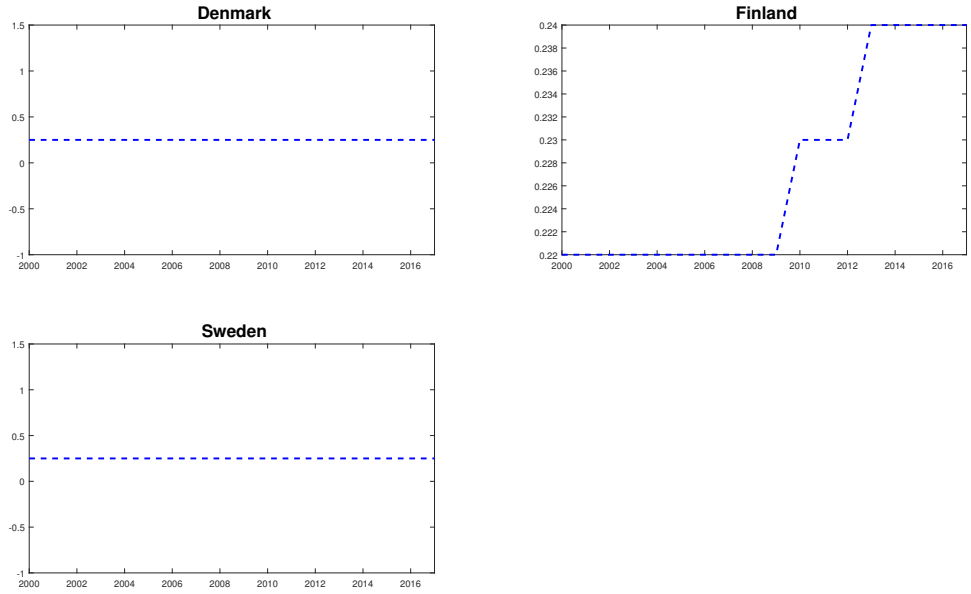

Figure C.18: Value-added tax (VAT) rates in the EU-28 (2000-2017): Nordic countries

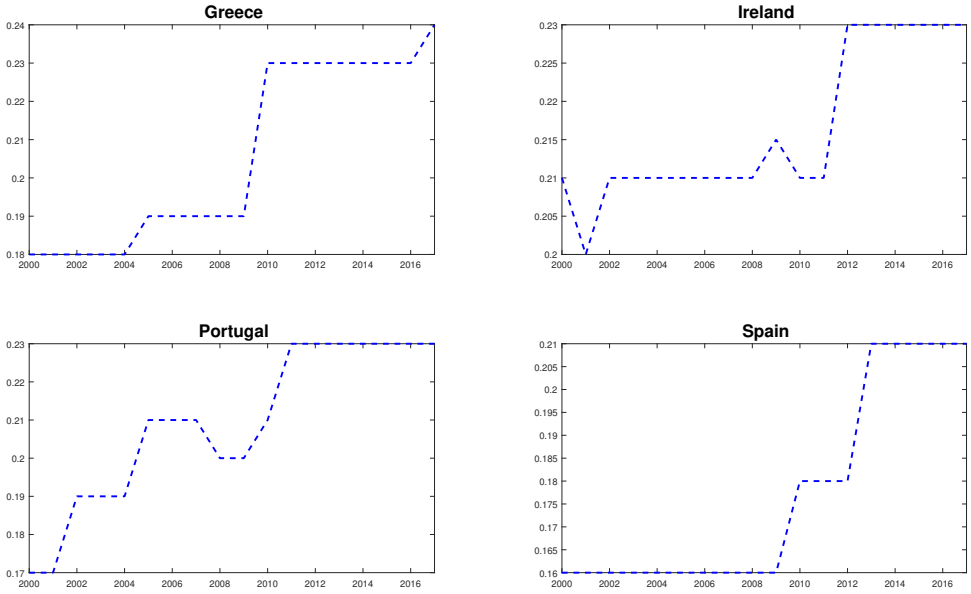

Figure C.19: Value-added tax (VAT) rates in the EU-28 (2000-2017): Greece, Italy, Portugal and Spain

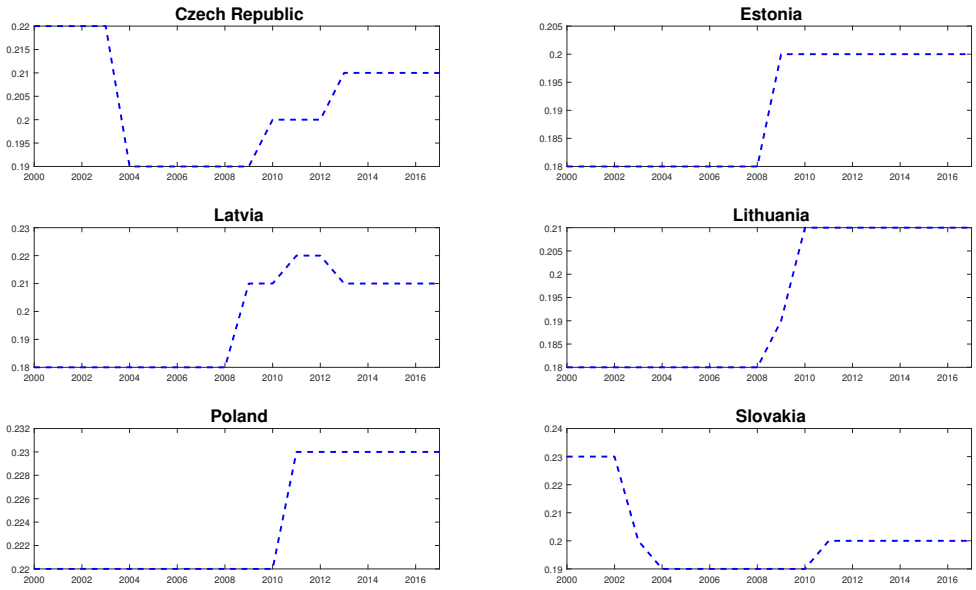

Figure C.20: Value-added tax (VAT) rates in the EU-28 (2000-2017): North-Eastern European countries

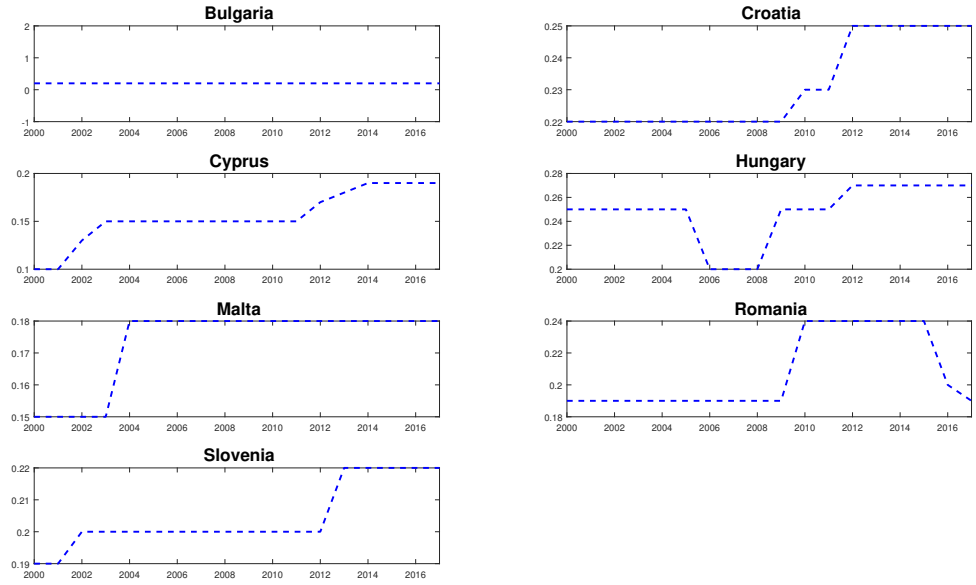

Figure C.21: Value-added tax (VAT) rates in the EU-28 (2000-2017): South-Eastern European countries

Model derivations

Each economy j is populated by N identical individuals, with perfect foresight and an infinite planning horizon. The representative agent is endowed with one unit of time, which she can use either for leisure time, l, or to work, $1-l$. The output of a firm, y, is determined by the following production function:

$$y_j(t) = A' G_j(t)^{\alpha} k_j(t)^{1-\alpha} (1-l_j)^{\alpha} \equiv A' \big(\frac{G_j(t)}{k_j(t)}\big)^{\alpha} (1-l_j)^{\alpha} k_j(t)$$

where k denotes the *per capita* stock of capital and G_j is the flow of productive government spending. We assume that the government uses a share g_j of aggregate output, Y, for productive spending:

$$G_j(t) = g_j Y_j(t)$$

Hence, aggregate output in each economy j is given by:

$$Y_j(t) = (A g_j^{\alpha})^{\frac{1}{1-\alpha}} (1-l_j)^{\frac{\alpha}{1-\alpha}} K_j$$

The welfare of the representative agent in this economy can be represented by the utility function:

$$\int_0^{\infty} e^{-\delta t} \frac{1}{\gamma} \Big[c_j l_j^{\theta} H_j^{\eta} \Big]^{\gamma} dt$$

where again it is implicitly assumed that the government claims a fraction of output, h_j for consumption spending:

$$H_j(t) = h_j Y_j(t)$$

The equilibrium in a centrally planned economy can thus be obtained by choosing the aggregate stock of capital K, flow of consumption C and leisure time l to maximize the utility of the representative agent in this economy, subject to the resource constraint of the economy:

$$\dot{K}_j = (1 - g_j - h_j) Y_j - C_j$$

The current-value Hamiltonian solving the central planner's problem in this economy can be described as:

$$\hat{H}(C_j, l_j, Y_j, K_j) \equiv e^{-\delta t}\Big\{\frac{1}{\gamma}\Big[(C_j/N_j)l_j^{\theta}(h_jY_j)^{\eta}\Big]^{\gamma}dt + \lambda(t)\Big[(1-g_j-h_j)Y_j - C_k - \dot{K}_j\Big] + \mu(t)\Big[(Ag_j^{\alpha})^{\frac{1}{1-\alpha}}(1-l_j)^{\frac{\alpha}{1-\alpha}}K_j - Y_j\Big]\Big\}$$

Defining $\Omega(l_j) \equiv \frac{\alpha}{\theta(1-\alpha)}\Big(\frac{l_j}{1-l_j}\Big)$, maximization with respect to the flow of consumption, C_j, leisure time, l_j, output, Y_j, and the stock of capital K_j, yields the following four optimal conditions:

$$N_j^{-\gamma}C_j/N_j^{\gamma-1}l_j^{\theta\gamma}(h_jY_j)^{\eta\gamma} = \lambda$$

$$\theta N_j^{-\gamma}C_j/N_j^{\gamma}l_j^{\theta\gamma-1}(h_jY_j)^{\eta\gamma} = \mu\frac{\alpha}{1-\alpha}(Ag_j^{\alpha})^{\frac{1}{1-\alpha}}(1-l_j)^{\frac{\alpha}{1-\alpha}-1}K_j$$

$$\eta N_j^{-\gamma}C_j/N_j^{\gamma}l_j^{\theta\gamma}(h_jY_j)^{\eta\gamma-1}g_c + \lambda[1-g_j-h_j] = \mu$$

$$\mu(Ag_j^{\alpha})^{\frac{1}{1-\alpha}}(1-l_j)^{\frac{\alpha}{1-\alpha}} = -\dot{\lambda} + \lambda p$$

The above equations can be re-arranged and combined with the aggregate resource constraint of the economy to describe the equilibrium of this economy featuring a central planner:

$$\frac{1}{\Omega(l_j)}\Big(\frac{C_j}{Y_j}\Big) = \frac{\mu}{\lambda}$$

$$\frac{\mu}{\lambda} = (1-g_j-h_j) + \eta\frac{C_j}{Y_j}$$

$$\psi_j = \frac{1}{1-\gamma(1+\eta)}\Big[\Big(\frac{\mu}{\lambda}\Big)\Big(\frac{Y_j}{K_j}\Big) - \rho\Big]$$

$$\psi_j = \Big[(1-g_j-h_j) - \Big(\frac{C_j}{Y_j}\Big)\Big]\Big(\frac{Y_j}{K_j}\Big)$$

$$\frac{Y_j}{K_j} = (\alpha g_j^{\alpha})^{\frac{1}{1-\alpha}}(1-l)^{\frac{\alpha}{1-\alpha}}$$

The balanced-growth path equilibrium is then described by the RR and PP loci, discussed more at length in text, which provide the equilibrium combinations of leisure time, l_j, and the rate of return on capital, ϕ_j, for which the equality of growth rates of consumption and capital, and product market equilibrium are ensured:

$$\psi_j = \frac{1}{1-\gamma(1+\eta)}\left[\frac{1-g_j-h_j}{1-\eta\Omega(l_j)}(Ag_j^{\alpha})^{\frac{1}{1-\alpha}}(1-l_j)^{\frac{\alpha}{1-\alpha}} - \delta\right]$$

$$\psi_j = (1-g_j-h_j)\frac{1-\eta\Omega(l_j)}{1-(1+\eta)\Omega(l_j)}(Ag_j^{\alpha})^{\frac{1}{1-\alpha}}(1-l_j)^{\frac{\alpha}{1-\alpha}}$$

In order to derive optimal government expenditure, the above Hamiltonian expression can be optimized for g_j and h_j tp yield:

$$g_j^* = \frac{\alpha}{1-\alpha}\frac{\mu}{\lambda}$$

$$h_j^* = \eta\frac{C_j}{Y_j}$$

These expressions simply express that, at the optimum, the marginal productivity of productive government expenditure equates to the marginal value of (foregone) private consumption ($\mu\partial Y_j/\partial g_j \equiv Y_j$), and the marginal utility of public consumption equates to the marginal utility of private consumption ($\partial U/\partial H_j \equiv \partial U/\partial C_j$). Finally, combining these with the optimality condition for the shadow value of output, the following condition can be written:

$$g_j^* = \alpha\Big(1 + h_j^* - h_j\Big)$$

Hence, the optimal values for government productive and consumption spending can be obtained:

$$g_j^* = \alpha$$

$$h_j^* = \eta(1-\alpha)\Omega(l_j^*)$$

Put simply, the optimal level of government productive expenditure depends upon the share of government consumption expenditure. If this is set at the optimum (i.e. for $h_j^* = h_j$), then the optimal share of government production expenditure is $g_j^* = \alpha$, which corresponds to the first-best government expenditure share, with a relative price of output $(\mu/\lambda) = 1-\alpha$.

Appendix D Tables (Chapter III)

Table D.1: Federal spending

	τ^K	τ^L	τ^C	h_j	g_j	l_j	ψ_j	ΔW
h_j = 20%								
$\tau^K \geq 0\%$								
	0.00	0.00	0.90	-	0.18	0.73	3.17%	-1.35%
	0.00	**-0.90**	**0.90**	-	**0.14**	0.61	**3.24%**	**4.02%**
Capital subsidies								
	-0.10	-0.90	0.90	-	0.08	0.63	3.46%	10.57%
	-0.15	**-0.20**	**0.90**	-	**0.08**	0.72	**3.57%**	**6.86%**
	-0.16	0.00	0.90	-	0.08	0.75	3.56%	9.21%
$\tau^K = 10\% + \tau^L = 20\%$								
	-	-	0.50	-	0.15	0.76	2.51%	4.76%
	-	-	0.70	-	0.20	0.76	2.63%	6.60%
	-	-	**0.90**	-	**0.25**	0.76	**2.73%**	**-10.64%**
$\tau^K = 10\% + \tau^C = 40\%$								
	-	0.00	-	-	0.10	0.73	2.40%	12.04%
	-	0.20	-	-	0.11	0.77	2.38%	12.45%
	-	**-0.45**	-	-	**0.08**	0.66	**2.40%**	**7.91%**
$\tau^L = 20\% + \tau^C = 60\%$								
	0.00	-	-	-	0.11	0.78	2.87%	11.03%
	-0.05	-	-	-	0.08	0.78	2.96%	8.73%
	-0.08	-	-	-	**0.06**	0.79	**2.97%**	**9.25%**

Table D.2: Federal spending

	τ^K	τ^L	τ^C	h_j	g_j	l_j	ψ_j	ΔW
h_j = 20%								
$\tau^C = 50\%$								
	-0.02	0.20	-	-	0.07	0.78	2.74%	9.77%
	-0.02	**0.19**	-	-	**0.07**	0.78	**2.75%**	**8.79%**
	-0.03	0.25	-	-	0.07	0.79	2.73%	10.45%
$\tau^C = 45\%$								
	0.00	**0.16**	-	-	**0.06**	0.77	**2.62%**	**9.88%**
	-0.01	0.25	-	-	0.06	0.79	2.61%	9.60%
	-0.01	0.16	-	-	0.05	0.77	2.61%	9.26%
	-0.02	0.40	-	-	0.06	0.82	2.60%	9.05%
$\tau^C = 40\%$								
	0.00	**0.32**	-	-	**0.05**	0.81	**2.47%**	**8.21%**
	-0.01	0.32	-	-	0.05	0.81	2.46%	7.61%
	0.00	0.41	-	-	0.06	0.83	2.47%	8.02%

Table D.3: Limited EU budget with common consumption vs. capital income taxes

	τ^K	τ^L	τ^C	h_j	g_j	l_j	ψ_j	ΔW
Benchmark	0.31	0.38	0.20	0.20	0.20	0.78	1.48%	
Optimal policy	0.00	-0.55	0.55	0.17	0.08	0.66	2.91%	17.94%
$\boldsymbol{h_j = 3\%}$								
$\overline{\tau}^C = 19\%$								
	0.00	0.00	-	-	0.08	0.75	2.78%	-14.84%
	0.00	0.15	-	-	0.09	0.77	2.78%	-15.04%
	-0.01	0.00	-	-	0.07	0.75	2.78%	-15.17%
	-0.01	**0.10**	-	-	**0.08**	0.77	**2.80%**	**-16.24%**
	-0.02	0.20	-	-	0.08	0.79	2.80%	-16.32%
	-0.03	0.30	-	-	0.08	0.81	2.78%	-15.80%
$\overline{\tau}^K = 16\%$								
	-	0.00	0.00	-	0.08	0.73	1.99%	-18.41%
	-	0.00	0.15	-	0.19	0.72	2.35%	-25.90%
	-	**-0.90**	**0.90**	-	**0.41**	0.58	**2.83%**	**-69.27%**

Appendix E Figures (Chapter IV)

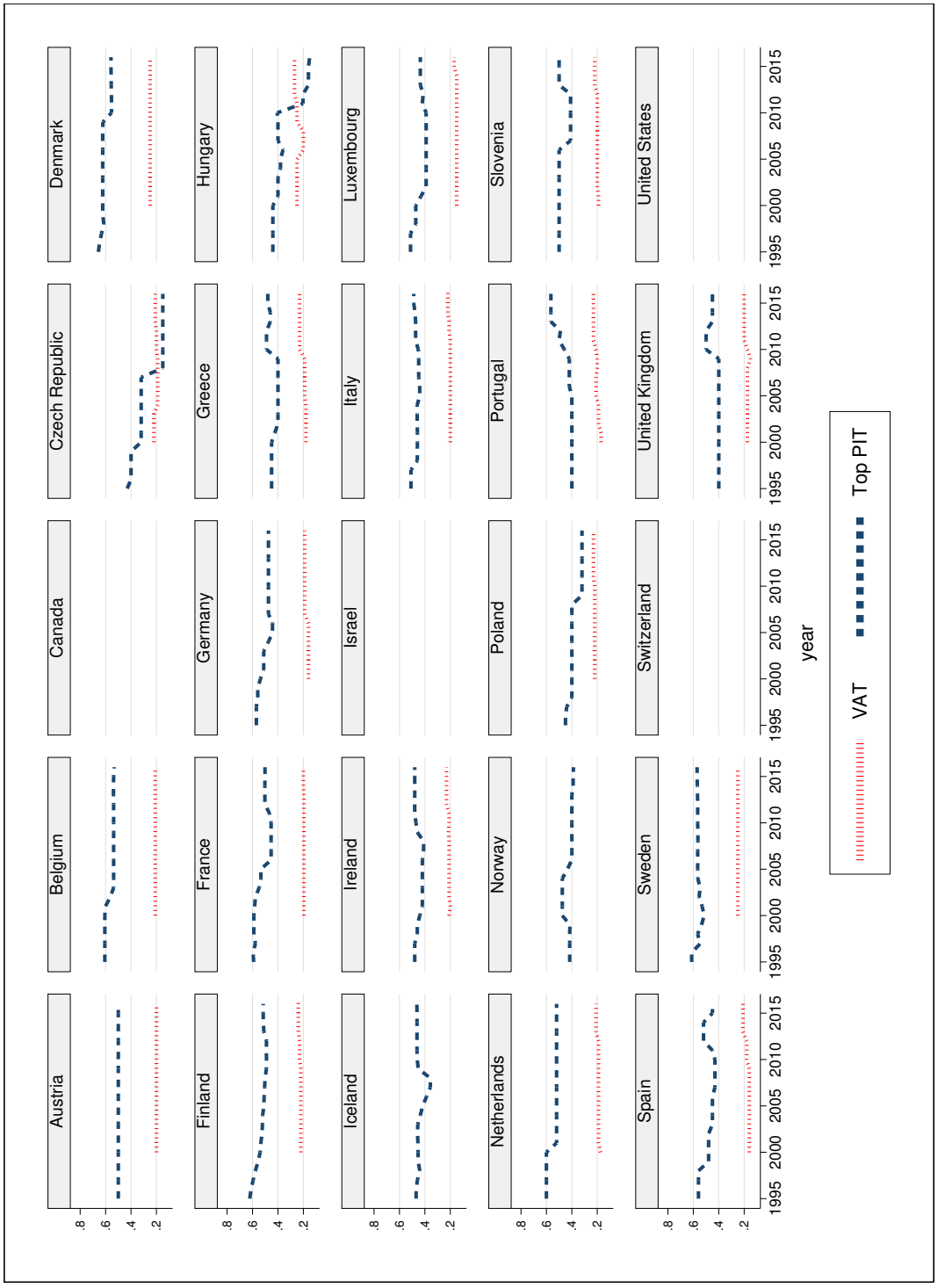

Figure E.1: Value-added tax (VAT) and top statutory personal income tax (PIT) rates in 21 OECD countries (1995-2016). The figure shows a downward trend in top PIT rates across OECD countries, with some exceptions of PIT rate increases, mostly in EMU countries under fiscal stress. Normal VAT rates, although broadly stable over the period, seem to follow a slight upward trend.

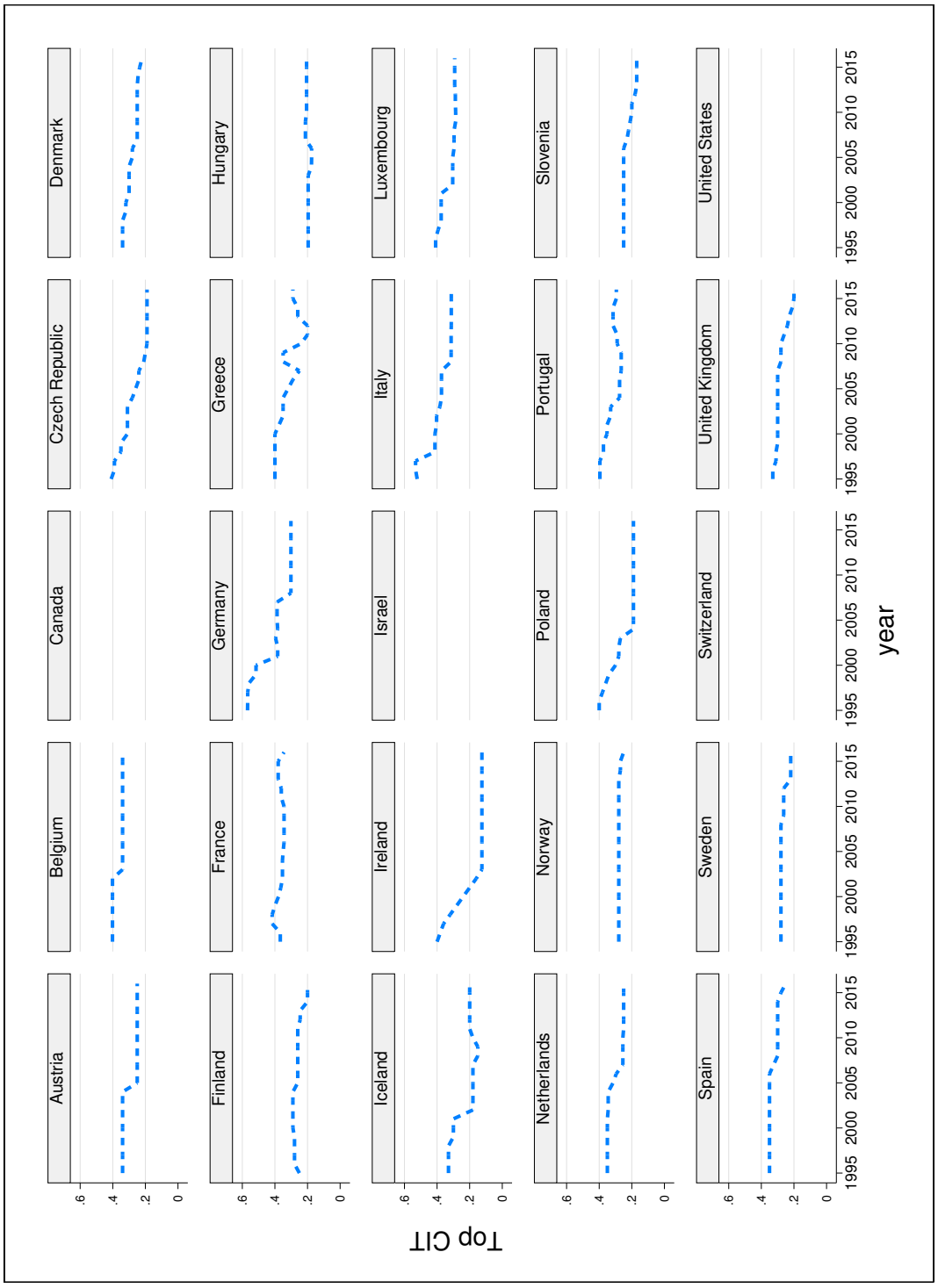

Figure E.2: Top statutory corporate income tax (CIT) rates in 21 OECD countries (1995-2016). The figure shows a downward trend in top CIT rates across OECD countries, with mild temporary increases in EMU countries under fiscal stress.

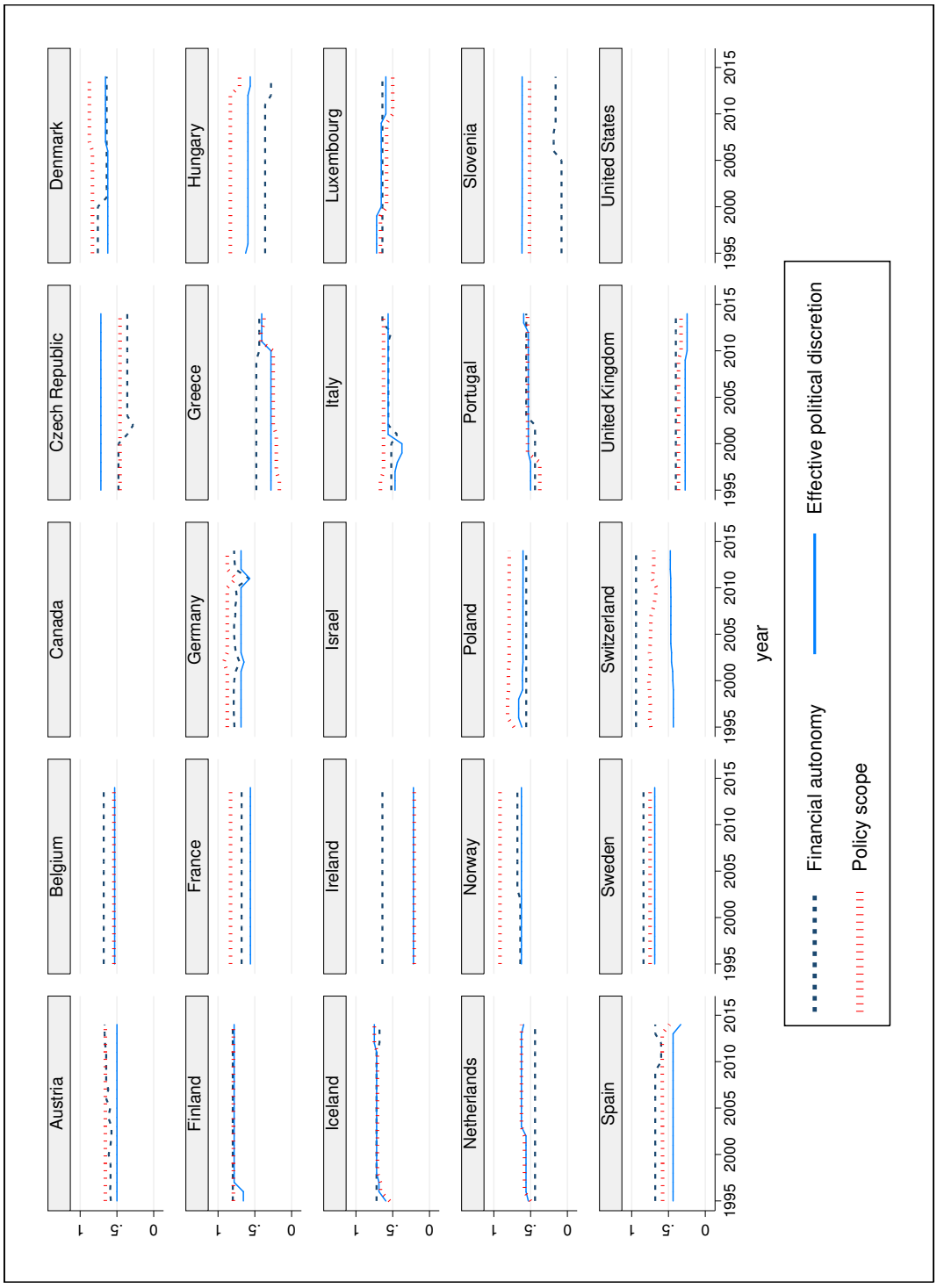

Figure E.3: Local autonomy index (1995-2016). The figure shows the evolution of sub-national autonomy over the last two decades, along three key dimensions: financial autonomy, effective political discretion and policy scope.

Appendix F Tables (Chapter IV)

Table F.1: Fiscal reaction functions of 25 OECD countries (1995-2016): baseline results. Dependent variable: cyclically-adjusted primary balances (CAPB). Estimates are based on a bias-corrected least squares dummy variable (LSDVC) estimator developed for autoregressive (unbalanced) panel data models, using bias approximations developed in Bruno (2005). Bias corrections use the standard Arellano and Bond (1991) estimator. Bootstrap standard errors, provided in brackets, are derived through the numerical derivation of a variance-covariance matrix for LSDVC using 100 repetitions. Normality of errors is assumed.

$s_{i,t}$ (CAPB)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$s_{i,t-1}$	0.709***	0.691***	0.672***	0.708***	0.694***	0.690***	0.672***	0.688***	0.694***	0.702***
	(0.045)	(0.036)	(0.043)	(0.036)	(0.042)	(0.051)	(0.042)	(0.049)	(0.049)	(0.041)
$b_{i,t-1}$	0.034***	0.042***	0.036***	0.034***	0.035***	0.040***	0.036***	0.031***	0.037***	0.035***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)	(0.011)	(0.009)	(0.010)	(0.011)	(0.010)
$\hat{y}_{i,t-1}$	-0.064	-0.059	-0.072	-0.064	-0.071	-0.080	-0.077*	-0.087	-0.081	-0.044
	(0.048)	(0.043)	(0.048)	(0.044)	(0.045)	(0.056)	(0.044)	(0.054)	(0.055)	(0.062)
D^{ebc}_{it}	0.000	0.000	0.000	0.000	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
f^{exp}_{it}		0.070**								
		(0.032)								
f^{rev}_{it}			-0.148**							
			(0.063)							
f^{vfi}_{it}				-0.003						
				(0.057)						
f^{lai}_{it}					-0.084					
					(0.072)					
$f^{exp}_{it} \times f^{lai}_{it}$						0.113				
						(0.072)				
$f^{rev}_{it} \times f^{lai}_{it}$							-0.197*			
							(0.106)			
$f^{vfi}_{it} \times f^{lai}_{it}$								-0.269		
								(0.314)		
$b_{i,t-1} \times f^{vfi}_{it} \times f^{lai}_{it}$									-0.462	
									(0.542)	
$\hat{y}_{i,t-1} \times f^{rev}_{it} \times f^{lai}_{it}$										-0.391
										(0.479)

*10% significance level, **5% significance level, ***1% significance level

Table F.2: Fiscal reaction functions of 25 OECD countries (1995-2016): potential debt service thresholds. Dependent variable: underlying primary balances (UPB). Estimates are based on a bias-corrected least squares dummy variable (LSDVC) estimator developed for autoregressive (unbalanced) panel data models, using bias approximations developed in Bruno (2005). Bias corrections use the standard Arellano and Bond (1991) estimator. Bootstrap standard errors, provided in brackets, are derived through the numerical derivation of a variance-covariance matrix.

$s_{i,t}$ (UPB)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$s_{i,t-1}$	0.814***	0.811***	0.803***	0.788***	0.812***	0.804***	0.794***	0.780***	0.811***	0.797***	0.802***	0.794***
	(0.033)	(0.034)	(0.033)	(0.032)	(0.033)	(0.034)	(0.033)	(0.033)	(0.034)	(0.034)	(0.034)	(0.034)
$b_{i,t-1}$	0.025***	0.024***	0.023***	0.021***	0.021***	0.021***	0.020***	0.019***	0.026***	0.026***	0.025***	0.024***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$\hat{y}_{i,t-1}$	-0.070***	-0.064**	-0.072***	-0.064**	-0.070***	-0.064**	-0.072***	-0.062**	-0.037	-0.022	-0.047	-0.043
	(0.028)	(0.028)	(0.028)	(0.027)	(0.028)	(0.028)	(0.027)	(0.027)	(0.040)	(0.034)	(0.032)	(0.030)
D_{it}^{ebc}	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$D_{i,t-1}^{\overline{bi}=2\%}$	0.002											
	(0.002											
$D_{i,t-1}^{\overline{bi}=3\%}$		0.005***										
		(0.002)										
$D_{i,t-1}^{\overline{bi}=4\%}$			0.005***									
			(0.002)									
$D_{i,t-1}^{\overline{bi}=5\%}$				0.010***								
				(0.002)								
$b_{i,t-1} \times D_{i,t-1}^{2}$					0.005*							
					(0.003)							
$b_{i,t-1} \times D_{i,t-1}^{3}$						0.007***						
						(0.002)						
$b_{i,t-1} \times D_{i,t-1}^{4}$							0.007***					
							(0.002)					
$b_{i,t-1} \times D_{i,t-1}^{5}$								0.011***				
								(0.002)				
$\hat{y}_{i,t-1} \times D_{i,t-1}^{2}$									-0.046			
									(0.041)			
$\hat{y}_{i,t-1} \times D_{i,t-1}^{3}$										-0.095***		
										(0.037)		
$\hat{y}_{i,t-1} \times D_{i,t-1}^{4}$											-0.063	
											(0.039)	
$\hat{y}_{i,t-1} \times D_{i,t-1}^{5}$												-0.122***
												(0.046)

*10% significance level, **5% significance level, ***1% significance level

Table F.3: Fiscal reaction functions of 24 OECD countries (1995-2016): baseline results. Greece excluded from the sample. Dependent variable: underlying primary balances (UPB). Estimates are based on a bias-corrected least squares dummy variable (LSDVC) estimator developed for autoregressive (unbalanced) panel data models, using bias approximations developed in Bruno (2005). Bias corrections use the standard Arellano and Bond (1991) estimator. Bootstrap standard errors, provided in brackets, are derived through the numerical derivation of a variance-covariance matrix.

$s_{i,t}$ (UPB)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$s_{i,t-1}$	0.815***	0.812***	0.775***	0.811***	0.840***	0.846***	0.822***	0.819***	0.836***	0.847***
	(0.032)	(0.036)	(0.034)	(0.036)	(0.035)	(0.035)	(0.035)	(0.036)	(0.037)	(0.034)
$b_{i,t-1}$	0.024***	0.025***	0.026***	0.023***	0.027***	0.025***	0.028***	0.022***	0.029***	0.028***
	(0.006)	(0.005)	(0.005)	(0.005)	(0.006)	(0.007)	(0.006)	(0.007)	(0.007)	(0.006)
$\hat{y}_{i,t-1}$	-0.048*	-0.045*	-0.053*	-0.052*	-0.051*	-0.053	-0.054**	-0.072**	-0.060*	-0.026
	(0.028)	(0.027)	(0.028)	(0.027)	(0.028)	(0.033)	(0.028)	(0.033)	(0.033)	(0.043)
D_{it}^{ebc}	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001v
f_{it}^{exp}		0.004								
		(0.018)								
f_{it}^{rev}			-0.106***							
			(0.034)							
f_{it}^{vfi}				-0.029						
				(0.031)						
f_{it}^{lai}					-0.034					
					(0.039)					
$f_{it}^{exp} \times f_{it}^{lai}$						-0.031				
						(0.039)				
$f_{it}^{rev} \times f_{it}^{lai}$							-0.095**			
							(0.046)			
$f_{it}^{vfi} \times f_{it}^{lai}$								-0.390**		
								(0.196)		
$b_{i,t-1} \times f_{it}^{vfi} \times f_{it}^{lai}$									-0.371	
									(0.277)	
$\hat{y}_{i,t-1} \times f_{it}^{rev} \times f_{it}^{lai}$										-0.266
										(0.315)

*10% significance level, **5% significance level, ***1% significance level

Table F.4: Fiscal reaction functions of 24 OECD countries (1995-2016): debt thresholds. Greece excluded from the sample. Dependent variable: underlying primary balances (UPB). Estimates are based on a bias-corrected least squares dummy variable (LSDVC) estimator developed for autoregressive (unbalanced) panel data models, using bias approximations developed in Bruno (2005). Bias corrections use the standard Arellano and Bond (1991) estimator. Bootstrap standard errors, provided in brackets, are derived through the numerical derivation of a variance-covariance matrix.

$s_{i,t}$ (UPB)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$s_{i,t-1}$	0.802***	0.815***	0.815***	0.807***	0.815***	0.814***	0.799***	0.811***	0.808***	0.800***
	(0.031)	(0.032)	(0.033)	(0.031)	(0.032)	(0.033)	(0.033)	(0.034)	(0.034)	(0.033)
$b_{i,t}$	0.031***	0.024***	0.022***	0.031***	0.024***	0.023***	0.030***	0.025***	0.031***	0.037***
	(0.007)	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)	(0.007)	(0.009)
$\hat{y}_{i,t}$	-0.052*	-0.048*	-0.049*	-0.051*	-0.048*	-0.049*	-0.046*	-0.048*	-0.047	-0.046*
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.029)	(0.028)
D_{it}^{ebc}	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$D_{it}^{\bar{b}=80\%}$	-0.005*									
	(0.003)									
$D_{it}^{\bar{b}=90\%}$		0.000								
		(0.003)								
$D_{it}^{\bar{b}=100\%}$			0.003							
			(0.003)							
$b_{i,t-1} \times D_{it}^{80}$				-0.005						
				(0.003)						
$b_{i,t-1} \times D_{it}^{90}$					0.000					
					(0.003)					
$b_{i,t-1} \times D_{it}^{100}$						0.002				
						(0.003)				
$D_{it}^{\bar{b}=50\%}$							-0.004**			
							(0.002)			
$D_{it}^{\bar{b}=60\%}$								-0.001		
								(0.002)		
$D_{it}^{\bar{b}=70\%}$									-0.004	
									(0.002)	
$b_{i,t-1} \times D_{it}^{50}$										-0.008**
										(0.005)

*10% significance level, **5% significance level, ***1% significance level

Table F.5: Fiscal reaction functions of 25 OECD countries (1995-2016): sub-national autonomy. Dependent variable: underlying primary balances (UPB). Estimates are based on a LSDVC estimator developed for autoregressive (unbalanced) panel data models (Bruno 2005), based on the standard Arellano and Bond (1991) estimator. Bootstrap standard errors in brackets.

$s_{i,t}$ (UPB)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$s_{i,t-1}$	0.838***	0.842***	0.843***	0.838***	0.820***	0.840***	0.821***
	0.033	0.032	0.033	0.043	0.032	0.042	0.041
$b_{i,t-1}$	0.030***	0.027***	0.025***	0.028***	0.029***	0.026***	0.025***
	0.006	0.006	0.006	0.006	0.006	0.006	0.006
$\hat{y}_{i,t-1}$	-0.060**	-0.065***	-0.071***	-0.068**	-0.069***	-0.071**	-0.082***
	0.026	0.026	0.027	0.033	0.026	0.032	0.032
D_{it}^{ebc}	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***
	0.001	0.001	0.001	0.001	0.001	0.001	0.001
$f_{it}^{lai(fa)}$	-0.047**						
	0.022						
$f_{it}^{lai(epd)}$		0.045					
		0.032					
$f_{it}^{lai(ps)}$			0.043				
			0.029				
$f_{it}^{exp} \times f_{it}^{(fa)}$				-0.003			
				0.031			
$f_{it}^{rev} \times f_{it}^{(fa)}$					-0.093		
					0.058		
$f_{it}^{vfi} \times f_{it}^{(fa)}$						-0.049	
						0.055	
$f_{it}^{vfi} \times f_{it}^{(ps)}$							-0.108*
							0.066