DEUTSCHE BUNDESBANK
EUROSYSTEM

Discussion Paper

Deutsche Bundesbank
No 26/2016

Budget-neutral labour tax wedge reductions: a simulation-based analysis for selected euro area countries

Maria-Grazia Attinasi
(European Central Bank)

Martino Tasso
(Banca d'Italia)

Doris Prammer
(Oesterreichische Nationalbank)

Stefan van Parys
(National Bank of Belgium)

Nikolai Stähler
(Deutsche Bundesbank)

Deutsche Bundesbank, Wilhelm-Epstein-Straße 14, 60431 Frankfurt am Main,
Postfach 10 06 02, 60006 Frankfurt am Main

Tel +49 69 9566-0

Please address all orders in writing to: Deutsche Bundesbank,
Press and Public Relations Division, at the above address or via fax +49 69 9566-3077

Internet http://www.bundesbank.de

ISBN 978–3–95729–277–3 (Printversion)
ISBN 978–3–95729–278–0 (Internetversion)

Non-technical summary

Research Question

In most Euro Area countries, the tax wedge on labour income is large relative to international standards. Since 2011, the European Commission's Country Specific Recommendations include calls for cutting labour taxes in a budget-neutral way. In this paper, we analyse (i.) how a reduction in the labour tax wedge affects output, consumption, employment, redistribution, international competitiveness and, ultimately, welfare; we assess (ii.) whether reducing the firms' or the workers' tax burden matters for its macroeconomic effects; we explore (iii.) how different ways of achieving budget neutrality affect the economy; and we test (iv.) the role of country-specific circumstances.

Contribution

We do this by means of model-based simulations using a macroeconomic New Keynesian dynamic stochastic equilibrium (DSGE) model of a monetary union that contains a complex labour market structure and a comprehensive public sector. We compare the outcome of reducing the labour tax wedge in Austria, Belgium, Germany and Italy. All these countries feature structural differences, inter alia, in terms of size, international trade relations and overall labour market efficiency.

Results

We find that a deficit-neutral reduction in the labour tax wedge is beneficial in terms of both welfare and output gains, as long as the financing measure does not harm private-sector productivity and/or the incentive for private capital investments overproportionately. The measure generating largest output gains and highest reductions in unemployment is a decrease in labour taxation financed by an increase in consumption taxes. However, as this fiscal devaluation directly increases consumption costs, financing a tax cut via a reduction in public purchases avoids the negative repercussions on private consumption and seems to be more beneficial in terms of welfare. We show that, when we assume that the firms can also adjust the intensive labour margin in response to policy changes, a reduction in the workers' and not the firms' burden is most beneficial.

Nichttechnische Zusammenfassung

Fragestellung

Im internationalen Umfeld ist die Steuer- und Abgabenbelastung des Faktors Arbeit in den meisten Mitgliedsstaaten der Eurozone hoch. Die Europäische Kommission fordert daher schon seit längerer Zeit, diesen Steuer- und Abgabenkeil defizitneutral zu reduzieren. In diesem Papier untersuchen wir, (i.) wie sich eine Reduktion dieser Belastung auf Output, Konsum, Beschäftigung, internationale Wettbewerbsfähigkeit und letztlich Wohlfahrt auswirkt; (ii.) welche Unterschiede auftreten, wenn Arbeitnehmer oder Arbeitgeber entlastet werden; (iii.) welche Auswirkungen unterschiedliche Gegenfinanzierungsmaßnahmen haben; und (iv.) welche Rolle länderspezifische Unterschiede spielen können.

Beitrag

Zur Analyse verwenden wir ein modernes makroökonomisches Simulationsmodell (ein sogenanntes dynamisches, stochastisches allgemeines Gleichgewichtsmodell), welches eine komplexe Arbeitsmarktstruktur und einen ausgereiften Fiskalsektor beinhaltet. Das Modell ist für Belgien, Deutschland, Österreich und Italien kalibriert, da diese Länder sich nicht nur hinsichtlich ihrer Größe sondern auch hinsichtlich ihrer Arbeitsmarkt- und Nachfragestruktur unterscheiden.

Ergebnisse

Unsere Ergebnisse legen nahe, dass eine defizitneutrale Reduktion sowohl aus Wachstums- als auch aus Wohlfahrtsgesichtspunkten wünschenswert ist, solange die Gegenfinanzierungsmaßnahmen die allgemeine privatwirtschaftliche Produktivität und/oder den Anreiz für private Kapitalinvestitionen nicht überproportional negativ beeinflussen. Fiskalische Abwertung (d.h. eine durch eine höhere Konsumbesteuerung finanzierte Reduktion der Steuer- und Abgabenlast) generiert gemäß unseren Simulationen die größten Wachstumseffekte. Allerdings erscheint aus Wohlfahrtsgesichtspunkten eine Reduktion des Staatsverbrauchs sinnvoller, weil diese Maßnahme vermeidet, die Preise für Konsumgüter politikinduziert zu erhöhen. Im Gegensatz zu den Erkenntnissen eines Großteils der Literatur weisen unsere Ergebnisse darauf hin, dass eine Entlastung der Arbeitnehmer dann vorteilhaft ist, wenn Arbeitgeber auf durch die Reformen ausgelöste Nachfrageänderungen leicht(er) mit einer Ausweitung der Arbeitszeit und eben nicht mit Neueinstellungen reagiern können.

Bundesbank Discussion Paper No 26/2016

Budget-Neutral Labour Tax Wedge Reductions: A Simulation-Based Analysis for Selected Euro Area Countries*

Maria-Grazia Attinasi
European Central Bank

Doris Prammer
Oesterreichische Nationalbank

Nikolai Stähler
Deutsche Bundesbank

Martino Tasso
Banca d'Italia

Stefan van Parys
National Bank of Belgium

Abstract

Budget-neutral tax wedge reductions rank high in the policy agenda of several EMU member states. Using a New Keynesian DSGE model of a monetary union with a complex labour market structure and a comprehensive public sector, we evaluate the macroeconomic and welfare effects of reducing the firms' and workers' labour tax rates under alternative financing instruments. Overall, a tax wedge reduction is beneficial in terms of both welfare and output, as long as the financing measure does not harm private-sector productivity and/or the incentive for private capital investments over-proportionately. While financing the labour tax wedge reduction by an increase in consumption taxation yields most favourable output effects, financing it by a reduction in government spending is more beneficial in terms of welfare as the latter does not imply a policy-induced increase in private consumption costs. We also show that, when we assume that firms can adjust the ex- and intensive labour margin in response to policy changes, a reduction in the workers' and not the firms' burden is most beneficial.

Keywords: Fiscal Policy, Tax Reforms, DSGE Modelling, Macroeconomics

JEL classification: H2, J6, E32, E62

*Contact: Maria-Grazia Attinasi (maria_grazia.Attinasi@ecb.int), Doris Prammer (doris.prammer@oenb.at), Nikolai Stähler (nikolai.staehler@bundesbank.de), Martino Tasso (martino.tasso@bancaditalia.it) and Stefan van Parys (stefan.vanparys@nbb.be). The authors thank Othman Bouabdallah, Giovanni Callegari, Francesco Drudi, Doug Hamilton, Mathias Hoffmann, Christophe Kamps, Ralph Lütticke, Jochen Mankart, Javier Pérez, Thomas Warmedinger, members of the European System of Central Banks' Working Group on Public Finances (WGPF) as well as participants of the 2015 National Tax Association Annual Conference in Boston for helpful comments. Nikolai Stähler gratefully acknowledges the hospitality of the ECB's Fiscal Policy Division, where a significant part of this work has been undertaken. Discussion papers represent the authors' personal opinions and do not necessarily reflect the views of the authors' institutions.

1 Introduction

In most Euro Area countries, the tax wedge on labour income is large relative to international standards (European Commission, 2014). Since 2011, the European Commission's Country Specific Recommendations include calls for reducing the tax wedge. In July 2014, the Eurogroup identified lowering labour taxes as a top policy priority. Moreover, given the tight fiscal situation of many member countries, it was recommended that such reforms should be implemented in a budget neutral way. The issue is again addressed in a recent publication (European Commission, 2016). Furthermore, given the weak labour market performance in the aftermath of the crisis and the fact that, within the Eurozone, about 18 million people are unemployed (yielding an average unemployment rate of 11%),[1] it is even claimed that "*the crisis will only be over when unemployment falls to socially sustainable levels*" and that "*jobs fail to be created* [...] *not because of the 'lack of demand' as often claimed, but mainly because wage costs are high relative to productivity* [and] *social insurance and tax burdens are heavy*" (Thimann, 2015).

In this paper, we analyse (i.) how a reduction in the labour tax wedge affects output, consumption, employment, international competitiveness, redistribution and, ultimately, welfare; we assess (ii.) whether cutting social security contributions or personal income tax rates matters for the macroeconomic and welfare effects; we explore (iii.) how different ways of achieving budget neutrality (e.g. increasing other taxes or reducing expenditures) affect the economy; and we test (iv.) the role of country-specific circumstances. We do this by means of model-based simulations using a macroeconomic New Keynesian dynamic stochastic equilibrium (DSGE) model of a monetary union that contains a complex labour market structure and a comprehensive public sector. We compare the outcome of reducing the labour tax wedge in Austria, Belgium, Germany and Italy. All these countries feature structural differences, inter alia, in terms of size of their economy, international trade relations and overall labour market efficiency.

We find that a budget-neutral reduction in the labour tax wedge has positive effects on output, consumption, investment, employment and international competitiveness unless it is financed by measures that reduce private-sector productivity and/or the incentives for private investment. This is the case when a cut in the tax wedge is financed via a reduction in public investment or an increase in taxes on capital interest. The former reduces private-sector productivity by, for example, reducing the quality of public infrastructure, while the latter reduces benefits from capital investments, which ultimately makes capital inputs more expensive. Reductions in public employment, which is also assumed to be private-sector productivity enhancing in our model, entails negative effects resulting from lower productivity, too. However, a reduction in public employment fosters additional job creation in the private sector as private sector wages are affected by the probability of finding a job in the public sector. Whenever this probability is decreased, the incentive to use the possibility of finding a job in the public sector as a threat point in private-sector wage bargaining is reduced, and therefore private sector wages fall thus increasing firms' incentives to hire. If this 'wage channel' is sufficiently strong to compensate for the 'productivity channel', this measure still boosts private-sector output, consumption and competitiveness.

[1] See http://ec.europa.eu/eurostat/statistics-explained/index.php/Unemployment_statistics# Unemployment_trends.

A fiscal devaluation – that is a cut in the tax wedge financed by an increase in consumption taxes – is the measure that yields the largest gains in terms of output and consumption as well as lower unemployment. The macroeconomic benefits of lowering of government purchases as a financing inistrument of direct tax cuts fall short of fiscal devaluation. The reason is that a reduction in public purchases, containing full home bias in our model, cannot be overcompensated for by an increase in private demand as part of the gains in net labour income will be spend for import goods. However, in terms of household welfare, this ranking is reversed due to the fact that fiscal devaluation dampens private consumption due to the policy-induced increase in consumption costs, which is not present when decreasing public purchases.

If, in response to a cut in the tax wedge, firms have the possibility to adjust employment via the intensive and the extensive margin (i.e. by changing hours worked of already employed workers or by hiring new workers, respectively), then reducing the workers' labour income tax yields more favourable effects compared to a cut in firms' social security contribution rates; a finding that is not in line with the majority of the literature on fiscal devaluation. The mechanism driving our results can be explained as follows. A reduction in the personal income tax rate directly increases workers' net income for any given gross wage. As workers now immediately earn higher net wages, it is relatively easy for firms to convince them to supply more hours of work and to accept a lower gross wage. Indeed, in order to save on search costs, firms have the incentive to adjust labour input through the intensive margin rather than by hiring new workers. Working more hours for only a slightly lower gross wage, while having to pay lower taxes boosts the average net labour income per worker and thereby private consumption of all households, including those who are constrained to spend their entire labour income each period. Therefore aggregate demand increases strongly and so does output.

By contrast, reducing the firms' tax burden makes it relatively more attractive to hire new workers. Even though unemployment falls more in this case, the output effects are smaller. When firms' labour costs are reduced, the average net wage income increases by less as it is only indirectly affected. In this situation workers are less willing to supply more hours of work and firms partly compensate this by increasing job creation. The latter, however, carries some additional search costs which in turn imply a smaller increase in average net wage income. As a result, the increase in private consumption demand is also smaller. Furthermore, in this case liquidity-constrained households even decrease their consumption as the income gain does not compensate for the increase in consumption costs which results from the indirect tax increase.

The reason for finding an opposite ranking compared to the literature we discuss below is because existing studies on fiscal devaluations generally do not consider the intensive and the extensive margin in a unified framework. Therefore, the increase in private consumption demand that follows from higher per-capita hours worked and higher net earnings is missing. For this reason, ignoring the intensive margin makes a reduction in social security contributions more efficient. This is the case because a reduction in social security contributions has a more direct downward impact on unit labour costs which, through the reduction in prices, feeds into higher exports. Indeed, our model is also able to reproduce this finding when the amount of hours worked is exogenously fixed to its initial steady-state value.

Turning to country-specific characteristics, we find that in countries characterised by

a relatively high degree of workers' bargaining power, such as Austria and Germany, a fiscal devaluation implemented via lower employers' social security contributions yields relatively lower gains. When the bargaining power is high, an increase in firms' profits (due to lower labour costs) yields a relatively higher increase (or lower reduction) in wage claims because the bargaining power determines the fraction workers obtain from these profits. In countries where the labour market is relatively rigid (i.e. low matching efficiency and/or high vacancy positing costs), such as in Belgium and especially Italy, the incentive to create additional jobs after a tax wedge reduction is lower because search costs increase relatively more. Furthermore, spillovers to the rest of the euro area are positive, small and depend on country size.

The rest of the paper is organized as follows. In Section 2, we discuss related literature. Section 3 describes the model and its calibration. In Section 4, we present the simulation design, while Section 5 discusses the results. A welfare assessment can be found in Section 6. Section 7 concludes.

2 Related literature

The impact of taxes on the labour market has been addressed from several angles in the economic literature. Empirical macroeconomic studies mostly use aggregate data and perform cross-country comparisons and, in line with microeconomic theory (see Meghir and Phillips, 2010, and Keane, 2011), they usually find harmful effects of tax wedges on employment (e.g., Daveri and Tabellini, 2000, and Bassanini and Duval, 2006). By calibrating a simple labour supply model to the features of the United States and the main European economies, Prescott (2004) finds that the differences in aggregated hours of work across the Atlantic are primarily driven by observed discrepancies in marginal effective tax rates.[2]

Coenen, McAdam and Straub (2008) analyse Prescott's insight through the lenses of a DSGE model. They find that reducing European tax wedges to levels comparable to the ones prevailing in the United States would increase the number of total hours worked by about 10 per cent and significantly boost GDP in the long run. Ohanian, Raffo and Rogerson (2008), using the framework of a neoclassical growth model calibrated to the economies of OECD countries in 1956-2004, also find that changes in tax rates explain most of the variability in worked hours across countries and through time.

Reductions in the labour tax wedge financed by higher consumption taxation have recently also been discussed with a focus on international competitiveness, often referred to as fiscal devaluation. Farhi, Gopinath and Itskhoki (2014) provide a formal analysis of fiscal devaluations in a New Keynesian open economy DSGE model. They find that an intended nominal devaluation can be robustly replicated with a small set of fiscal instruments (namely labour income and consumption taxes). However, their contribution also shows that one should not expect too much from the tool of fiscal devaluation for plausible changes in tax rates. For example, a 10% nominal devaluation in Spain would require an increase of VAT taxes of as much as 7.6 percentage points.

[2]This paper spurred a long series of reactions. Alesina, Glaeser and Sacerdote (2006) present a critical evaluation of Prescott's argument. Even though the authors recognise the importance of taxes, they consider other labour market institutions more relevant. Empirically, Nickell, Nunziata and Ochel (2005) discuss this issue for OECD countries.

Gadatsch, Stähler and Weigert (2015) show that Germany's fiscal devaluation 1999 to 2003 (generating a decrease in effective labour taxation by about two percentage points) improved GDP by only about a quarter percentage point. Similarly, Lipinska and von Thadden (2009) show in a two-country DSGE model with a Walrasian labour market without matching frictions that fiscal devaluations generate only small quantitative effects. Engler, Ganelli, Trevala and Voigts (2014) show that, if only employers' social security contributions are decreased (instead of employees' and employers' contributions or labour taxes per se as done in the similar model by Lipinska and von Thadden), expected effects can be somewhat larger, which they attribute to higher competitiveness gains. Stähler and Thomas (2012) and Boscá, Doménech and Ferri (2013) show positive effects of fiscal devaluation in Spain. The positive effect of a fiscal devaluation is also confirmed by Gomes, Jacquinot and Pisani (2016), who include Portugal in their analysis, and CPB (2013), the latter using country-specific general equilibrium models for four euro area countries. Using the multi-country version of the Commission's QUEST model, the European Commission shows that fiscal devaluation mildly affects GDP positively already in the short to medium run, and can indeed significantly increase GDP in the long run (European Commission, 2013). They also compare targeted tax reductions for differently skilled workers and find that cutting labour income tax rates for low-skilled (and, therefore, low-wage earning) workers further augments GDP improvements because these workers are the ones with higher labour supply elasticity. Langot, Patureau and Sopraseuth (2014) also find beneficial effects of fiscal devaluation in a model-based analysis for France. To our knowledge, the existing literature on fiscal devaluation usually focuses on one type of fiscal devaluation, i.e. either a reduction in employee's labour taxation or a reduction in employer's social security contribution. A notable exception to this is Burgert and Roeger (2014) who assess the efficiency of both types of fiscal devaluation using the European Commission's Quest III model. They conclude that the long run effects are identical in both scenarios, only the short term efficiency is higher if employee's labour taxes are reduced.

Distributional effects of fiscal devaluation have, to our knowledge, not gained much attention in the theoretical literature so far. In a micro-simulation study, CPB (2013) and Picos-Sánchez and Thomas (2015) find that fiscal devaluation tends to be regressive. This is confirmed by Burgert and Roeger (2014), especially in a situation in which transfer income recipients are not compensated for the increase consumption taxes. The CPB (2013) qualifies, however, that if the social security cuts are targeted to low income earners, a fiscal devaluation becomes progressive.

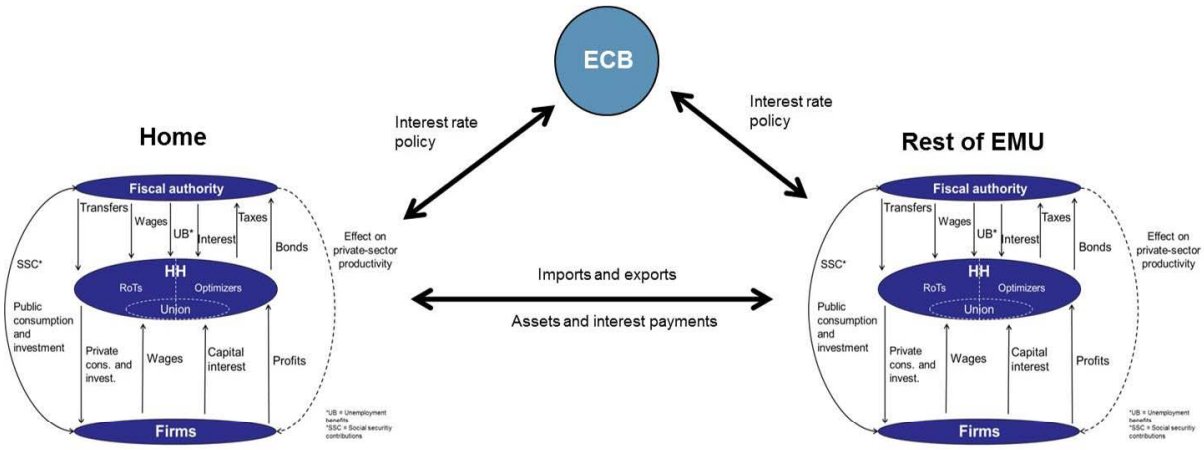
3 The economic environment

In this section, we will first provide a brief overview of the model we use for our analysis. Figure 1 is a graphical representation of the model. A detailed formal description of the model, including the general calibration strategy, the targeted steady state and some important cross-country differences can be found in the appendix.

3.1 The model

The model we use is a significant extension of *FiMod*, which is a dynamic stochastic general equilibrium (DSGE) model suitable for fiscal policy simulations (see Stähler and Thomas, 2012). The extensions come in mainly by introducing hours worked as an intensive margin for firms to adjust to policy changes and by assuming that public employment has a productive role in the economy. Overall, the model is quite a prototypical New Keynesian DSGE model in line with Smets and Wouters (2003, 2007), Christiano, Eichenbaum and Evans (2005), Christoffel, Kuester and Linzert (2009) or Boscá, Doménech and Ferri (2011). It features a two-country monetary union structure in which the home country (Austria, Belgium, Germany or Italy for the purpose of this paper) is member of the monetary union. The foreign country represents the rest of the monetary union. The integration of a labour market with search characteristics, based on Pissarides (2000), allows including involuntary unemployment. Furthermore, the model also contains a comprehensive public sector.

Figure 1: Model overview



More precisely, the model is set up as follows. Infinitely-lived households make optimal choices regarding savings in physical capital as well as national and international financial assets and purchases of consumption and investment goods. The latter add to the private sector capital stock, which is rented out to private firms. Household members may find a job either in the private or public sector or stay unemployed. Once employed, households face a disutility of providing work, which increases in the amount of hours of work provided. Hence, households receive interest and wage payments, unemployment benefits and other fiscal transfers, and they pay taxes. In line with Galí, Lopez-Salido and Valles (2007), the model assumes that a fraction of households does not participate in asset markets. Thus, a household of this type consumes all of its net income each period. These households have become known as "rule-of-thumb" (RoT) households in the literature.

On the firms' side, monopolistic competitors in each region produce a variety of differentiated products and sell these to the domestic and foreign markets. No price discrimination between markets is assumed. Firms use labour and private capital as production

inputs. The public capital stock is productivity-enhancing in the private sector as in Coenen, Straub and Trabandt (2013). An analogous assumption holds for public employment following Fernández-de-Cordoba, Pérez and Torres (2012).[3] Both, the provision of public capital and public employment, is outside the firms' control and decided by the fiscal authority. Cost minimisation determines the amount of private labour and capital input per firm. Because firms enjoy monopolistic power, they are able to set their nominal prices. Wage setting and hours determination is modelled as a Nash game between workers and firms in line with Christoffel, Costain, de Walque, Kuester, Linzert, Millard and Pierrard (2009) and de Walque, Pierrard, Snessens and Wouters (2009). Both price and wage setting are undertaken in a staggered manner as in Calvo (1983).

The model provides a relatively sophisticated public sector with multiple types of public revenue and expenditure. For instance, revenue comes from taxation of private consumption, labour income (paid by both employees and employers, the latter termed social security contributions), investment income and lump-sum taxes. Public expenditure comprises unemployment benefits and other transfers, public consumption and public investment. Public consumption is divided between public purchases and the public sector wage bill. As already mentioned, the public capital stock and public employment have a positive impact on the productivity of private firms. We assume full home bias in government consumption and investment, which can be justified by the fact that there is evidence for a strong home bias in government procurement (see, among others, Trionfetti, 2004, and Brulhart and Trionfetti, 2004). The model thus features a considerable number of feedback channels between fiscal policy, the government budget and the general economic situation. A fiscal policy rule that responds to the debt ratio ensures that, in the long run, the ratio converges towards a target value and a sovereign default is thus ruled out.

The monetary authority sets the nominal reference interest rate. In the Euro Area, it sets a common rate according to a Taylor-type rule that responds to measured Euro-Area-wide inflation and the output gap, which has become a common assumption in monetary DSGE models (see, for example, the New Area-Wide Model (NAWM) used by the European Central Bank; Christoffel, Coenen and Warne, 2008; or Coenen, Straub and Trabandt, 2013).

3.2 Calibration

The model is calibrated to quarterly frequency and, in the current paper, the home country either represents Austria, Belgium, Germany or Italy, respectively. The foreign country is, then, the rest of the European Monetary Union (EMU) excluding the home country. The target values are summarized in Table 1.

[3] Coenen, Straub and Trabandt (2013) model private and public capital as a CES aggregator in which private and public capital stock are imperfect substitutes. In earlier contributions, such as Barro (1990), Baxter and King (1993), Pappa (2009), Leeper, Walker and Yang (2010), or Stähler and Thomas (2012), public capital augments private-sector productivity in a multiplicative way. We believe that assuming private and public capital (and also employment) to be at least partly substitutable is highly justifiable.

Table 1: Cross-country differences in targeting steady-state variables

Targeted variable	**Austria**		**Belgium**		**Germany**		**Italy**	
	Home	RoE	Home	RoE	Home	RoE	Home	RoE
Relative population	0.03	0.97	0.04	0.96	0.27	0.73	0.20	0.80
Relative GDP per capita	1.00	0.84	1.00	0.75	1.00	0.90	1.00	1.09
Imports-to-GDP ratio	0.29	n.a.	0.48	n.a.	0.15	n.a.	0.12	n.a.
Public revenues								
Consumption tax rate	0.23	0.19	0.21	0.19	0.18	0.20	0.18	0.19
Capital tax rate	0.26	0.29	0.32	0.29	0.21	0.32	0.31	0.26
Labour income tax rate	0.36	0.28	0.36	0.28	0.30	0.28	0.31	0.28
SSC rate	0.17	0.22	0.22	0.22	0.17	0.25	0.29	0.21
Public spending								
Gov. purchases-to-GDP ratio	0.09	0.11	0.11	0.12	0.11	0.10	0.09	0.11
Gov. investment-to-GDP ratio	0.01	0.02	0.02	0.02	0.02	0.03	0.02	0.02
Gov. subsidies-to-GDP ratio	0.23	0.16	0.18	0.22	0.18	0.18	0.19	0.18
Public-sector wage bill	0.08	0.08	0.09	0.08	0.06	0.09	0.08	0.08
Debt-to-GDP ratio	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Labour market								
Unemployment rate	0.04	0.09	0.08	0.09	0.08	0.09	0.09	0.09
Public employees/total employment	0.13	0.18	0.18	0.18	0.13	0.20	0.17	0.18
Premium of public over private wages	0.08	0.08	0.00	0.08	0.02	0.09	0.18	0.07
Replacement rate (unemployment benefits)	0.69	0.52	0.64	0.52	0.61	0.52	0.41	0.52
Vacancy filling rate (private)	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Vacancy filling rate (public)	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80

Notes: Sources as described in the main text. Tax rates are implicit tax rates, calculated as tax revenues divided by its base, public spending is in per cent of GDP. The "n.a." for the imports-to-GDP ratio in RoE is due to the fact that this needs to be derived "endogenously" to match a steady-state net foreign asset position of zero together with a steady-state real exchange rate of one, which is governed by setting the home-bias parameter accordingly (see Table 2).

For the general calibration strategy, we broadly rely on Stähler and Thomas (2012). This means that our strategy consists of (i) matching some steady-state variables with their counterparts in the data and (ii) carefully choosing the remaining free parameter values in line with the existing literature. The data we use is based on a large data set ranging from 1999q1 to 2013q4 for the Euro Area containing a rich set of quarterly fiscal variables, described in more detail in Gadatsch, Hauzenberger and Stähler (2016). The primary sources for the various variables are the European System of Accounts (ESA) for the main aggregates and the European Commission for the fiscal variables. Some labour market variables come from OECD data. Hence, in the initial steady state, we match data averages with the corresponding model variables. Furthermore, we normalize home-country per-capita GDP, PPI inflation and the terms of trade to one and set the net foreign asset position to zero. Then, we target home-country import and export shares vis-à-vis the euro area, which is the reason we have to derive the corresponding home bias

parameters endogenously. We also set the foreign-country per-capita GDP relative to the home-country per-capita GDP. A value above one for the foreign country indicates that the home country has a lower than EMU-average per-capita GDP level, while a value below one indicates the opposite. Vacancy filling rates for the Euro Area are estimated in Christoffel, Kuester and Linzert (2009) and assumed to be equal across countries due to the lack of reliable data. We normalise total time available to a household member to one and, hence, assume that, once employed, 1/3 of total time is devoted to work in the initial steady state, which is a standard assumption in the literature. As regards the debt-to-GDP ratio, we assume that, in the initial and the new steady state, countries will have to converge to Maastricht Treaty target, and we set it equal to 60% for all countries.

Table 2: Parametric cross-country differences

Parameter	**Austria**	**Belgium**	**Germany**	**Italy**
Labour market matching efficiency	0.54	0.44	0.44	0.42
Vacancy posting costs	0.08	0.50	0.24	2.00
Bargaining power of workers	0.55	0.34	0.50	0.11
Disutility of work	2.38	2.94	3.06	3.43
Relative preference for domestic goods	0.65	0.37	0.81	0.84
Share of liquidity-constrained consumers	0.46	0.46	0.46	0.50

Notes: This table shows structural differences emerging from targeting the steady-state values indicated in Table 1. The detailed description of the calibration strategy, including the presentation of all remaining parameters, which are assumed to be equal across countries, is relegated to the appendix.

A detailed description of the entire parameter choice is relegated to the appendix. They are standard values from the literature and similar across countries. However, given that the initial steady state of our model is matched with the values indicated in Table 1, some parameters are derived endogenously. These parameters are summarised in Table 2 and highlight structural country-specific differences related to our model calibration. Country differences are mainly driven by different degrees of labour market flexibility, search costs, workers' bargaining power and the degree of home bias in private consumption and investment.

4 Simulation design

In order to assess the macroeconomic effects of reducing the tax wedge, and to make them comparable across countries, we calibrate a reduction in the labour income tax and/or social security contribution rates that yields an increase in the governments' primary deficit-to-GDP ratio by one percentage point *ex ante*, that is, holding constant everything other than changes in the stated instruments. A higher (lower) reduction in the tax/contribution rates would, naturally, imply stronger (weaker) long-run effects. In order to compensate for the *ex ante* revenue losses, we then calibrate an increase in other revenue components (consumption or capital taxes) or a decrease in the expenditure com-

ponents (public purchases, investment or employment) such that, *ex ante*, the budget is balanced. Hence, from an *ex-ante* perspective, we will simulate a tax or tax/expenditure shift in the corresponding economy.

These permanent changes in fiscal instruments will permanently alter the behaviour of agents in general equilibrium and will then have permanent economic effects. For example, a higher consumption tax rate induces households to consume less *ceteris paribus*, while lower labour taxation changes job creation and wage setting. Because of such 'second round effects', macroeconomic aggregates and the government's budget will be affected permanently, implying a permanent change in public revenues and spending – in addition to the changes in the fiscal instruments by themselves. In the end, this would imply a permanent change in the public debt-to-GDP level.

Since we want the debt-to-GDP ratio to eventually converge to 60% again (i.e. we assume that countries have to comply with the Maastricht Treaty criterion in the new steady state as well), we assume that lump-sum taxes levied only to capital-holding households react in order to ensure convergence in the long run (along the transition, the debt-to-GDP ratio may well deviate from target). Although this type of taxes does not exist in practice, its use in the simulation has several advantages. First, changes in the lump-sum tax revenue-to-GDP ratio can be interpreted as fiscal space generated (or reduced) by the reform. Alternatively, it shows to what extent the reform measure is self-financing. Second, lump-sum taxes do not affect agents' optimisation behaviour and, thus, allow assessing the effects of the reform measure in isolation. Using any other fiscal instrument for debt stabilisation purposes would distort the economy, thus making it extremely difficult to disentangle the effects of specific reform measures from those that stabilise debt, especially along the transition path. Finally, the use of any other fiscal instrument to stabilise debt would affect the new long-run steady state *and* the transition. Given the difficulty to predict how fiscal authorities will react in response to the additional (or lower) fiscal space, we believe that being agnostic about the precise debt-stabilising instrument – which will likely be a combination of several instruments – and reporting its effect on the fiscal space is the best choice.

Nevertheless, in order to address this potential criticism, we also conducted simulations in which we use a distortionary fiscal instruments as an *ex-post* (debt) stabilizing tool. That is, we compensate for the revenue losses generated by the reduction in the labour tax wedge by not balancing the budget from an *ex-ante* perspective but balancing it *ex post* taking into account the 'second round effects' of the final steady state. Results indicate that the simulation results presented in the main text do not change qualitatively. In general, however, *ex-post* stabilisation generates more (un)favourable effects whenever the reform yields additional fiscal space (tightening); see also Appendix for details. For all simulations, we assume that the economy is initially in steady state. Each fiscal measure is implemented by changing the corresponding long-run target (parameter) such that the measure is permanent. We then derive the final steady state that arises after the policy change and calculate the transition from the initial to the final steady state under perfect foresight. In this calculation, we assume that no other shocks hit the economy during the transition path, which allows us to attribute all the effects to the policy measure.

5 Simulation results

In this section, we present long-run effects and transition dynamics for each reform measure described above. Results are reported in percentage deviations of key macroeconomic variables from their initial steady-state values (percentage point deviations for rates and ratios). To get a better understanding of the transmission mechanisms, we will show impulse response functions (IRFs) for selected simulations.

5.1 Reducing the tax wedge and different financing schemes

In a first step, we assess the effects of a reduction in the labour tax wedge implemented as a reduction in either the personal income tax (PIT) paid by employees or the social security contributions (SSC) paid by the employers' side, assuming that it is financed by an increase in the consumption tax rate. In a second step we look at the implications of using different instruments to finance the corresponding revenue loss.

5.1.1 Fiscal devaluation: comparing tax and social security rate reductions

Table 3 displays the long-run changes of selected key macroeconomic variables after a fiscal devaluation episode when (i.) reducing the workers' personal labour income tax rate and when (ii.) reducing the firms' social security contribution rate only. In these simulations, it is assumed that the reduction in the labour tax wedge is always financed by an appropriate increase in the consumption tax rate *ex ante*. The transition dynamics of selected key macroeconomic variables are shown in Figure 2 for Germany. They are analogous in the other countries.

Table 3: Permanent effects of fiscal devaluation

Long-run changes in	**Austria**		**Belgium**		**Germany**		**Italy**	
	Δ PIT	Δ SSC	Δ PIT	Δ SSC	Δ PIT	Δ SSC	Δ PIT	Δ SSC
GDP	0.74	0.33	0.77	0.33	0.66	0.31	0.98	0.49
Private consumption	0.58	0.24	0.34	0.10	0.64	0.26	0.85	0.17
... of optimizers	0.71	0.71	0.38	0.58	0.79	0.71	1.12	0.84
... of RoTs	0.35	-0.57	0.28	-0.74	0.39	-0.51	0.43	-0.84
Private investment	0.48	0.22	0.27	0.17	0.55	0.26	0.88	0.47
Unemployment rate	-0.38	-0.51	-0.28	-0.39	-0.38	-0.41	-0.24	-0.30
Per-capita hours (private)	0.58	-0.15	0.82	-0.02	0.39	-0.11	0.94	0.22
Total hours (private sector)	1.03	0.46	1.20	0.50	0.86	0.40	1.27	0.61
Average gross wages	-0.60	1.69	-1.11	1.44	-0.41	1.79	-0.91	1.47
Average net wage income	3.58	1.53	3.53	1.42	3.36	1.68	4.71	1.69
Unit labour costs	-0.37	-0.21	-0.76	-0.47	-0.26	-0.19	-0.72	-0.91

continued on next page

continued from previous page

Long-run changes in	**Austria**		**Belgium**		**Germany**		**Italy**	
	Δ PIT	Δ SSC	Δ PIT	Δ SSC	Δ PIT	Δ SSC	Δ PIT	Δ SSC
Internat. competitiveness	0.87	0.37	0.90	0.30	0.77	0.32	1.02	0.28
PIT rate	-2.30	-0.00	-2.46	0.00	-2.36	-0.00	-3.14	0.00
SSC rate	0.00	-2.30	0.00	-2.46	0.00	-2.36	0.00	-3.14
Consumption tax rate	1.48	1.48	1.60	1.60	1.54	1.54	1.72	1.72
Lump-sum tax-to-GDP ratio	-0.30	-0.71	-0.21	-0.66	-0.29	-0.63	-0.28	-0.59

Notes: Table shows deviations of final relative to initial steady-state values in per cent (percentage points for rates and ratios). GDP is defined as private sector-output plus public sector production at input costs (i.e. the public-sctor gross wage bill). Changes in per-capita hours are in per cent; changes in total hours in the private sector are defined as the number of privately-employed people multiplied by the amount of per-capita hours in that sector, again in per cent. International competitiveness is defined as foreign relative to home PPI. The reduction (increase) in the lump-sum tax-to-GDP ratio can be interpreted as the fiscal space (tightening) generated by the reform.

The following results stand out. On the one side, a reduction in labour taxation (regardless of whether on the employees' or employers' side) permanently reduces unit labour costs and induces firms to reduce prices via the marginal costs channel. Lower prices are beneficial to international competitiveness and foster exports. Lower unit labour increase labour demand through the creation of additional jobs and/or an increase the amount of hours worked in the medium run. In case of the former, unemployment falls. Taken together, this raises aggregate domestic demand for private goods. This, plus higher foreign/export demand increases output, which also fosters the incentive for capital investment. On the other side, the increase in the consumption tax rate dampens domestic private consumption *ceteris paribus* as it makes consumption spending more expensive. The total effect on private consumption depends on whether the personal income tax or the social security contribution rate is reduced because the former reduces net labour income by more than the latter.

When social security contributions are decreased, the increase in aggregate net wage income is not sufficient to compensate for the increase in consumption costs and the consumption of RoT households falls. However, in this case, capital-holding households benefit from higher expected future wealth (due to a permanent rise in output) and from a higher permanent reduction in lump-sum taxes. Under the permanent income hypothesis, capital-holding households frontload some of this and consume more already on impact. When the personal income tax rate is reduced, the increase in net labour income compensates for the higher costs of consumption. As a result the consumption of rule-of-thumb (RoT) households, who spend their entire income each period, increases (see Figure 2). As a result, total private consumption increases more when the personal income tax is reduced.

The different macroeconomic transmission of a reduction in the two types of labour taxes can be explained by the fact that lowering the workers' or the firms' burden affects the economy differently. More precisely, for any given gross wage, a decrease in the

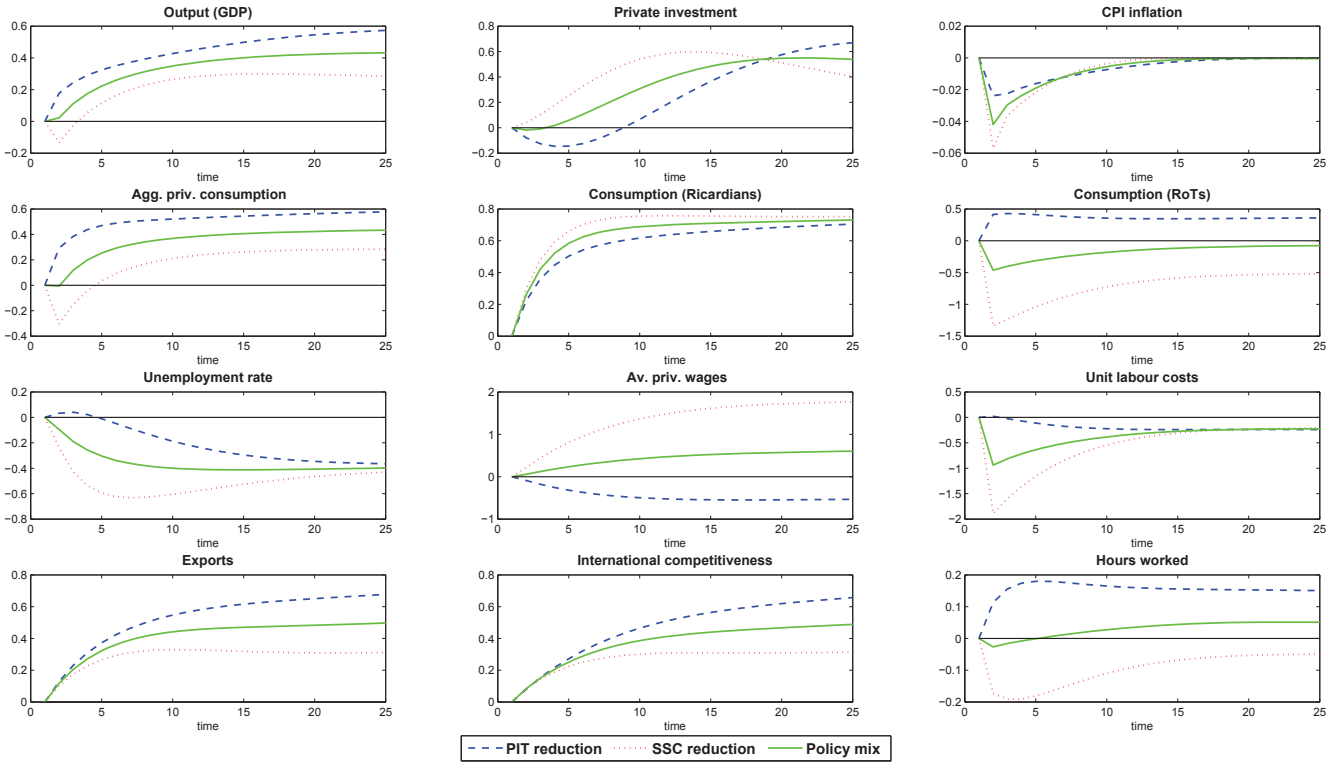
labour income tax rate immediately augments net wage income. Workers are then willing to accept lower gross wages in the bargaining process as, everything else equal, they, in principle, target a certain total net wage income. Thus, private wage claims eventually fall (see dashed blue line in Figure 2 for the transition and Table 3 for the long run), thus reducing unit labour costs and increasing the incentive for firms to create jobs and to augment employment. Even though gross wages fall, households' net wage income increases because the gross wage reduction is overcompensated by the reduction in the labour income tax rate. Therefore the consumption of RoT households, who spend their entire per-period income, increases.

A decrease in the social security contribution rate (see dotted red line in Figure 2 for the transition and Table 3 for the long run), directly affects the unit labour costs of firms without having to take the detour via the wage bargaining channel. Again, the fall in unit labour costs increases the incentive for firms to create jobs and augments employment as well as firms' profits. But this tax reduction does not have a direct impact on consumers' net income. Because higher employment implies higher chances for unemployed workers to find a job, their fall-back position in the wage bargaining game increases. This augments their reservation wage and, hence, net and, therefore, gross wage claims. Still, unit labour costs fall because the wage increase is outperformed by the fall in payroll taxes (unit labour costs are define as the aggregated gross wage payments including social security payments divided by private-sector output). Relative to a decrease in the personal labour income tax rate, the fall in unit labour costs is stronger on impact and for the first four years.[4] The positive GDP effect is relatively weaker because private consumption demand increases by less.

Furthermore, depending on whether the tax wedge on firms' or the workers' is lowered yields differences in how firms adjust employment as an input to production. When the personal income tax rate is reduced, the increase in net labour income of workers incites workers to supply more hours. Moreover, it is less costly for firms to produce additional output by increasing working time of those already employed relative to employing more workers as the latter involves hiring/search costs. On the contrary, when the firms' tax burden is decreased, the increase in net labour income received by workers is lower, as is the (voluntary) supply of additional working hours. As a result, firms prefer to hire more workers instead of increasing working time. Hence, the total amount of hours worked increases more in case of a personal income tax rate reduction, while unemployment falls more in case of a reduction in social security contributions (see Table 3).

[4]In the long run, this is reversed because a reduction in the personal labour income tax rate also increases the supply of hours worked (see next paragraph) which gives workers more leeway to accept a lower gross wage while keeping a high enough total net income.

Figure 2: Transition dynamics (IRFs) for fiscal devaluation in Germany



Summarising, the model simulations show that from an efficiency perspective – in terms of higher output – lowering labour taxes on the employees' side yields larger gains, which also holds from a redistribution perspective as it does not harm liquidity-constrained households' consumption. However, from the perspective of reducing the unemployment rate, a decrease in social security contributions seems more appropriate because, in that case, firms and workers are less inclined to use the intensive margin to increase production. Even though output and consumption increase more in the case of a personal income tax rate reduction, the effects on welfare are not straightforward because, in this case, the disutility of providing more working hours increases. This is discussed in more detail in Section 6.[5]

There is an interesting observation we can make related to the literature discussed in Section 2. A relatively common finding of the literature on fiscal devaluation is that a cut in social security contributions is more beneficial in terms of output, consumption and employment gains relative to a cut in the workers' personal income tax rate. We find the opposite in our model simulations. The reason for this is that, in contrast to most of the existing literature using models with a search labour market, we introduce the intensive margin as an additional tool firms can use to adjust whenever labour market conditions/policies have changed. When we simulate our model by excluding the intensive adjustment margin (i.e. we fix exogenously the amount of hours worked to its initial steady-state level), we also find that a cut in social security contributions is more beneficial (see Table 4).

Table 4: Permanent effects of fiscal devaluation with exogenously fixed hours worked

Long-run changes in	**Austria**		**Belgium**		**Germany**		**Italy**	
	Δ PIT	Δ SSC	Δ PIT	Δ SSC	Δ PIT	Δ SSC	Δ PIT	Δ SSC
GDP	0.30	0.45	0.27	0.35	0.34	0.41	0.20	0.31
Private consumption	0.23	0.34	0.09	0.11	0.31	0.37	-0.01	-0.03
... of optimizers	0.21	0.85	0.01	0.61	0.32	0.87	-0.17	0.55
... of RoTs	0.26	-0.54	0.22	-0.74	0.29	-0.47	0.22	-0.89
Private investment	0.20	0.30	0.14	0.18	0.29	0.35	0.21	0.32
Unemployment rate	-0.35	-0.52	-0.30	-0.39	-0.35	-0.42	-0.18	-0.29
Per-capita hours (private)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total hours (private sector)	0.42	0.62	0.39	0.52	0.43	0.53	0.24	0.38

continued on next page

[5]Although it is largely a political economy issue which instrument to use in order to reduce the labour tax wedge, which cannot be captured in the model at hand, we also simulate – for completeness – a fiscal devaluation by reducing both labour income taxes and social security contributions at the same time (assuming that each instrument is reduced by an amount in order to, again, generate a reduction in the primary deficit-to-GDP ratio by one percentage point). Most of the tax wedge reductions in the past have been a combination of reducing workers' and firms' contribution rates at the same time. The results are presented by the solid green line in Figure 2. As we see, the impact of this policy mix is a weighted average of both previous simulations. Therefore, long-run results can also be calculated as a weighted average of the results presented in Table 3.

continued from previous page

Long-run changes in	**Austria**		**Belgium**		**Germany**		**Italy**	
	Δ PIT	Δ SSC	Δ PIT	Δ SSC	Δ PIT	Δ SSC	Δ PIT	Δ SSC
Average gross wages	-0.27	1.60	-0.46	1.43	-0.25	1.75	-0.59	1.55
Average net wage income	3.33	1.60	3.36	1.43	3.13	1.75	4.07	1.55
Unit labour costs	-0.17	-0.26	-0.36	-0.48	-0.17	-0.21	-0.56	-0.87
Internat. competitiveness	0.34	0.50	0.24	0.31	0.34	0.42	0.03	0.05
PIT rate	-2.30	-0.00	-2.46	0.00	-2.36	0.00	-3.14	0.00
SSC rate	0.00	-2.30	0.00	-2.46	0.00	-2.36	0.00	-3.14
Consumption tax rate	1.48	1.48	1.60	1.60	1.54	1.54	1.72	1.72
Lump-sum tax-to-GDP ratio	-0.15	-0.75	-0.08	-0.66	-0.17	-0.67	0.02	-0.52

Notes: Table shows deviations of final relative to initial steady-state values in per cent (percentage points for rates and ratios). GDP is defined as private sector-output plus public sector production at input costs (i.e. the public-sctor gross wage bill). Changes in per-capita hours are in per cent; changes in total hours in the private sector are defined as the number of privately-employed people multiplied by the amount of per-capita hours in that sector, again in per cent. International competitiveness is defined as foreign relative to home PPI. The reduction (increase) in the lump-sum tax-to-GDP ratio can be interpreted as the fiscal space (tightening) generated by the reform.

Why is this? When comparing the results of Table 3 (simulation with the hours margin) to those of Table 4 (simulation without the hours margin), we see that, in terms of the shock to fiscal policy variables, we simulate exactly the same scenario. We also see that, overall, the effects of a fiscal devaluation when the firms' social security contribution rate is lowered are basically the same across the two setups. However, when a fiscal devaluation is implemented by reducing the workers' tax burden, differences across the two setups are notable: output and consumption gains after cutting the workers' personal income tax rate are now less than half as large as they were in the case with varying hours. The cut in the personal income tax rate still induces workers to accept lower wages. But, because the increase in net wages cannot incite workers to supply more hours (when hours are fixed), firms have to increase production by employing more workers. The increase in effective labour input, expressed by total hours in Tables 3 and 4, is now only half as large as it is with varying hours, as it is soley driven by higher job creation, which is costly. Higher labour demand, by increasing the re-employment chances of unemployed workers, also increases the workers' fall-back position in the bargaining process thus leading to an increase in gross wages (without the beneficial side-effect of having employed workers work more). This increases gross wages *ceteris paribus* and explains why the reduction in gross wages is lower when hours worked are fixed. Because of the fixed amount of hours, the rise in net wage income per employed worker is also lower than in the case of flexible hours. Hence, the positive impact on consumption – especially of RoT consumers – is diminished when fixing hours worked, which explains why the output effect is weaker. Furthermore, because more people are hired, the increase in search costs is higher relative to the simulation with varying hours, which further contributes to

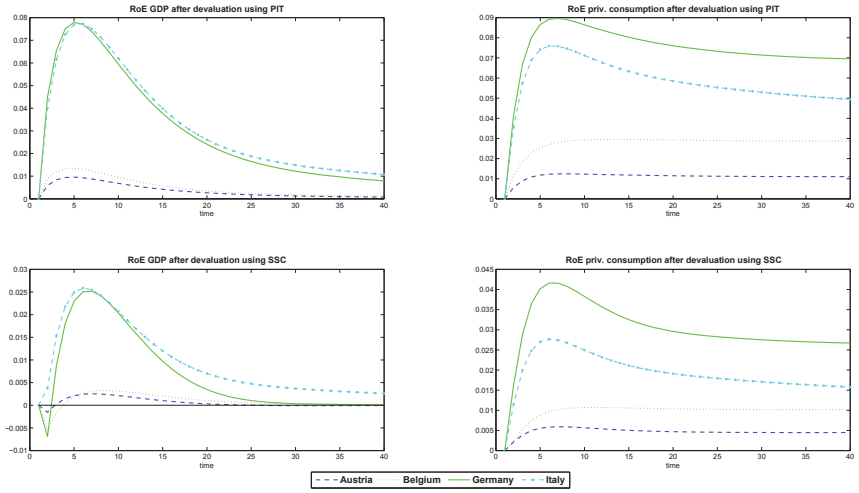
the reduction in optimizers' consumption due to the fact that this decreases firms' profits. Hence, by fixing hours worked in our model, the demand-driven increase in output after a fiscal devaluation implemented via a cut in the workers' personal labour income tax rate is diminished. We provide a detailed formal explanation of this issue in the Appendix. Of course, whether or not the amount of hours worked can change is a modelling choice. Given the institutional labour market framework in most European economies, in which unions bargain over wages and hours (plus other working conditions), assuming that hours worked do change – at least in the long run – is plausible. An increase in working hours by about one per cent (which, in our simulations, is the maximum increase in hours and the case for Italy, see Table 3) translates into an increase of weekly working time by a bit less than half an hour (assuming a 40hours week), which seems reasonable.

We now turn to addressing the role of country-specific differences. There are several interesting observations we can make. Mainly three distinct elements can influence the effectiveness of fiscal policies in improving output and the performance of labour markets. First, for countries characterised by a relatively high degree of workers' bargaining power, such as Austria and Germany, any reduction in unit labour costs is relatively lower. This is due to the fact that, when the bargaining power is high, an increase in firms' profits yields a relatively higher increase (or lower reduction) in wage claims because the bargaining power determines the fraction workers obtain from these profits. Taken only the differences in the bargaining power, benefits from fiscal devaluation should therefore be lower in countries characterised by a high degree of workers' bargaining power *ceteris paribus*.

Second, in countries with a relatively rigid labour market in terms of low matching efficiency and/or high vacancy positing costs, such as Belgium and especially Italy, the incentive to create additional jobs after a fiscal devaluation are lower because search costs increase relatively more. Taking only this argument by itself, fiscal devaluation should be more effective in countries characterised by more efficient labour markets. Overall, our simulations suggest however that the wage bargaining channel dominates the labour market efficiency channel, such that Belgium and Italy gain more, especially when reducing personal labour income tax rates.

Third, countries with a higher share of liquidity-constrained consumers, such as Italy, tend to benefit more from reforms that increase average net labour income because these households spend their income each period. Hence, the consumption demand-driven boom will be fostered by a higher share of rule-of-thumb households. Finally, spillovers to the rest of the euro area are positive but small (see Figure 3), which is in line with existing literature. Part of the increase in domestic consumption and investment as a result of fiscal devaluation translates into higher demand for foreign goods. This increases output and consumption and improves labour market developments in the rest of the Euro Area (RoE), too. A second channel is the monetary policy channel. The decrease in domestic producer prices eventually yields a decrease in consumer price inflation, inducing monetary policy to temporarily decrease interest rates, which fosters investment and output for the remaining member countries, too. These effects, however, significantly depend on country size. For small countries, such as Austria and Belgium, the effect on the remaining member states is negligible small.

Figure 3: Spillovers of fiscal devaluation to RoE



5.1.2 Alternative fiscal instruments to finance labour tax reductions

We now look at the macroeconomic effects of a decrease in the labour tax wedge when this is financed by alternatively reducing public consumption (i.e. a reduction in government purchases, C^g, and public employment, N^g), public investment, I^g, and increasing the capital tax rate, τ^k. The reduction in the workers' personal income tax rate is taken as the benchmark.

Figure 4 compares a reduction in public purchases and a reduction in public employment to finance the decrease in the tax wedge to a fiscal devaluation in Germany. Financing a tax wedge reduction via lower government purchases has negative short-run effects on GDP, as it reduces aggregate demand. However, no adverse effects for consumption of liquidity-constrained households materialise as they benefit from lower labour taxes. In particular, private consumption of both capital-holding and RoTs increases as lower labour taxes translate immediately into a higher net wage income and the dampening effect of higher consumption taxes is absent. The improvement in international competitiveness, via lower unit labour costs, increases private consumption and exports. But this is not sufficient to compensate for the loss in public consumption and GDP declines initially. The latter is reversed when the labour market improvements resulting from lower labour taxes start to materialise. In the medium-term private employment and wages start to increase on the back of higher domestic consumption and exports. This is a result of eventually higher re-employment chances and, therefore, increased fall-back utility of (unemployed) workers. Nonetheless, higher private consumption in the long-run only slightly compensates the one percentage point loss in public consumption which, in contrast to private consumption, is assumed to entail a full home bias (see Table 5). Hence, the private demand-driven GDP increase is dampened, which also implies lower effects on overall employment (level and hours worked) in the long run. The GDP-dampening effect of lower public purchases is smaller in countries with a relatively high home-bias in private consumption and investment and a relatively low bargaining power of workers (e.g. Italy). Hence, those countries gain more when financing the reduction in the labour tax wedge by lower public purchases.

Figure 4: Transition dynamics (IRFs) for alternative financing schemes in Germany

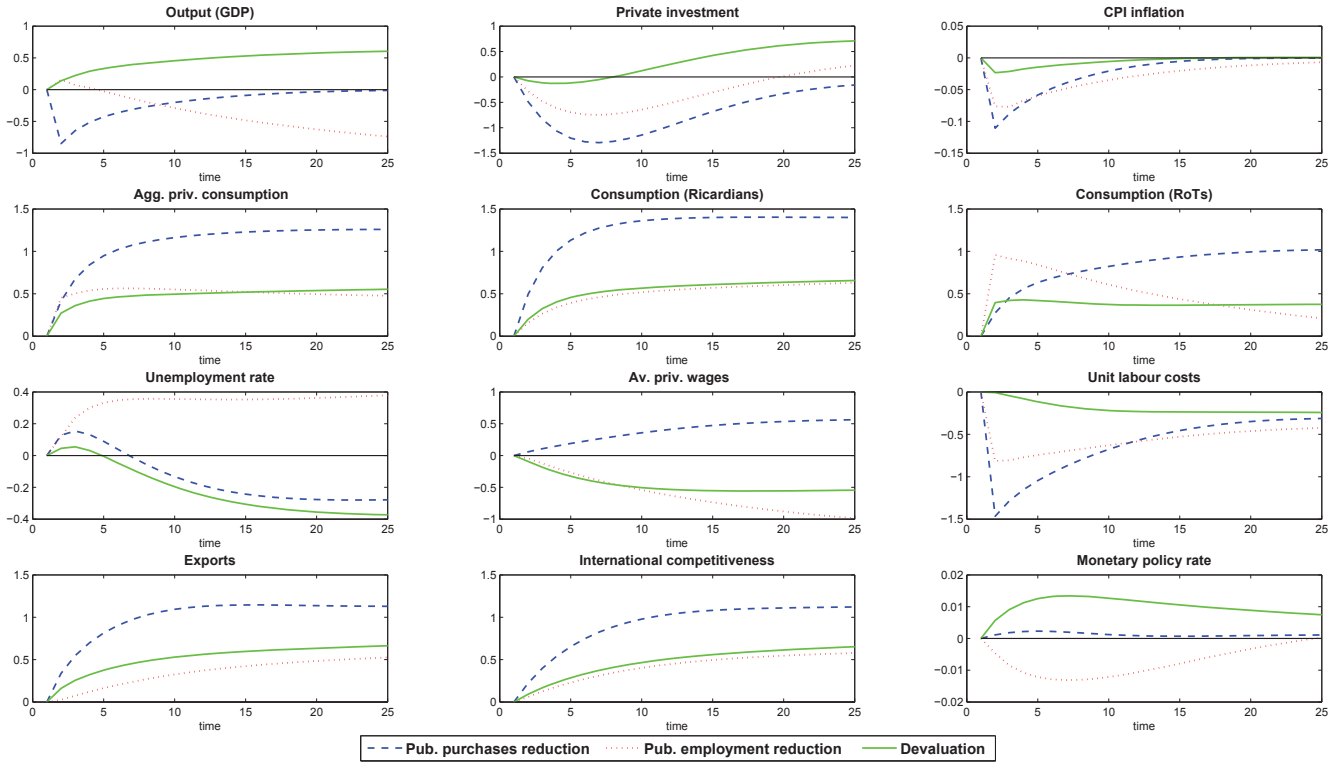


Table 5: Permanent effects of financing PIT reduction with public purchases and employment

Long-run changes in	**Austria**		**Belgium**		**Germany**		**Italy**	
	ΔC^g	ΔN^g	ΔC^g	ΔN^g	ΔC^g	ΔN^g	ΔC^g	ΔN^g
GDP	0.25	-0.87	0.25	-0.75	0.18	-0.94	0.45	-0.24
Private-sector output	0.27	0.98	0.27	1.19	0.20	0.73	0.49	1.74
Private consumption	1.24	0.73	0.87	0.58	1.45	0.70	1.80	1.25
... of optimizers	1.17	1.04	0.60	0.73	1.44	0.94	1.86	2.03
... of RoTs	1.34	0.19	1.33	0.31	1.48	0.30	1.72	0.07
Private investment	-0.25	0.58	-0.70	0.29	-0.07	0.56	0.19	1.45
Unemployment rate	-0.20	0.20	-0.07	0.83	-0.25	0.48	-0.15	0.33
Private employment	0.20	2.90	0.07	2.58	0.25	2.47	0.15	3.24
Per-capita hours	0.30	-0.54	0.67	-0.33	0.03	-0.42	0.49	-0.57
Total hours (private sector)	0.55	2.94	0.76	3.07	0.34	2.65	0.68	3.65
Average gross wages	-0.84	-2.49	-1.57	-2.78	-0.50	-2.26	-0.91	-3.48
Average net wage income	3.05	0.48	2.89	0.61	2.90	0.62	4.24	0.47
Unit labour costs	-0.57	-0.60	-1.09	-0.98	-0.36	-0.39	-0.72	-1.66
Internat. competitiveness	1.52	1.09	1.59	1.42	1.44	0.83	1.79	1.55
PIT rate	-2.30	-2.30	-2.46	-2.46	-2.36	-2.36	-3.14	-3.14
Public purchases	-10.83	0.00	-9.09	0.00	-8.93	0.00	-10.99	0.00
Public employment rate	0.00	-3.09	-0.00	-3.41	-0.00	-2.95	-0.00	-3.56
Lump-sum tax-to-GDP ratio	-0.23	-0.19	-0.10	-0.09	-0.24	-0.02	-0.24	-0.16

Notes: Table shows deviations of final relative to initial steady-state values in per cent (percentage points for rates and ratios). GDP is defined as private sector-output plus public sector production at input costs (i.e. the public-sctor gross wage bill). Changes in per-capita hours are in per cent; changes in total hours in the private sector are defined as the number of privately-employed people multiplied by the amount of per-capita hours in that sector, again in per cent. International competitiveness is defined as foreign relative to home PPI. The reduction (increase) in the lump-sum tax-to-GDP ratio can be interpreted as the fiscal space (tightening) generated by the reform.

As regards a decrease in public employment to finance the reduction in the labour tax wedge, we note that there are two opposing effects at work (dotted red line in Figure 4). On the one hand, there is a 'wage channel' which improves aggregate private output. A decrease in public employment diminishes the probability of finding a job in the public sector, thereby decreasing the workers' fall-back utility. Hence, workers will accept lower wages in the private sector beyond what the reduction in the personal income tax rate would entail. This eventually improves unit labour costs, fosters private employment and international competitiveness. Note that, in this simulation, the unemployment rate increases even though private employment increases significantly. This is due to the fact that the private sector does not fully absorb the employment reductions in the public sector. On the other hand, there is a 'productivity channel' which lowers aggregate output.

As public employees are assumed to positively contribute to private-sector productivity, a reduction in public employment dampens private-sector production capacities. Which of the two effects dominates depends on the relative size of these effects. The wage channel is larger the more workers rely on their fall-back utility in the bargaining game. This is the case if the workers' bargaining power vis-à-vis the firms is low. In such a situation, wages fall relatively more after a cut in public employment such that private-sector wage reductions can dominate productivity losses and further improve private-sector output. But it may have negative distributional consequences in terms of optimisers' and RoTs' consumption behaviour (the latter increasing much less) because it shifts income from wages to firms' profits, the latter belonging to optimisers only. As we can see from inspecting the effects on long-run private-sector output, the wage channel is strongest in Italy, characterised by low bargaining power, where private-sector outcome increases most, while the productivity channel is strongest in Germany (see Table 5). In our simulations, the wage channel always dominates and private-sector outcome increases. Still, we observe a fall in GDP. This is due to the fact that we have defined GDP as the sum of private-sector output and public production evaluated at input costs in line with national accounting (see Stähler and Thomas, 2012, for a more detailed discussion). As public employment is reduced significantly, this reduces public production and thus GDP.[6]

In Table 6 we further see how measures that have not yet been discussed fit in the comparison. It is evident that financing the labour tax wedge reduction by increases in the capital tax rate or the reduction in public investments has clear negative effects. An increase in the capital tax rate reduces gains from capital investment, which induces Ricardian households to invest less. This, in turn, eventually reduces the private-sector capital stock and private-sector productivity. Hence, it increases marginal production costs. As a result, production decreases and the initial improvements in unit labour costs as well as international competitiveness are eaten up by the weaker capital investment incentives in the long run. A decrease in public investment is even less favourable as, in the medium to long-run, it reduces the public sector capital stock which, in turn, reduces private-sector productivity and, hence, the production capacity. Therefore, output, consumption, investment and trade fall significantly. The increase in total hours worked can be attributed to the fact that production becomes more labour intensive. However, this does not mean that more jobs are created but that existing workers are forced to work more, which, in the case of a reduction in public investment, they will accept due to the high losses in private consumption.

As regards the decrease in public investment, we should however note that, given the public investment-to-GDP ratio ranging between a bit more than one and three per cent in the initial steady state (see Table 1), an *ex-ante* decrease in public investment expenditure generating an one-percentage point drop in the primary deficit-to-GDP ratio

[6]Note furthermore that, in addition to what has just been explained, how the wage and the productivity channels are related is strongly affected by the 'efficiency' of the public sector. If the public sector is deemed to be inefficient, this clearly goes in favour of the wage channel. For the simulations at hand, we assumed an equally productive public sector in all countries for simplicity and because it is extremely difficult to realistically parameterise public-sector efficiency. However, if one believes that the public sector is less efficient in one country than in others, this will strengthen the wage channel in that economy further and, therefore, make this measure relatively more attractive. If private output can be boosted sufficiently, this may even overturn the negative GDP effect.

as described in Section 4, generates a drop in investment up to more than 80% (see Table 6). This does not seem to be too realistic and, therefore, this exercise is only shown for completeness. It nevertheless shows that using a reduction in public investment as a financing instrument does have significant drawbacks.

Table 6: Permanent effects of financing PIT reduction with public investment and capital taxes

Long-run changes in	**Austria**		**Belgium**		**Germany**		**Italy**	
	ΔI^g	$\Delta\tau^k$	ΔI^g	$\Delta\tau^k$	ΔI^g	$\Delta\tau^k$	ΔI^g	$\Delta\tau^k$
GDP	-7.10	-1.80	-2.86	-1.93	-3.48	-1.65	-1.78	-1.81
Private consumption	-3.99	0.12	-0.33	0.80	-1.90	-0.17	-0.40	-0.03
... of optimizers	-6.30	-0.44	-1.15	0.47	-3.26	-0.87	-1.29	-0.94
... of RoTs	-0.02	1.08	1.09	1.38	0.44	1.04	0.94	1.32
Private investment	-8.78	-8.71	-3.36	-8.83	-5.01	-8.30	-2.85	-9.57
Unemployment rate	1.24	0.05	0.17	-0.11	0.49	0.06	0.17	0.15
Per-capita hours	4.56	1.23	1.67	0.82	2.61	1.34	1.65	1.84
Total hours (private sector)	3.00	1.16	1.44	0.96	1.98	1.26	1.42	1.64
Average gross wages	-7.80	-2.32	-3.08	-1.60	-5.00	-2.64	-3.17	-3.18
Average net wage income	-0.12	2.45	2.32	3.01	0.78	2.00	2.09	3.22
Unit labour costs	2.84	0.78	1.51	1.50	0.63	0.36	0.14	0.37
Internat. competitiveness	-7.37	-2.19	-2.35	-2.52	-3.04	-2.06	-0.97	-2.26
PIT rate	-2.30	-2.30	-2.46	-2.46	-2.36	-2.36	-2.50	-3.14
Capital tax rate	0.00	15.98	0.00	15.36	0.00	16.49	0.00	15.16
Public investment	-83.33	0.00	-58.82	0.00	-62.50	0.00	-45.45	0.00
Lump-sum tax-to-GDP ratio	2.57	-0.10	0.74	-0.27	1.22	0.05	0.53	-0.05

Notes: Table shows deviations of final relative to initial steady-state values in per cent (percentage points for rates and ratios). GDP is defined as private sector-output plus public sector production at input costs (i.e. the public-sctor gross wage bill). Changes in per-capita hours are in per cent; changes in total hours in the private sector are defined as the number of privately-employed people multiplied by the amount of per-capita hours in that sector, again in per cent. International competitiveness is defined as foreign relative to home PPI. The reduction (increase) in the lump-sum tax-to-GDP ratio can be interpreted as the fiscal space (tightening) generated by the reform.

As regards the simulation using capital taxes as the financing instrument, it should also be borne in mind that our model with the standard DSGE assumption of infinitely-lived households tends to resemble the view on capital taxation based on the models presented by Judd (1985) and Chamley (1986). There, the tax burden on capital income compounds prohibitively and capital accumulation as well as aggregate output are significantly reduced by taxes on capital. The issue is discussed in detail in Kempkes and Stähler (2016). Therefore, the very unfavourable outcome for financing the reduction in the labour tax wedge by increasing capital taxation may be due to our model setup, at

least partly. Still, in order to finance the reduction in the labour tax wedge, the required increase in the capital tax rate amounts to about 16 percentage points for all countries. It does not seem implausible that an increase of such size would significantly affect economic activity.

6 A welfare perspective

We are now interested in how to evaluate these reforms in terms of the well-being of the inhabitants of the reforming country. The advantage of having a theoretical model like ours is that we are able to calculate (household type-specific) welfare to address this issue. In doing so, we compute the life-time consumption-equivalent gain of each type of household in line with Lucas (2003) as a result of the change in fiscal policy. Results are presented in Table 7. We first show the welfare difference between the initial and the final steady state and, in a second step, the welfare effects including the transition thereto. The numbers presented in the tables can be interpreted as how much of initial steady-state consumption (in per cent) a household would be willing to give up in order to be indifferent between living in the original or in the alternative regime (after the reform). Positive values therefore imply a welfare gain, while negative values signal a welfare loss.

Table 7 shows that fiscally devaluating via a reduction in the firms' social security contributions always hurts liquidity-constrained consumers. The reason for this is that the gain in net labour income cannot overcompensate for the policy-induced increase in consumption costs. Welfare decreases because despite of lower per-capita input of working hours, the loss in consumption utility is too strong to be compensated for. Unless the gains in firms' profits are strong enough to boost optimisers' consumption sufficiently much, this measure is thus welfare detrimental or neutral. Once taking into account the transition path, welfare of liquidity-constrained households always decreases because of the strong initial drop in their consumption on impact. On the contrary, fiscal devaluation by means of a reduction in the workers' personal income tax rate affects welfare positively because, in this case, the negative effect on RoTs' consumption vanishes. Again, when taking into account the transition path, welfare gains are somewhat lower because it takes time to reach the final steady-state values.

Moreover Table 7 also reveals that, in terms of welfare gains, financing a reduction in the labour tax wedge via a cut in public purchases is superior to a fiscal devaluation, even though the former measure generates significantly lower output gains (see previous section). The main reason for this is that, while having similar labour market effects, reductions in public purchases do not increase consumption costs. Therefore, the increase in consumption of optimising and liquidity-constrained consumers is much stronger, translating into higher welfare gains. This also holds when taking into account the transition to the new steady state, again at somewhat lower gains because it takes time to reach the new steady state. A similar argument holds for using a public employment reduction as the financing instrument because, as we have seen in the previous section, this boost private-sector employment and the increase in aggregate net wage income significantly.

Table 7: Welfare gains/losses in Home

Simulation	**Austria**			**Belgium**			**Germany**			**Italy**		
	ce^o	ce^r	ce^{tot}	ce^o	ce^r	ce^{tot}	ce^o	ce^r	ce^{tot}	ce^o	ce^r	ce^{tot}
in steady state												
Devaluation (PIT)	0.66	0.31	0.50	0.31	0.23	0.27	0.74	0.36	0.56	1.03	0.37	0.70
Devaluation (SSC)	0.70	-0.58	0.11	0.57	-0.75	-0.04	0.70	-0.51	0.14	0.81	-0.86	-0.02
PIT and public purchases cuts	1.14	1.32	1.23	0.55	1.30	0.89	1.42	1.47	1.44	1.81	1.69	1.75
PIT and public employment cuts	0.96	0.22	0.62	0.63	0.36	0.50	0.84	0.34	0.61	1.90	0.12	1.01
including transition												
Devaluation (PIT)	0.58	0.30	0.46	0.28	0.23	0.25	0.66	0.35	0.52	0.91	0.36	0.64
Devaluation (SSC)	0.69	-0.61	0.09	0.56	-0.77	-0.05	0.68	-0.55	0.12	0.76	-0.88	-0.06
PIT and public purchases cuts	1.08	1.29	1.18	0.56	1.28	0.89	1.36	1.43	1.39	1.70	1.66	1.68
PIT and public employment cuts	0.81	0.36	0.60	0.47	0.50	0.48	0.67	0.49	0.59	1.54	0.17	0.85

Notes: Table presents steady-state welfare gains/losses after the reform measures simulated in Section 5 in terms of how much of initial steady-state consumption (in per cent) a household of type $i = o, r$ would be willing to give up in order to be indifferent between living in the original or in the alternative regime (first section "*in steady state*"). We, then, calculate the welfare gains/losses including the transition paths (first section "*including transition*"). Total economy-wide welfare gains/losses are define as $ce^{tot} = (1-\mu)ce^o + \mu^r$, where μ is the share or rule-of-thumb consumers.

Table 8: Welfare gains/losses in rest of the euro area

Simulation	**Austria**			**Belgium**			**Germany**			**Italy**		
	ce^o	ce^r	ce^{tot}	ce^o	ce^r	ce^{tot}	ce^o	ce^r	ce^{tot}	ce^o	ce^r	ce^{tot}
in steady state												
Devaluation (PIT)	-0.04	-0.03	-0.03	-0.03	-0.04	-0.03	0.06	-0.00	0.03	-0.03	-0.05	-0.04
Devaluation (SSC)	0.02	0.01	0.02	0.02	0.01	0.01	0.05	0.02	0.03	-0.01	-0.01	-0.01
PIT and public purchases cuts	0.00	-0.01	-0.01	0.01	-0.02	-0.00	0.18	0.03	0.11	0.05	-0.01	0.02
PIT and public employment cuts	0.07	0.04	0.05	0.09	0.04	0.07	0.14	0.05	0.10	0.13	0.06	0.10
including transition												
Devaluation (PIT)	-0.04	-0.03	-0.04	-0.03	-0.03	-0.03	0.06	-0.00	0.03	-0.03	-0.04	-0.04
Devaluation (SSC)	0.02	0.01	0.02	0.02	0.01	0.01	0.05	0.02	0.04	-0.01	-0.01	-0.01
PIT and public purchases cuts	-0.00	-0.01	-0.01	0.02	-0.01	0.00	0.18	0.05	0.12	0.06	0.01	0.04
PIT and public employment cuts	0.05	0.02	0.04	0.06	0.02	0.04	0.10	0.02	0.07	0.07	0.01	0.04

Notes: Table presents steady-state welfare gains/losses after the reform measures simulated in Section 5 in terms of how much of initial steady-state consumption (in per cent) a household of type $i = o, r$ would be willing to give up in order to be indifferent between living in the original or in the alternative regime (first section "*in steady state*"). We, then, calculate the welfare gains/losses including the transition paths (first section "*including transition*"). Total economy-wide welfare gains/losses are define as $ce^{tot} = (1-\mu)ce^o + \mu^r$, where μ is the share or rule-of-thumb consumers.

While we have seen in Section 5 that there are no negative spillovers to the rest of the euro area in terms of output and/or consumption losses, it may still be interesting to assess how welfare in the rest of the euro area is affected if one country in the union reduces its labour tax wedge in a budget neutral way. Table 8 summarises the welfare effects in the rest of the euro area. Given the spillovers generated by the tax wedge reduction in the home country, discussed in Section 5.1.1, there are two opposing welfare effects for the rest of the euro area. On the one hand, higher private demand for foreign goods in the home country increases labour and capital income income in the rest of the euro area, ultimately implying higher consumption and, thus, higher welfare there, too. On the other hand, higher output is also produced by augmented labour input, decreasing welfare correspondingly. If the increase in income and, thus, consumption is sufficiently strong to overcompensate for the increase in the disutility of work, households in the rest of the euro area gain. This is the case if spillovers are sufficiently large, which holds more for large countries characterised by a relatively large import share and measures strongly fostering private demand (such as financing the labour tax wedge reduction by public expenditure cuts). Hence, a tax wedge reduction in one country can entail "beggar-thy-neighbour" effects. However, if present, they are small.

7 Conclusions

Budget-neutral tax wedge reductions are one of the policy priorities in many EMU member states. By means of a New Keynesian DSGE model of a monetary union with a complex labour market structure and a comprehensive public sector, this paper assesses the macroeconomic and welfare implications of reductions in firms' and workers' labour tax rates financed by different fiscal policy measures. Overall, the paper shows that a reduction in the tax wedge is beneficial in terms of both welfare and output gains, as long as the financing measure does not harm private-sector productivity and/or the incentive for private capital investments over-proportionately. Opposite to the existing literature, the paper shows that, when firms' can vary the intensive margin of labour demand to adjust to policy changes, a reduction in the workers' and not the firms' burden is most beneficial.

Appendix

In this appendix, we will first describe the model in formal detail and, then, come to the detailed parameter calibration. Furthermore, we will show the results of assuming *ex-post* stabilisation using the corresponding financing instrument as discussed in Section 4.

A.1 The model

The model we use for our analysis is an extension of *FiMod* (Stähler and Thomas, 2012), which is a two-country monetary union DSGE model with frictional labour markets and a fiscal block that includes a wide range of taxes and disaggregation of government spending. The extensions come in mainly by modifying the production technology such that

public capital and employment can be, at least partly, substituted for by private capital and employment, respectively. Furthermore, we also give firms an intensive margin to adjust for variations in demand (output) by introducing endogenous working time (hours worked). Households, firms, policymakers and the external sector interact each period by trading final goods, financial assets and production factors. We will start by describing the household and the firm sector, focus on the labour market, and then describe policy authorities as well as market clearing.

For what follows, we normalize population size of the entire monetary union to unity, of which $\omega \in (0,1)$ live in Home (Austria, Belgium, Germany or Italy, respectively), while the remaining $(1-\omega)$ live in the rest of EMU. Throughout the formal model description, quantity variables will be expressed in per capita terms, unless otherwise indicated. Both regions are modeled analogously, while we allow structural parameters to differ. Hence, we restrict ourselves to explaining the home country in detail only. If the explicit description of the foreign country is necessary, we use asterisks to denote decisions made by the corresponding foreign agents as well as the structural parameters.

A.1.1 Households

As in Galí et al. (2007), each country is populated by a share $(1-\mu)$ of Ricardian households who have access to capital markets and, therefore, substitute consumption intertemporally (optimizers). The remaining share $\mu \in [0,1)$ is considered to be liquidity-constrained in the sense that they consume all their labour income in each period ("*rule-of-thumb*", RoT household). The welfare function of each type of representative household at time $t=0$ is given by

$$\mathcal{W}_0^i = E_0 \left\{ \sum_{t=0}^{\infty} \beta^t \cdot \underbrace{\left(\frac{\left(c_t^i - hab \cdot c_{t-1}^i\right)^{1-\sigma_c}}{1-\sigma_c} - \kappa^h \cdot \left(n_t^{i,p} \cdot \frac{{l_t^{i,p}}^{1+\sigma_h}}{1+\sigma_h} + n_t^{i,g} \cdot \frac{{l_t^{i,g}}^{1+\sigma_h}}{1+\sigma_h} \right) \right)}_{=U(c^i, l^{i,p}, l^{i,g})} \right\}, \tag{A.1}$$

where E_t is the expectations operator conditional on time-t information, c_t^i denotes household consumption of final goods, and the superscripts $i = o, r$ denote optimizing and RoT households, respectively. h denotes the degree of habit formation in consumption.

Inside each household, its members may be employed in the public sector (denoted by $n_t^{g,i}$), in the private sector (denoted by $n_t^{p,i}$) or be unemployed (denoted by u_t^i). Households face disutility of providing hours worked, $l_t^{i,p}$ or $l_t^{i,g}$, once employed in one of the two sectors. Disutility increases in the amount of hours worked, where κ^h is a scaling parameter and σ_h a shape parameter of the disutility function. As becomes clear below, we will assume full consumption insurance within each household as in Andolfatto (1996) or Merz (1995).

Households in both countries trade consumption and investment goods as well as international nominal bonds. The consumption and investment baskets, c_t^i and I_t^o, respectively, of a household of type i (only type o for investment) in the home country are given by

$$x_t^i = \left(\frac{x_{At}^i}{\vartheta} \right)^{\vartheta} \left(\frac{x_{Bt}^i}{1-\vartheta} \right)^{1-\vartheta},$$

with $x_t^i = \{c_t^i, I_t^o\}$, where c_{At}^i, I_{At}^o and c_{Bt}^i, I_{Bt}^o represent consumption/investment demand of goods produced in Home (country A) and the rest of EMU (region B), respectively, and $\vartheta = \omega + \psi$, where ψ is a parameter capturing the degree of home bias in consumption. Note that $\vartheta^* = \omega - \psi^*$. From now onwards, let $p_{Bt} \equiv P_{Bt}/P_{At}$ denote the *terms of trade*, where P_{At} and P_{Bt} are the *producer price indexes* (PPI) in countries A and B, respectively. Cost minimization by the household then implies $x_{At}^i/x_{Bt}^i = (\vartheta)/(1-\vartheta) \cdot p_{Bt}$. Nominal expenditure in consumption and investment goods equal $P_{At}c_{At}^i + P_{Bt}c_{Bt}^i = P_t c_t^i$ and $P_{At}I_{At}^o + P_{Bt}I_{Bt}^o = P_t I_t^o$, respectively, where $P_t = (P_{At})^{\vartheta}(P_{Bt})^{1-\vartheta}$ is the corresponding *consumer price index* (CPI). Notice that $P_t = P_{At} \cdot p_{Bt}^{1-\vartheta}$.[7] Therefore, CPI inflation, $\pi_t \equiv P_t/P_{t-1}$, evolves according to $\pi_t = \pi_{At}(p_{Bt}/p_{Bt-1})^{1-\vartheta}$, where $\pi_{At} \equiv P_{At}/P_{At-1}$ is PPI inflation in country A.

Each household's real labour income (gross of taxes) is given by $w_t^p n_t^{p,i} l_t^{p,i} + w_t^g n_t^{g,i} l_t^{g,i}$, where w_t^p is the hourly real wage paid in the private sector (to be derived later) and w_t^g is the hourly real wage of the government sector. The labour income tax rate is denoted by τ_t^w. Household members who are unemployed receive unemployment benefits κ_t^B. τ_t^c denotes the consumption tax rate and T_t^i are lump-sum taxes (or, if negative, subsidies).

Optimizing households can further invest in physical capital, domestic government bonds or international assets. Investments in physical capital k_t^o earn a real rental rate r_t^k, while the capital depreciates at rate δ^k. Returns on physical capital net of depreciation allowances are taxed at rate τ_t^k. Nominal government bonds B_t^o pay a gross nominal interest rate R_t. Finally, D_t^o denote holdings of international nominal bonds, which pay the gross nominal interest rate R_t^{ecb}.[8] Π_t^o are nominal per capita profits generated by firms net of vacancy posting costs. We assume that all firms are owned by the optimizing households and that profits are redistributed in a lump-sum manner. Summarising, and bearing in mind that RoT households consume all their income each period, the period-budget constraint of the representative household i in real terms is

$$\begin{aligned}(1+\tau^c)c_t^i + I_t^i + \frac{B_t^i + D_t^i}{P_t} \quad + \quad T_t^i = {} & \frac{\Pi_t^i}{P_t} + \left((1-\tau^k)r_t^k + \tau^k\delta^k\right)k_{t-1}^i \\ & + \frac{R_{t-1}B_{t-1}^i}{P_t} + \frac{R_{t-1}^{ecb}D_{t-1}^i}{P_t} - \frac{\psi_d}{2}\cdot\left(\frac{D_t^i}{P_t} - \frac{\bar{D}^i}{\bar{P}}\right)^2 \\ & + (1-\tau^w)\left(w_t^p n_t^{p,i} l_t^{p,i} + w_t^g n_t^{g,i} l_t^{g,i}\right) + u_t^i \kappa_t^B, \qquad \text{(A.2)}\end{aligned}$$

with $I_t^r = B_t^r = D_t^r = k_t^r = \Pi_t^r = 0\,\forall t$. Taking into account that RoT households do not own physical capital, the capital-law of motion is given by $k_t^o = (1-\delta^k)k_{t-1}^o + \left[1 - S\left(I_t^o/I_{t-1}^o\right)\right]I_t^o$, where $S\left(I_t^o/I_{t-1}^o\right) = \frac{\kappa_I}{2}\left(I_t^o/I_{t-1}^o - 1\right)^2$ represents investment adjustment costs (see Christiano et al., 2005, for discussion). Maximizing (A.1) subject to the budget constraint and the capital-law of motion yields standard first-order conditions for optimizing households.

[7] Foreign country CPI is analogously given by $P_t^* = P_{At}^{\vartheta^*}P_{Bt}^{1-\vartheta^*} = P_{Bt}(1/p_{Bt})^{\vartheta^*}$.

[8] In order to ensure stationarity of international bond holdings, we follow Schmitt-Grohé and Uribe (2003) and assume that there exist portfolio adjustment costs of the form $\psi_d/2\left(d_t - \bar{d}\right)^2$, with $\psi_d > 0$ and $d_t \equiv D_t/P_t$. We assume for simplicity that trading in domestic government and in international bonds is not taxed.

A.1.2 Production

The retail and intermediate goods sectors of the economy are similar to Smets and Wouters (2003, 2007) or Christiano et al. (2005), with the exception that labour services are not hired directly from the households but from a sector of firms that produce homogenous labour services in the manner of Christoffel at al. (2009), de Walque et al. (2009), Boscá et al. (2011) or Stähler and Thomas (2012).

A.1.2.1 Final goods producer

There is a measure-ω continuum of firms in the final goods sector, in which firms purchase a variety of differentiated intermediate goods and bundle these into a final good, which is sold under perfect competition. Assuming that the law of one price holds within the union, the price of the home country's final good is the same in both countries, equal to P_{At}. The problem of the representative retail firm reads $\max_{\{\tilde{y}_t(j):j\in[0,\omega]\}} P_{At}Y_t - \int_0^\omega P_{At}(j)\tilde{y}_t(j)dj$, where $Y_t = \left(\int_0^\omega \left(\frac{1}{\omega}\right)^{1/\epsilon} \tilde{y}_t(j)^{(\epsilon-1)/\epsilon}dj\right)^{\epsilon/(\epsilon-1)}$ with $\epsilon > 1$ is the retailer's production function, $\tilde{y}_t(j)$ is the retailer's demand for each differentiated input $j \in [0,\omega]$, and $P_{At}(j)$ is the nominal price of each input. The standard first-order condition for the problem is given by $\tilde{y}_t(j) = (P_{At}(j)/P_{At})^{-\epsilon}\frac{Y_t}{\omega}$. Combining the latter with the retailer's production function and the zero profit condition, we obtain that the producer price index in the home country must equal $P_{At} = \left(\int_0^\omega \frac{1}{\omega}P_{At}(j)^{1-\epsilon}dj\right)^{1/(1-\epsilon)}$. Total demand for each intermediate input equals $\omega\tilde{y}_t(j) \equiv y_t(j) = \left(\frac{P_{At}(j)}{P_{At}}\right)^{-\epsilon} Y_t$ as there are ω retail firms.

A.1.2.2 Intermediate goods

Each intermediate goods producer $j \in [0,\omega]$ faces the technology

$$y_t(j) = \epsilon^a \cdot \left[\tilde{k}_t(j)\right]^{\alpha} \cdot \left[\tilde{lab}_t(j)\right]^{(1-\alpha)}, \tag{A.3}$$

where $\alpha \in [0,1]$ is the elasticity of output with respect to capital, $\tilde{lab}_t(j)$ denotes the demand for effective labour services, $\tilde{k}_t(j)$ is the demand for effective capital and ϵ^a is total factor productivity. Following Coenen, Straub and Trabandt (2013), we assume that effective capital is a CES composite given by

$$\tilde{k}_t(j) = \left(\alpha_k^{\frac{1}{v_k}} \left(k^p_{t-1}(j)\right)^{\frac{v_k-1}{v_k}} + (1-\alpha_k)^{\frac{1}{v_k}} \left(k^g_{t-1}\right)^{\frac{v_k-1}{v_k}}\right)^{\frac{v_k}{v_k-1}},$$

where k^g_{t-1} is the public capital stock available in period t, which is determined by government investment. It is assumed to be productivity-enhancing, where $\alpha_k \in (0,1]$ is a share parameter, and the parameter v_k denotes the elasticity of substitution between private capital services and the public capital stock (see also Leeper et al., 2010, and Pappa, 2010, for discussion). An analogous aggregator is given for public employment,

$$\tilde{lab}_t(j) = \left(\alpha_g^{\frac{1}{v_g}} \left(N^p_t(j)\right)^{\frac{v_g-1}{v_g}} + (1-\alpha_g)^{\frac{1}{v_g}} \left(N^g_t\right)^{\frac{v_g-1}{v_g}}\right)^{\frac{v_g}{v_g-1}},$$

following Fernández-de-Cordoba et al. (2012). Intermediate goods firms acquire private labour and capital services in perfectly competitive factor markets at real (CPI-deflated) prices x_t and r_t^k, respectively. Cost minimization subject to (A.3) implies the factor demand conditions for capital and labour $r_t^k = mc_t \cdot \alpha \cdot y_t(j)/\tilde{k}_t(j) \cdot \partial \tilde{k}_t(j)/\partial k_{t-1}^p(j)$ and $x_t = mc_t \cdot (1-\alpha) \cdot y_t(j)/\tilde{lab}_t(j) \cdot \partial \tilde{lab}_t(j)/\partial N_t^p(j)$, where mc_t is the real (CPI-deflated) marginal cost common to all intermediate good producers. The capital-labour ratios are equalized across firms because of constant returns to scale in capital and labour and perfectly competitive (private) input prices.

As is standard in the literature, intermediate goods firms set nominal prices à la Calvo (1983). This implies that a randomly chosen fraction $\theta_P \in [0,1)$ of firms cannot re-optimize their price in each period. A firm that has the chance to re-optimize its price in period t maximises $E_t \sum_{z=0}^{\infty} (\beta\theta_P)^z \frac{\lambda_{t+z}^o}{\lambda_t^o} \left[\frac{P_{At}(j)}{P_{t+z}} - mc_{t+z} \right] y_{t+z}(j)$ with respect to the nominal price $P_{At}(j)$, subject to $y_{t+z}(j) = \left(P_{At}(j)/P_{At+z}\right)^{-\epsilon} Y_{t+z}$. λ_t^i represents the marginal consumption-utility of households of type i. The first-order condition is standard and implies the standard law of motion for the price level, $1 = \theta_P \left(\frac{1}{\pi_{At}}\right)^{1-\epsilon} + (1-\theta_P)\tilde{p}_t^{1-\epsilon}$, where $\tilde{p}_t \equiv \tilde{P}_{At}/P_{At}$ is the relative (PPI-deflated) optimal price and $\tilde{P}_{At}$ is the optimal price chosen by all period-t price setters.

A.1.3 The labour market

Following Christoffel et al. (2009) or de Walque et al. (2009), we assume that labour firms hire workers from the household sector in order to produce homogenous labour services, which they sell to intermediate goods producers at the perfectly competitive price x_t. The production function of each labour firm is linear in the number of hours worked by its employee. With N_t^p being the fraction of the total labour force employed in the private sector and the fact that optimizers and RoTs will work the same amount of hours (which we show below), the total per-capita supply of labour services is given by $Lab_t = N_t^P \cdot l_t^p$. Equilibrium in the market for labour services requires that $\omega Lab_t = \int_0^{\omega} lab_t(j)dj$.

Using demand for each intermediate inputs and the production function (A.3) plus the fact that the capital-labour ratio is equalized across intermediate goods firms, this yields $Y_t D_t = \epsilon^a \tilde{k}_t^{\alpha} \tilde{Lab}_t^{1-\alpha}$, where $D_t \equiv \int_0^{\omega} \omega^{-1} \left(P_{At}(j)/P_{At}\right)^{-\epsilon} dj$ is a measure of price dispersion. In what follows, we will specify the matching process, flows in the labour market, private-sector vacancy creation, the corresponding wage determination and labour market participation decisions. Government wages and employment are autonomously chosen by the fiscal authority (see section A.1.4).

A.1.3.1 Matching process and labour market flows

A household member can be in one of three states: (i) employed in the public sector, (ii) employed in the private sector, or (iii) unemployed. Unemployment is the residual state in the sense that a worker whose employment relationship ends flows into unemployment. All unemployed workers look for job opportunities and search for a job. We assume that searchers are randomly matched to the private or the public sector.

Denoting total sector-specific per capita employment in period t by $N_t^f = (1-\mu)n_t^{f,o} + \mu n_t^{f,r}$, where $f = p, g$ stands for private and government employment, the total economy-

wide employment rate is given by $N_t^{tot} = N_t^p + N_t^g$, while the aggregate unemployment rate is given by $U_t = 1 - N_t^{tot}$. Following Blanchard and Galí (2010), we assume that the hiring round takes place at the beginning of each period, and that new hires start producing immediately. We also assume that workers dismissed at the end of period $t-1$ start searching for a new job at the beginning of period t. Therefore, the pool of searching workers at the beginning of period t is given by

$$\tilde{U}_t = U_{t-1} + s^p N_{t-1}^p + s^g N_{t-1}^g.$$

where s^f, with $f = p, g$, represents the constant separation rate in the private (p) and public (g) sector.The matching process is governed by a standard Cobb-Douglas aggregate matching function for each sector $f = p, g$, $M_t^f = \kappa_e^f \cdot \left(\tilde{U}_t\right)^{\varphi^f} \cdot \left(v_t^f\right)^{(1-\varphi^f)}$, where $\kappa_e^f > 0$ is the sector-specific matching efficiency parameter, $\varphi^f \in (0,1)$ the sector-specific matching elasticity and M_t^f the number of new matches formed in period t resulting from the total number of searchers and the number of sector-specific vacancies v_t^f. The probability for an unemployed worker to find a job in sector f can thus be stated as $p_t^f = M_t^f / \tilde{U}_t$, while the probability of filling a vacancy is given by $q_t^f = M_t^f / v_t^f$. With the constant separation rate in each sector, the law of motion for sector-specific employment rates is therefore given by

$$N_t^f = \left(1 - s^f\right) \cdot N_{t-1}^f + p_t^f \cdot \tilde{U}_t. \tag{A.4}$$

Thus, employment in sector f today is given by yesterday's employment that has not been destroyed plus newly created matches in that sector.

A.1.3.2 Asset value of jobs, wage bargaining and job creation

As is standard in the literature, we assume that firms and workers bargain about their share of the overall match surplus to determine wages and hours. Following Boscá et al. (2009, 2010, 2011), we assume that a union, which takes into account (aggregate) utility of optimizing and RoT households, undertakes the bargaining. Furthermore, we assume staggered bargaining of nominal wages and hours similar to Gertler et al. (2008). This implies that, each period, a randomly chosen fraction θ_w of continuing firms cannot renegotiate wages and hours, while a fraction θ_w^n of newly created firms does not bargain either and is stuck having to pay the previous period's average nominal wage for the average hours worked of the previous period. When letting $J_t\left(\tilde{W}_t^p\right)$ be the value function of employment for firms that are allowed to bargain and $\Omega_t \equiv (1-\mu) H_t^{o,p}\left(\tilde{W}_t^p\right) + \mu H_t^{r,p}\left(\tilde{W}_t^p\right)$ that of the union, where $H_t^{i,p}\left(\tilde{W}_t^p\right)$ is the corresponding household type-i utility, the Nash problem is given by

$$\max_{\tilde{W}_t^p, \tilde{l}_t^p} \; [\Omega_t]^{\xi} \left[J_t\left(\tilde{W}_t^p\right)\right]^{1-\xi}, \tag{A.5}$$

where $\xi \in [0,1)$ is the union's bargaining power, $\tilde{W}_t^p$ denotes the nominal wage negotiated in period t and $\tilde{l}_t^p$ the corresponding amount of hours worked. The value function of a

firm that renegotiates in that period is given by

$$J_t\left(\tilde{W}_t^p\right) = E_t\sum_{k=0}^{\infty}\left\{[\beta\cdot(1-s^p)\cdot\theta_w]^k\cdot\frac{\lambda_{t+k}^o}{\lambda_t^o}\cdot\left[x_{t+k}-(1+\tau_{t+k}^{sc})\cdot\frac{\tilde{W}_t^p}{P_{t+k}}\right]\cdot\tilde{l}_t^p\right\}$$
$$+(1-\theta_w)\cdot E_t\sum_{k=1}^{\infty}\left\{[\beta\cdot(1-s^p)]^k\cdot\theta_w^{k-1}\cdot\frac{\lambda_{t+k}^o}{\lambda_t^o}\cdot J_{t+k}\left(\tilde{W}_{t+k}^p\right)\right\},$$

where τ_t^{sc} is the social security contribution rate. The value of the firm is the discounted profit flow in those future states in which it is not allowed to renegotiate plus its continuation value should it have the chance to re-optimise in the next period. For new jobs where firm and worker do not bargain, the nominal wage equals last period's average nominal wage, W_{t-1}^p, the amount of hours is given by l_{t-1}^p, and the value of the job equals

$$J_t\left(W_{t-1}^p\right) = J_t\left(\tilde{W}_t^p\right) - E_t\sum_{k=0}^{\infty}\left\{[\beta\cdot(1-s^p)\cdot\theta_w]^k\cdot\frac{\lambda_{t+k}^o}{\lambda_t^o}\cdot(1+\tau_{t+k}^{sc})\cdot\frac{W_{t-1}^p\cdot l_{t-1}^p-\tilde{W}_t^p\cdot\tilde{l}_t^p}{P_{t+k}}\right\}.$$

The derivation and a more detailed description can be found in Stähler and Thomas (2012). Analogously, we can derive how workers value a match surplus. Since different household types use different stochastic discount factors, we must distinguish between the surplus for an optimizing and a rule-of-thumb household. For a worker belonging to a type-i household, the surplus value of a job in a renegotiating firm is given by

$$H_t^{i,p}\left(\tilde{W}_t^p\right) = E_t\sum_{k=0}^{\infty}\left\{[\beta\cdot(1-s^p)\cdot\theta_w]^k\cdot\frac{\lambda_{t+k}^i}{\lambda_t^i}\cdot\left[(1-\tau_{t+k}^w)\cdot\frac{\tilde{W}_t^p}{P_{t+k}}\cdot\tilde{l}_t^p-\kappa^h\cdot\frac{\tilde{l}_t^{p\,1+\sigma_h}}{(1+\sigma_h)\lambda_{t+k}^i}\right.\right.$$
$$\left.\left.-\Xi_{t+k}^{i,p}\right]\right\}+(1-\theta_w)\cdot E_t\sum_{k=1}^{\infty}\left\{[\beta\cdot(1-s^p)]^k\cdot\theta_w^{k-1}\cdot\frac{\lambda_{t+k}^i}{\lambda_t^i}\cdot H_{t+k}^{i,p}(\tilde{W}_{t+k}^p)\right\},$$

for $i=o,r$, where

$$\Xi_t^{i,f}=\kappa_t^B+\beta(1-s^f)E_t\frac{\lambda_{t+1}^i}{\lambda_t^i}\left\{p_{t+1}^g H_{t+1}^{i,g}+p_{t+1}^p\left[(1-\theta_w^n)H_{t+1}^{i,p}\left(\tilde{W}_{t+1}^p\right)+\theta_w^n H_{t+1}^{i,p}\left(W_t^p\right)\right]\right\},$$

represents the outside option of a type-i worker employed in sector $f=p,g$ at time t. The latter is the sum of unemployment benefits, κ_t^B, and the expected value of searching for a job in the following period, where p_{t+1}^f is the probability of finding a job in sector $f=p,g$. Conditional on landing on a private-sector job ($f=p$), the surplus value for the worker is contingent on whether the firm is allowed to bargain (in which case the worker receives $\tilde{W}_{t+1}^p$ and works $\tilde{l}_{t+1}^p$ hours) or not (in which case she receives today's average wage, W_t^p and works l_t^p hours). In new jobs where the wage and hours are not optimally bargained, the surplus value enjoyed by type-i workers is given by

$$H_t^{i,p}\left(W_{t-1}^p\right) = H_t^{i,p}\left(\tilde{W}_t^p\right) + E_t\sum_{k=0}^{\infty}\left\{[\beta\cdot(1-s^p)\cdot\theta_w]^k\cdot\frac{\lambda_{t+k}^i}{\lambda_t^i}\cdot(1-\tau_{t+k}^w)\cdot\frac{W_{t-1}^p\cdot l_{t-1}^p-\tilde{W}_t^p\cdot\tilde{l}_t^p}{P_{t+k}}\right\}.$$

Note that $H_t^{i,g}$ denotes the surplus value of a government job for a type-i worker. As wages there are autonomously set by the fiscal authority, the asset value function simplifies to

$$H_t^{i,g} = (1-\tau_t^w) w_t^g \cdot l_t^g - \Xi_t^{i,g} - \kappa^h \cdot \frac{l_t^{g\,1+\sigma_h}}{1+\sigma_h} + \beta(1-s^g) E_t \left\{ \frac{\lambda_{t+1}^i}{\lambda_t^i} \cdot H_{t+1}^{i,g} \right\},$$

where w_t^g is the real wage paid by the government and l_t^g the amount of hours a worker employed by the government has to work. Given the asset value functions of firms and workers, we are now in a position to solve the wage bargaining game (A.5). The resulting sharing rule is given by

$$\Omega_t = \frac{\xi}{1-\xi} \cdot \frac{E_t \sum_{z=0}^{\infty} \left\{ \left((1-\mu) \frac{\lambda_{t+z}^o}{\lambda_t^o} + \mu \frac{\lambda_{t+z}^r}{\lambda_t^r} \right) \left[\beta(1-s^p)\theta_w \right]^z \frac{(1-\tau_{t+z}^w)}{P_{t+z}} \right\}}{E_t \sum_{z=0}^{\infty} \left\{ \frac{\lambda_{t+z}^o}{\lambda_t^o} \left[\beta(1-s^p)\theta_w \right]^z \frac{(1+\tau_{t+z}^{sc})}{P_{t+z}} \right\}} \cdot J_t \left(\tilde{W}_t^p \right). \quad \text{(A.6)}$$

Solving equation (A.6) for $\tilde{W}_t^p$ by using the corresponding asset value functions gives the optimal wage bargained in period t. The average real wage in the private sector, $w_t^p \equiv W_t^p / P_t$, hence evolves according to

$$w_t^p = \frac{(1-s^p) N_{t-1}^p}{N_t^p} \left[(1-\theta_w) \tilde{w}_t^p + \theta_w \cdot \frac{w_{t-1}^p}{\pi_t} \right] + \frac{M_t^P}{N_t^p} \left[(1-\theta_w^n) \tilde{w}_t^p + \theta_w^n \cdot \frac{w_{t-1}^p}{\pi_t} \right], \quad \text{(A.7)}$$

where $\tilde{w}_t^p \equiv \tilde{W}_t^p / P_t$ is the real optimally bargained wage and $w_{t-1}^p / \pi_t = W_{t-1}^p / P_t$ is the real value of yesterday's average nominal wage at today's prices. We have also taken into account the fact that new and continuing jobs pay the optimally bargained wage with probabilities $1-\theta_w^n$ and $1-\theta_w$, respectively.

For the hours determination in the private sector, we get, after some tedious rearranging, which is very well described in de Walque et al. (2009),

$$\begin{aligned} & E_t \sum_{z=0}^{\infty} \left\{ \frac{\lambda_{t+z}^o}{\lambda_t^o} \left[\beta(1-s^p)\theta_w \right]^z x_{t+z} \right\} \cdot \frac{E_t \sum_{z=0}^{\infty} \left\{ \left((1-\mu) \frac{\lambda_{t+z}^o}{\lambda_t^o} + \mu \frac{\lambda_{t+z}^r}{\lambda_t^r} \right) \left[\beta(1-s^p)\theta_w \right]^z \frac{(1-\tau_{t+z}^w)}{P_{t+z}} \right\}}{E_t \sum_{z=0}^{\infty} \left\{ \frac{\lambda_{t+z}^o}{\lambda_t^o} \left[\beta(1-s^p)\theta_w \right]^z \frac{(1+\tau_{t+z}^{sc})}{P_{t+z}} \right\}} \\ & = E_t \sum_{z=0}^{\infty} \left\{ \left((1-\mu) \frac{\kappa^h}{\lambda_t^o} + \mu \frac{\kappa^h}{\lambda_t^r} \right) \left[\beta(1-s^p)\theta_w \right]^z \right\} \cdot \tilde{l}_t^{p\,\sigma_h}, \end{aligned} \quad \text{(A.8)}$$

while average hours worked in period t are analogously aggregated as wages, see equation (A.7). It remains to determine how jobs are created. As is standard in the literature, we assume that opening a vacancy has a real (CPI-deflated) flow cost of κ_v^p. Following Pissarides (2009), we further assume that free entry into the vacancy posting market drives the expected value of a vacancy to zero. Under our assumption of instantaneous hiring, real vacancy posting costs, κ_v^p, must equal the time-t vacancy filling probability, q_t^p, times the expected value of a filled job in period t net of training costs. The latter condition can be expressed as

$$\frac{\kappa_v^p}{q_t^p} = (1-\theta_w^n) \cdot J_t \left(\tilde{W}_t^p \right) + \theta_w^n \cdot J_t \left(W_{t-1}^p \right), \quad \text{(A.9)}$$

where we take into account that the wage of the newly-created job may be optimally bargained with probability $1-\theta_w^n$.

A.1.4 Fiscal authorities

Defining the (CPI-deflated) per capita value of end-of-period government debt as $b_t \equiv B_t/P_t$, we can state that it evolves according to a standard debt accumulation equation, $b_t = \frac{R_{t-1}}{\pi_t} b_{t-1} + PD_t$, where PD_t denotes real (CPI-deflated) per capita primary deficit. The latter is given by per capita fiscal expenditures minus per capita fiscal revenues,

$$\begin{aligned} PD_t &= \left[\frac{G_t}{p_{Bt}^{1-\omega-\psi}} + \kappa_t^B U_t + \kappa_v^g v_t^g + Sub_t\right] - \left[(\tau_t^w + \tau_t^{sc})\left[w_t^p N_t^P l_t^p + w_t^g N_t^g l_t^g\right]\right. \\ &\quad \left. + \tau_t^c C_t + \tau_t^k (r_t^k - \delta^k) k_{t-1} + T_t\right], \end{aligned}$$

where G_t denotes per capita government spending in goods and services expressed in PPI terms (hence the correction for the CPI-to-PPI ratio, $P_t/P_{At} = p_{Bt}^{1-\omega-\psi}$). Letting C_t^g and I_t^g denote real per capita public purchases and public investment, respectively, we have the following nominal relationship: $P_{At}G_t = P_{At}\left(C_t^g + I_t^g\right) + (1+\tau_t^{sc})P_t w_t^g N_t^g l_t^g$. Dividing by P_{At} and using $P_t/P_{At} = p_{Bt}^{1-\omega-\psi}$, we obtain $G_t = C_t^g + I_t^g + \left[(1+\tau_t^{sc}) w_t^g N_t^g l_t^g\right] p_{Bt}^{1-\omega-\psi}$.

We assume that $\kappa_t^B = rrs \cdot (1-\bar{\tau}^w)\bar{w}^p \bar{l}^p$. Here, rrs is then the unemployment benefit replacement ratio and the bar indicates (initial) steady-state values. Given public investment, the stock of public physical capital evolves as follows, $k_t^g = (1-\delta^g)k_{t-1}^g + I_t^g$, where we assume that the public capital stock depreciates at rate δ^g. To guarantee stationarity of public debt, for *at least* one fiscal instrument $X \in \{\tau^w, \tau^{sc}, \tau^b, \tau^c, \tau^k, C^g, I^g, w^g, N^g, l^g, T^o, T^r\}$, the government must follow a fiscal rule of the form

$$X_t = \bar{X} + \rho_X\left(X_{t-1} - \bar{X}\right) + (1-\rho_X)\,\phi_X \cdot \left(\frac{b_{t-1}}{Y_{t-1}^{tot}} p_{Bt-1}^{1-\omega-\psi} - \omega^b\right) + \epsilon_t^X, \tag{A.10}$$

in which the coefficient ϕ_X, i.e. fiscal policy's stance on debt deviations from target, is non-zero (positive for revenue instruments, negative for expenditure instruments). ρ_X is a smoothing parameter.

A.1.5 International linkages and union-wide monetary policy

This section describes the international linkages via trade in goods and foreign assets, market clearing and the union-wide monetary policy rule.

A.1.5.1 International linkages

International linkages between the two countries are given by trade in goods and services as well as in international bonds. The home country's net foreign asset position, expressed in terms of PPI, evolves according to

$$d_t = \frac{R_{t-1}^{ecb} \cdot d_{t-1}}{\pi_{At}} + \frac{1-\omega}{\omega}\left(C_{At}^* + I_{At}^*\right) - p_{Bt}\left(C_{Bt} + I_{Bt}\right), \tag{A.11}$$

where $(1-\omega)\left(C_{At}^{*}+I_{At}^{*}\right)/\omega$ are real per capita exports and $p_{Bt}\left(C_{Bt}+I_{Bt}\right)$ are real per capita imports. Zero net supply of international bonds implies $\omega d_t+(1-\omega)\,p_t^B d_t^{*}=0$. Terms of trade $p_{Bt}=P_{Bt}/P_{At}$ evolve according to $p_{Bt}=(\pi_{Bt}/\pi_{At})\,p_{Bt-1}$. Finally, the home current account is defined as $ca_t=d_t-d_{t-1}/\pi_{At}$.

A.1.5.2 Equilibrium in goods markets and GDP

Market clearing implies that private per capita production in the home and foreign country, Y_t and Y_t^{*} respectively, is used for private and public consumption and private and public investment demand as well as private and public vacancy posting costs,

$$Y_t=C_{At}+I_{At}+C_t^{g}+I_t^{g}+\frac{1-\omega}{\omega}\left(C_{At}^{*}+I_{At}^{*}\right)+{p_t^B}^{1-\omega-\Psi}\,\kappa_v^{p}\left(v_t^{p}+v_t^{g}\right), \tag{A.12}$$

$$Y_t^{*}=C_{Bt}^{*}+I_{Bt}^{*}+C_t^{g*}+I_t^{g*}+\frac{\omega}{1-\omega}\left(C_{Bt}+I_{Bt}\right)+\left(1/p_t^B\right)^{\omega-\Psi^{*}}\kappa_v^{p*}\left(v_t^{p*}+v_t^{g*}\right), \tag{A.13}$$

where we have assumed that vacancy positing costs in the private and public sector are the same, $\kappa_v^{g}=\kappa_v^{p}$. Consistent with national accounting and in line with Stähler and Thomas (2012), each country's GDP is the sum of private-sector production and government production of goods and services. The latter is measured at input costs, that is, by the gross government wage bill. Hence, home and foreign real (PPI-deflated) per capita GDP are given by $Y_t^{tot}=Y_t+(1+\tau_t^{sc})w_t^{g}N_t^{g}l_t^{g}p_{Bt}^{1-\omega-\psi}$ and $Y_t^{tot,*}=Y_t^{*}+(1+\tau_t^{sc*})w_t^{g*}N_t^{g*}l_t^{g*}p_{Bt}^{-(\omega-\psi^{*})}$, respectively.

A.1.5.3 Monetary authority

We assume that the area-wide monetary authority has its nominal interest rate, R_t^{ecb}, respond to deviations of area-wide inflation from its long-run target, $\bar{\pi}$, and to area-wide GDP growth, according to a simple Taylor rule,

$$\frac{R_t^{ecb}}{\bar{R}^{ecb}}=\left(\frac{R_{t-1}^{ecb}}{\bar{R}^{ecb}}\right)^{\rho_R}\left\{\left[\left(\frac{\pi_t}{\bar{\pi}}\right)^{\omega}\left(\frac{\pi_t^{*}}{\bar{\pi}^{*}}\right)^{1-\omega}\right]^{\phi_\pi}\left[\left(\frac{Y_t}{\bar{Y}}\right)^{\omega}\left(\frac{Y_t^{*}}{\bar{Y}*}\right)^{1-\omega}\right]^{\phi_y}\right\}^{(1-\rho_R)},$$

where ρ_R is a smoothing parameter, ϕ_π and ϕ_y are the monetary policy's stance on inflation and output growth, respectively. This completes the model description. We now turn to the model calibration.

A.1.6 Welfare

In order to assess welfare effects of the reform measures, we compute the life-time consumption-equivalent gain of each type of household as a result of the change in fiscal policy.[9] We will take into account the welfare difference between the initial and the final steady state as well as the transition thereto. More precisely, we calculate the consumption-equivalent

[9] Among the large literature using consumption equivalents for welfare comparison, see, for example, Barro (2006), Cristoffel et al. (2009), Krebs (2003), Lucas (2003), Obstfeld (1994) and Otrok (2001).

welfare gain, ce^i, such that

$$\sum_{t=0}^{\infty} \left(\beta^i\right)^t U\left((1+ce^i)\bar{c}^i, \bar{l}^p, \bar{l}^g\right) = \sum_{t=0}^{\infty} \left(\beta^i\right)^t U\left(c_t^i, l_t^p, l_t^g\right),$$

where the utility function $U(\cdot)$ is given by equation (A.1) and the bar indicates initial steady-state values. Hence, ce^i represents the amount of initial steady-state consumption a household of type i is willing to give up in order to live in the alternative regime after the policy change. Economy-wide welfare is computed as $ce^{tot} = (1-\mu)ce^o + \mu ce^r$.

A.2 Model calibration

In this section, we describe the common parameter calibration. The country-specific parameters that are necessary to derive the targeted steady state are given in Table 2 of the main text. Table A.1 summarises the common parameters. For the general calibration strategy, we follow Stähler and Thomas (2012) and Gadatsch, Stähler and Weigert (2015); see also Section 3.2 of the main text.

In calibrating the model to European data, we strongly rely on Christoffel, Kuester and Linzert (2009), who estimate a model with a search and matching labour market to European data. Note that the simulation results are highly robust to alternative parameter calibration. The discount factor is set to $\beta = 0.992$ to match an annual real rate of 3.2%. Risk aversion $\sigma_c = 2$ as well as habits in consumption $h = 0.6$ are set close to the mode estimates in Smets and Wouters (2003). The share of RoTs, μ, is set to 0.5 for Italy and 0.46 for Austria, Belgium and Germany in line with Le Blanc, Porpiglia, Teppa, Zhu and Ziegelmeyer (2014). Forni, Monteforte and Sessa (2009) find similar values for the overall euro area. Monetary policy parameters are standard values of a conventional Taylor rule, while the price mark-up and the Calvo parameters for prices and wages are set in line with estimates from the New Area Wide Model (see Christoffel, Coenen and Warne, 2008, for a discussion). Capital depreciation is set to a standard value of $\delta^p = \delta^g = 0.025$ and the capital share in production is set to one third (Cooley and Prescott, 1995), while capital adjustment costs are set to a standard value close to 5. For the CES aggregator of private and public capital, we rely on the estimates of Coenen, Straub and Trabandt (2013), ie we set $\alpha_k = 0.9$ and $v_k = 0.84$. Similar values are chosen for CES aggregator of private and public employment. According to Schmitt-Grohé and Uribe (2003), it is sufficient to choose a rather small value for the risk premium parameter on international bonds in order to generate a stable equilibrium. So we opt for $\Psi_d = \Psi_d^* = 0.01$.

Regarding the labour market, the elasticity of the matching function in the private sector, φ^p, is set to 0.5 in line with Burda and Weder (2002), Petrongolo and Pissarides (2001) and Christoffel, Kuester and Linzert (2009). The value in the public sector, φ^g, is set a bit lower, to 0.3, following Afonso and Gomes (2014). The bargaining power of workers is derived endogenously to match the premium of public over private wages and presented in Table 2. It is, therefore, country-specific and does not comply with the Hosios condition (see Hosios, 1990, for a discussion). However, there is no reason why this condition should be met in reality. The quarterly separation rate in the private sector is set to 0.04 in line with Christoffel, Kuester and Linzert (2009). Again, it is a bit lower

in the public sector. For nominal wage rigidities, Christoffel, Kuester and Linzert (2009), Cociago, Ropele, Muscatelli and Tirelli (2008) and de Walque, Pierrard, Snessens and Wouters (2009) find a rather high degree of stickiness (note that the latter paper is based on US data, however). We opt for a middle value of these studies and set $\theta_w = \theta_w^n = 0.83$. Given these parameters, it remains to derive the efficiency of the matching function as well as vacancy posting costs endogenously to meet the targeted labour market variables shown in Table 1. They are, therefore, country-specific and shown in Table 2.

Table A.1: Baseline parameter calibration

Parameter	Symbol	Value
Monetary policy		
Interest rate smoothing	ρ_R	0.85
Stance on inflation	ϕ_π	1.5
Stance on output gap	ϕ_y	0.125
Fiscal policy		
Lump-sum tax smoothing	$\rho_T = \rho_T^*$	0.9
Stance on debt (lump-sum tax)	$\phi_T = \phi_T^*$	0.05
Price and wage stickiness		
Calvo parameter (prices)	θ_P	0.9
Market power (markup)	ϵ	4
Calvo parameter (existing wages)	θ_w	0.83
Calvo parameter (new wages)	θ_w^n	0.83
Preferences		
Discount rate	β	0.992
Risk aversion	σ_c	2
Habits in consumption	h	0.6
Trade in internat. bonds		
Risk premium parameter	$\psi_d = \psi_d^*$	0.01
Production		
Private sector capital depreciation	δ^k	0.025
Public sector capital depreciation	δ^g	0.025
Private sector capital share in prod.	α	0.33
Public sector capital/employment influence in private production	α_k, α_g	0.9
Substitutability public/private capital/employment	v_k, v_g	0.84
Adjustment cost parameter	κ_I	4.94
Labour market		
Matching elasticity (private sector)	φ^p	0.5
Matching elasticity (public sector)	φ^g	0.3
Separation rate (public sector)	s^g	0.02
Separation rate (private sector)	s^p	0.04

Notes: Parameter values chosen as described in the text. Fiscal instrument used is labour income tax (hence, fiscal policy's stance on debt deviations, ϕ_X, are set to zero for all other fiscal instruments) and home and foreign country parameters are equal (both true unless indicated differently). For the 'fiscal devaluation' simulation to follow, the persistence and stance parameters ρ_T^*, $\rho_{\tau^{sc}}$, and ϕ_T^* and $\phi_{\tau^{sc}}$ are changed according to the description in the main text and $\phi_{\tau^w} = \phi_{\tau^w}^* = 0$ (indicated by † in the table).

A.3 Ex-post stabilisation

In this appendix, we show that our results also hold when using the financing instrument as an ex-post stabilisation tool. More precisely, we simulate a decrease in the workers'

personal income tax rate financed by an increase in the consumption tax rate and by a reduction in government purchases. However, the budget is no longer balanced ex-ante by this instrument but it is balanced ex-post taking into account the 'second-round effects'. As claimed in Section 4, we see that the results are not changed qualitatively. From a quantitative perspective, ex-post stabilisation is more favourable because it implies a lower increase in the consumption tax rate (a lower reduction in public purchases, respectively) in the long run. We assume that lump-sum taxes are not changed in the new long-run equilibrium. Results are summarised in Table A.2.

Table A.2: Exemplary ex-post simulation

Long-run changes in	**Austria**		**Belgium**		**Germany**		**Italy**	
	$\Delta\tau^c$	ΔC^g	$\Delta\tau^c$	ΔC^g	$\Delta\tau^c$	ΔC^g	$\Delta\tau^c$	ΔC^g
GDP	0.86	0.49	0.85	0.35	0.78	0.42	1.09	0.68
Private consumption	0.68	1.15	0.39	0.84	0.77	1.36	0.96	1.70
... of optimizers	0.64	0.99	0.29	0.53	0.75	1.23	1.08	1.65
... of RoTs	0.75	1.42	0.55	1.37	0.79	1.57	0.77	1.78
Private investment	0.55	0.01	0.30	-0.58	0.65	0.19	0.97	0.44
Unemployment rate	-0.39	-0.26	-0.28	-0.10	-0.39	-0.30	-0.26	-0.18
Per-capita hours	0.74	0.51	0.96	0.76	0.52	0.25	1.07	0.72
Total hours (private sector)	1.21	0.83	1.34	0.89	1.02	0.63	1.41	0.96
Average gross wages	-0.70	-0.86	-1.22	-1.58	-0.47	-0.53	-0.97	-0.97
Average net wage income	3.64	3.24	3.55	2.97	3.44	3.09	4.77	4.41
Unit labour costs	-0.42	-0.56	-0.82	-1.09	-0.29	-0.36	-0.75	-0.76
Internat. competitiveness	1.02	1.47	1.00	1.57	0.92	1.40	1.15	1.75
PIT rate	-2.30	-2.30	-2.46	-2.46	-2.36	-2.36	-3.14	-3.14
Public purchases	0.00	-7.94	0.00	-8.09	0.00	-6.56	0.00	-8.55
Consumption tax rate	1.02	-0.00	1.28	0.00	1.11	0.00	1.34	-0.00

Notes: Table shows deviations of final relative to initial steady-state values in per cent (percentage points for rates and ratios). GDP is defined as private sector-output plus public sector production at input costs (i.e. the public-sctor gross wage bill). Changes in per-capita hours are in per cent; changes in total hours in the private sector are defined as the number of privately-employed people multiplied by the amount of per-capita hours in that sector, again in per cent. The reduction (increase) in the lump-sum tax-to-GDP ratio can be interpreted as the fiscal space (tightening) generated by the reform.

B.1 Inspecting the difference in the labour market transmission of tax reductions on the workers' and the firms' side

In this appendix, we will inspect the mechanism driving the labour market effects of a tax wedge reduction in more formal detail. For this purpose, we simplify the model presented in Section A.1 by assuming no liquidity-constrained consumers, $\mu = 0$, and no wage stickiness, $\theta_w = \theta_w^n = 0$. We will only focus on steady-state comparisons. These assumptions highly simplify the exposition of the argument without loss of generality. Furthermore, we will proceed in four steps for the ease of understanding. Under the simplifying assumptions, equation (A.6) in steady state becomes

$$\bar{\Omega} = \frac{\xi}{1-\xi} \cdot \frac{1-\bar{\tau}^w}{1+\bar{\tau}^{sc}} \cdot \bar{J}. \tag{B.1}$$

In a **first step**, let us ignore public employment, the endogenous provision of hours worked and the time variation in unemployment benefits by exogenously imposing $\bar{p}^g = \kappa^h = 0$, $\bar{l} = 1$ and $\bar{\kappa}^B$ to be fixed at some value. Then, after some algebra, the steady-state wage can be expressed as

$$(1-\bar{\tau}^w)\,(1+\bar{\tau}^{sc})\,\bar{w}^p = \xi\,(1-\bar{\tau}^w)\,\left[\bar{x} + \beta(1-s^p)\,\kappa^v \cdot \bar{\theta}^p\right] + (1-\xi)\,(1+\bar{\tau}^{sc})\,\bar{\kappa}^B, \tag{B.2}$$

where $\bar{\theta}^p = \bar{v}^p/\bar{\tilde{U}}$. Substituting into the job creation condition, equation (A.9), and rearranging yields

$$[1-\beta(1-s^p)]\,\frac{\kappa^v}{q(\bar{\theta}^p)} + \beta(1-s^p)\,\xi\,\kappa^v\bar{\theta}^p = (1-\xi)\,\left[\bar{x} + \frac{1+\bar{\tau}^{sc}}{1-\bar{\tau}^w} \cdot \bar{\kappa}^B\right]. \tag{B.3}$$

It is straightforward to see that $d\bar{\theta}^p/d\bar{\tau}^w = \frac{1+\bar{\tau}^{sc}}{1-\bar{\tau}^w} \cdot d\bar{\theta}^p/d\bar{\tau}^{sc}$ and, because $\frac{1+\bar{\tau}^{sc}}{1-\bar{\tau}^w} > 1$, it must hold that $|d\bar{\theta}^p/d\bar{\tau}^w| > |d\bar{\theta}^p/d\bar{\tau}^{sc}|$. In words, this implies that, in our simple model, a labour income tax reduction on the workers' side will affect job creation more positively than a reduction of the social security contributions levied on firms. In principle, this already goes in the direction of what we find in our paper. However, from Pissarides (2000, p. 205), we know that, "*in general, tax incidence is independent of who pays the tax*", while we find that this is not the case here.

In order to solve this alleged contradiction, let us, in a **second step**, allow for time variation in unemployment benefits by assuming that $\kappa_t^B = rrs\,(1-\tau_{t-1}^w)\,w_{t-1}$ as we also do in our model. In this case, we get

$$(1-\bar{\tau}^w)\,(1+\bar{\tau}^{sc})\,(1-(1-\xi)rrs)\,\bar{w}^p = \xi\,(1-\bar{\tau}^w)\,\left[\bar{x} + \beta(1-s^p)\,\kappa^v \cdot \bar{\theta}^p\right] \tag{B.4}$$

as the steady-state wage, which after substituting in the job creation condition and rearranging yields

$$[1-\beta(1-s^p)]\,[1-rrs(1-\xi)]\,\frac{\kappa^v}{q(\bar{\theta}^p)} + \beta(1-s^p)\,\xi\,\kappa^v\bar{\theta}^p = (1-\xi)\,(1-rrs)\cdot\bar{x}. \tag{B.5}$$

Clearly, it no longer plays a role who pays taxes. As Pissarides (2000, chapter 9) has shown, what matters for job creation is the tax level itself – governed by the parameter rrs in our simplified model – but not by who pays the tax. This finding is reconciled in equation (B.5) and depends on the assumption that unemployment benefits are a fraction of net wages received by workers, which is also the underlying assumption driving the result in Pissarides (2000). The difference to the situatin after the first step when assuming fixed unemployment benefits in equation (B.3) can be explained as follows. In this case, the relative value of employment over unemployment is affected more by the workers' labour tax rate than by the social security contribution rate due to different effects on the workers' outside option in the bargaining process.[10] Hence, changes in the labour income tax rate will, in this situation, have a larger effect on job creation and it will, then, matter who actually pays the tax, while it does not matter if unemployment benefits are some fraction of net wages.

Even though our model includes time-varying unemployment benefits, simulations still show that results clearly depend on who has to pay the tax. In order to explain why this is the case, let us include public employment into this Section's analysis as a **third step**. In this case, we get

$$\begin{aligned}
&(1-\bar{\tau}^{w})\,(1+\bar{\tau}^{sc})\,\left(1-(1-\xi)rrs\left(1-\frac{\beta(1-s^{p})\bar{p}^{g}}{1-\beta(1-s^{g})(1-\bar{p}^{g})}\right)\right)\bar{w}^{p}\\
=\;&\xi\,(1-\bar{\tau}^{w})\left[\bar{x}+\beta(1-s^{p})\,\kappa^{v}\cdot\bar{\theta}^{p}\left(1+\frac{\beta(1-s^{p})\bar{p}^{g}}{1-\beta(1-s^{g})(1-\bar{p}^{g})}\right)\right]\\
&+(1-\xi)\frac{\beta(1-s^{p})\bar{p}^{g}}{1-\beta(1-s^{g})(1-\bar{p}^{g})}(1-\bar{\tau}^{w})\,(1+\bar{\tau}^{sc})\,\bar{w}^{g},
\end{aligned}\tag{B.6}$$

where use has been made of the workers' marginal utility of being employed in the public sector, H_t^g, evaluated in steady state. It is straightforward to see that a higher wage rate in the public sector, $\bar{w}^g$, as well as a higher probability of finding a job in the public sector, $\bar{p}^g$, augment the wages workers demand in private-sector wage negotiations because the possibility to find a job in the public sector increases the workers' fall-back utility. Substituting the wage resulting from taking into account public employment, equation (B.6), into the job creation condition yields

$$\begin{aligned}
&[1-\beta(1-s^{p})]\left(1-(1-\xi)rrs\left(1-\frac{\beta(1-s^{p})\bar{p}^{g}}{1-\beta(1-s^{g})(1-\bar{p}^{g})}\right)\right)\frac{\kappa^{v}}{q(\bar{\theta}^{p})}\\
&+\beta(1-s^{p})\,\xi\,\kappa^{v}\bar{\theta}^{p}\left(1+\frac{\beta(1-s^{p})\bar{p}^{g}}{1-\beta(1-s^{g})(1-\bar{p}^{g})}\right)\\
=\;&(1-\xi)\left(1-rrs\left(1-\frac{\beta(1-s^{p})\bar{p}^{g}}{1-\beta(1-s^{g})(1-\bar{p}^{g})}\right)\right)\cdot\bar{x}-(1-\xi)\frac{\beta(1-s^{p})\bar{p}^{g}\cdot(1+\bar{\tau}^{sc})\,\bar{w}^{g}}{1-\beta(1-s^{g})(1-\bar{p}^{g})}.
\end{aligned}\tag{B.7}$$

Formally, we immediately see from equation (B.7) that $|d\bar{\theta}^{p}/d\bar{\tau}^{w}|=0$, whereas $|d\bar{\theta}^{p}/d\bar{\tau}^{sc}|>0$. In words, this means that, when taking into account public employment – still ignoring the endogenous provision of hours worked –, a tax wedge reduction using social security contributions levied on firms is more favourable than reducing the workers' labour income

[10] This holds unless $(1+\bar{\tau}^{sc})=(1-\bar{\tau}^{w})^{-1}$, which is not the case in our model and, most likely, not in reality.

tax rate. This is also what we found in Section 5.1.1 in the full model when ignoring hours worked.

After the second step in this model, we saw that it does not make a difference who pays taxes when assuming time-varying unemployment benefits. The argument is analogous for a decrease in the workers' personal income tax rate when taking into account public employment, because the decrease in $\bar{\tau}^w$ affects steady-state utility of being employed in the private or the public sector and of being unemployed in the same direction and by the same relative amount. Hence, the relationship between the workers' steady-state utilities and fall-back utilities remains constant. On the contrary, for given public wages and public employment, an increase in social security contributions on the firms' side only reduces job creation incentives in the private sector, which makes public employment relatively more attractive and increases the workers' fall-back utility (in relative terms). Hence, when ignoring the intensive hours margin, the fact that reductions in the firms' social security contributions generate more favourable effects is driven by lowering the relative attractiveness of public-sector employment and, thereby, producing a reduced fall-back position of workers.

In a **last step**, we now also take into account the intensive hours margin. Given that hours in the public sector are assumed to be an exogenous policy variable, we ignore it in the following exposition for the sake of brevity. However, including hours worked in the private sector bargaining, we need to add $(1-\xi)(1+\bar{\tau}^{sc})\kappa^h / \left(\bar{\lambda}(1+\sigma_h)\right) \bar{l}^{p\,1+\sigma_h}$ to the right-hand-side of equation (B.6), where $\bar{\lambda} = \left(\bar{c}^{\sigma_c}\left(1+\bar{\tau}^c\right)\right)^{-1}$ is households' marginal utility of consumption. Substituting into the job creation condition, we know that we need to add $-(1-\xi)(1+\bar{\tau}^{sc})/(1+\bar{\tau}^w)\kappa^h / \left(\bar{\lambda}(1+\sigma_h)\right) \bar{l}^{p\,1+\sigma_h}$ there in order take into account endogenous hours worked in the private sector. Deriving this latter term with respect to $\bar{\tau}^w$ and $\bar{\tau}^{sc}$ implies that, from the perspective of the intensive hours margin, a reduction in the workers' personal income tax rate yields higher incentives for additional job creation as a reduction in firms' social security contributions. The argument is analogous to the one made after step one where we had exogenously given unemployment benefits.

Hence, a labour tax wedge reduction by means of a PIT or SSC decrease now entails a trade-off in the workers' fall-back utility. It either makes public employment less attractive in relative terms (see equation (B.7)) or it decreases the relative disutility of labour supply more strongly, depending on which instrument is used. Which effect dominates depends on how these two elements in the fall-back position of the worker are related. Furthermore, we know from the hours bargaining condition, equation (8) evaluated in steady state, that $|d\bar{l}^p/d\bar{\tau}^w| = \frac{1-\bar{\tau}^{sc}}{1+\bar{\tau}^w} \cdot |d\bar{l}^p/d\bar{\tau}^{sc}|$. This implies that a reduction in the personal income tax rate fosters the provision of (additional) working hors more than a reduction in the firms' social security contribution rate. Therefore, the trade-off is tilted towards a reduction in the workers' personal income tax rate when taking into account the additional hours margin. Our simulations show that this effect overcompensates for the public employment effect when hours are taken into account.

References

Afonso, A. and P. Gomes [2014], "Interactions Between Private and Public Sector Wages", *Journal of Macroeconomics*, 39, 97–112.

Alesina, A. F., Glaeser, E. L. and B. Sacerdote [2006], "Work and leisure in the US and Europe: why so different?", *NBER Macroeconomics Annual 2005*, 20, 1–100.

Andolfatto, D. [1996], "Business Cycles and Labor-Market Search", *American Economic Review*, 86, 112–132.

Bassanini, A. and Duval, R. [2006], "The Determinants of Unemployment Across OECD Countries: Reassessing the Role of Policies and Institutions", *OECD Economic Studies*, 42, 7–86.

Barro, R. J. [1990], "Government Spending in a Simple Model of Endogenous Growth", *Journal of Political Economy* 98, S103–S126.

Barro, R. J. [2006], "Rare Disasters and Asset Markets in the Twentieth Century", *Quarterly Journal of Economics* 121, 823–866.

Baxter, M. and R. G. King [1993], "Fiscal Policy in General Equilibrium", *American Economic Review*, 83, 315-334.

Blanchard, O. and J. Galí [2010], "Labor Markets and Monetary Policy: A New-Keynesian Model with Unemployment", *American Economic Journal: Macroeconomics*, 2, 1–30.

Boscá, J. E., A. Díaz, R. Doménech, E. Pérez, J. Ferri and L. Puch [2010], "A Rational Expectations Model for Simulation and Policy Evaluation of the Spanish Economy", *SERIEs - Journal of the Spanish Economic Association*, 1, 135–169.

Boscá, J. E., R. Doménech and J. Ferri [2009], "Tax Reforms and Labour-Market Performance: An Evaluation for Spain Using REMS", *Moneda y Credito*, 228, 145–188.

Boscá, J. E., R. Doménech and J. Ferri [2011], "Search, Nash Bargaining and Rule of Thumb Consumers", *European Economic Review*, 55, 927–942.

Boscá, J. E., R. Doménech and J. Ferri [2013], "Fiscal Devaluations in EMU", BBVA Working Papers, No. 12/11, Madrid.

Brulhart, M. and F. Trionfetti [2004], "Public Expenditure, International Specialisation and Agglomeration", *European Economic Review*, 48, 851–881.

Burda, M. and M. Weder [2002], "Complementarity of Labor Market Institutions, Equilibrium Unemployment and the Propagation of Business Cycles", *German Economic Review*, 3, 1–24.

Burgert, M. and W. Roeger [2014], "Fiscal Devaluation: Efficiency and Equity", European Commission Economic Papers 542, December 2014.

Calvo, G. [1983], "Staggered Prices in a Utility-Maximizing Framework", *Journal of Monetary Economics*, 12, 383–398.

Chamley, C. [1986], "Optimal Taxation of Capital Income in General Equilibrium with Infinite Lives", *Econometrica*, 54, 607–622.

Christiano, L., M. Eichenbaum and C. Evans [2005], "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy", *Journal of Political Economy*, 113, 1–45.

Christoffel, K., G. Coenen and A. Warne [2008], "The New Area-Wide Model of the Euro Area: A Micro-Founded Open-Economy Model for Forecasting and Policy Analysis", ECB Working Paper No. 944, European Central Bank, Frankfurt.

Christoffel, K., J. Costain, G. de Walque, K. Kuester, T. Linzert, S. Millard and O. Pierrard [2009], "Inflation Dynamics with Labour Market Matching: Assessing Alternative Specifications", ECB Working Paper No. 1053, European Central Bank, Frankfurt.

Christoffel, K., K. Kuester and T. Linzert [2009], "The Role of Labor Markets for Euro Area Monetary Policy", *European Economic Review*, 53, 908–936.

Coenen, G., P. McAdam and R. Straub [2008], "Tax Reform and Labour-Market Performance in the Euro Area: A Simulation-Based Analysis Using the New Area-Wide Model", *Journal of Economics Dynamics and Control*, 32, 2543–2583.

Coenen, G., R. Straub and M. Trabandt [2013], "Gauging the Effects of Fiscal Stimulus Packages in the Euro Area", *Journal of Economic Dynamics and Control*, 37, 367–386.

Colciago, A., Ropele, T., Muscatelli, V. A. and P. Tirelli [2008], "The Role of Fiscal Policy in a Monetary Union: Are National Automatic Stabilizers Effective?", *Review of International Economics*, 16, 591–610.

Cooley, T. F. and E. C. Prescott [1995], "Economic Growth and Business Cycles", pp. 1–38 in: T. F. Cooley (ed), *Frontiers in Business Cycle Research*, Princeton University Press, Princeton, NJ.

CPB [2013], "Study on the Impacts of Fiscal Devaluation", CPB Netherlands Bureau for Economic Analysis and CAPP in consortium with CASE, CEPII, ETLA, IFO, IFS, HIS, Taxation Paper, No. 36, Directorate-General for Taxation and Customs Union, European Commission.

Daveri, F. and Tabellini, G. [2000], "Unemployment, Growth and Taxation in Industrial Countries", *Economic Policy*, 15, 47–104.

De Walque, G., O.Pierrard, H. S. Snessens and R. Wouters [2009], "Sequential Bargaining in a New-Keynesian Model with Frictional Unemployment and Wage Negotiation", *Annales d'Economie et de Statistique*, 95–96, 223–250.

Engler, P., G. Ganelli, J. Trevala and S. Voigts [2014], "Fiscal Devaluation in a Monetary Union", IMF Working Paper, No. WP 14/201, Washington.

European Commission [2013], "Tax Reforms in EU Member States - Tax Policy Challenges for Economic Growth and Fiscal Sustainability", European Economy, No. 5/2013, Brussels.

European Commission [2014], "Taxation Trends in the European Union", 2014 edition.

European Commission [2016], "The Economic Impact of Selected Structural Reform Measures in Italy, France, Spain and Portugal", European Economy, Institutional Papers, No. 023, April 2016.

Farhi, E., G. Gopinath and O. Itskhoki [2014], "Fiscal Devaluations", *Review of Economic Studies*, 81, 725–760.

Fernández-de-Cordoba, G., Pérez, J. J. and Torres, J. L. [2012], "Public and Private Sector Wages Interactions in a General Equilibrium Model", *Public Choice*, 150, 309–326.

Forni, L., L. Monteforte and L. Sessa [2009], "The General Equilibrium Effects of Fiscal Policy: Estimates for the Euro Area", *Journal of Public Economics*, 93, 559–585.

Gadatsch, N., K. Hauzenberger and N. Stähler [2016], "Fiscal Policy During the Crisis: A Look on Germany and the Euro Area with GEAR", *Economic Modelling*, 52, 997–1016.

Gadatsch, N., N. Stähler and B. Weigert [2015], "German Labor Market and Fiscal Reforms 1999-2008: Can They Be Blamed for Intra-Euro Area Imbalances?", Deutsche Bundesbank, Discussion paper Series, No. 29/2015, Frankfurt.

Galí, J., J. D. Lopez-Salido and J. Vallés [2007], "Understanding the Effects of Government Spending on Consumption", *Journal of the European Economics Association*, 5, 227–270.

Gertler, M., L. Sala and A. Trigari [2008], "An Estimated Monetary DSGE Model with Unemployment and Staggered Nominal Wage Bargaining", *Journal of Money, Credit and Banking*, 40, 1713–1764.

Gomes, S., P. Jacquinot and M. Pisani [2016], "Fiscal Devaluation in the Euro Area: A Model-Based Analysis", *Economic Modelling*, 52, 58–70.

Hosios, A. J. [2001], "On the Efficiency of Matching and Related Models of Search and Unemployment", *Review of Economic Studies*, 57, 279–298.

Judd, K. L. [1985], "Redistributive Taxation in a Simple Perfect Foresight Model", *Journal of Public Economics*, 28, 59–83.

Keane, M. P. [2011], "Labor Supply and Taxes: A Survey", *Journal of Economic Literature*, 49, 961–1075.

Kempkes, G. and N. Stähler [2016], "A One-Off Wealth Levy? Assessing the Pros and Cons, and the Importance of Credibility", *Fiscal Studies*, forthcoming.

Krebs, T. [2003], "Growth and Welfare Effects of Business Cycles in Economies with Idiosyncratic Human Capital Risk", *Review of Economic Dynamics* 6, 846–868.

Langot, F., L. Patureau and T. Sopraseuth [2014], "Fiscal Devaluation and Structural Gaps", Banque der France, Working Papers, No. 508, Paris.

Le Blanc, J., A. Porpiglia, F. Teppa, J. Zhu and M. Ziegelmeyer [2014], "Household Saving Behavior and Credit Constraints in the Euro Area", Deutsche Bundesbank, Discussion paper Series, No. 16/2014, Frankfurt.

Leeper, E. M., T. B. Walker and S. C. S. Yang [2010], "Government Investment and Fiscal Stimulus", *Journal of Monetary Economics*, 57, 1000–1012.

Lipińska, A. and L. von Thadden [2009], "Monetary and Fiscal Policy Aspects of Indirect Tax Changes in a Monetary Union", European Central Bank, Working Paper, No. 1097, Frankfurt am Main.

Lucas, R. [2003], "Macroeconomic Priorities", *American Economic Review* 93, 1–14.

Meghir, C. and D. Phillips [2010], "Labor Supply and Taxes", pp. 202–274 in: S. Adams et al. (eds), *Dimensions of Tax Design: The Mirrlees Review*, Oxford University Press, Oxford.

Merz, M. [1995], "Search in the Labor Market and the Real Business Cycle", *Journal of Monetary Economics*, 36, 269–300.

Nickell, S., L. Nunziata and W. Ochel [2005], "Unemployment in the OECD Since the 1960s. What Do We Know?", *The Economic Journal*, 115, 1–27.

Obstfeld, M. [1994], "Evaluating Risky Consumption Paths: The Role of Intertemporal Substitutability", *European Economic Review*, 38, 1471–1486.

Ohanian, L., A. Raffo and R. Rogerson [2008], "Long-Term Changes in Labor Supply and Taxes: Evidence from OECD Countries, 1956-2004", *Journal of Monetary Economics*, 55, 1353–1362.

Otrok, C. [2001], "On Measuring the Welfare Cost of Business Cycles", *Journal of Monetary Economics*, 47, pp. 61–92.

Pappa, E. [2009], "The Effects Of Fiscal Shocks On Employment And The Real Wage", *International Economic Review*, 50, 217–244.

Petrongolo, B. and C. Pissarides [2001], "Looking into the Black Box: A Survey of the Matching Function", *Journal of Economic Literature*, 39, 390–431.

Picos-Sánchez, F. and A. Thomas [2015], "A Revenue-Neutral Shift from SSC to VAT: Analysis of the Distributional Impact of 12 EU-OECD Countries", *FinanzArchiv: Public Finance Analysis*, 71, 278–298.

Pissarides, C. [2000], "*Equilibrium Unemployment Theory*", MIT Press, second edition, Cambridge, MA.

Pissarides, C. [2009], "The Unemployment Volatility Puzzle: Is Wage Stickiness the Answer?", *Econometrica*, 77, 1339–1369.

Prescott, E. C. [2004], "Why do Americans Work So Much More than Europeans?", National Bureau of Economic Research (NBER), Working Paper, 10316.

Schmitt-Grohé, S. and M. Uribe [2003], "Closing Small Open Economy Models", *Journal of International Economics*, 61, 163–185.

Smets, F. and R. Wouters [2003], "An Estimated Stochastic General Equilibrium Model of the Euro Area", *Journal of the European Economic Association*, 1, 1123–1175.

Smets, F. and R. Wouters [2007], "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach", *American Economic Review*, 97, 586–606.

Stähler, N. and C. Thomas [2012], "FiMod – A DSGE Model for Fiscal Policy Simulations", *Economic Modelling*, 29, 239–261.

Thimann, C. [2015], "The Microeconomic Dimension of the Eurozone Crisis and Why European Politics Cannot Solve Them", *Journal of Economic Perspectives*, 29, 141–164.

Trionfetti, F. [2000], "*Discriminatory Public Procurement and International Trade*", Blackwell Publishers.