# Structural Reforms in the European Union

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# Contents

# Introduction

The process of European economic integration has been associated with significant changes in the framework for economic policy. The most apparent institutional change was the introduction of the euro as the common currency in the member states of the euro area. However, the first steps towards the economic integration of European countries were already taken many years before. In 1951, only a few years after the Second World War, the so-called *Inner Six* (Belgium, France, Italy, Luxembourg, the Netherlands and West Germany) founded the European Coal and Steel Community, establishing a common market for coal and steel. The next step was the creation of the European Economic Community including a customs union under the umbrella of the European Communities laid down in the Treaty of Rome in 1957. In 1992, the twelve member states of the European Communities signed the Maastricht Treaty which formally established the European Union (EU) and, as one of its main pillars, the Economic and Monetary Union (EMU). The latter provided gradual economic convergence and further integration that culminated in the creation of the euro area with the introduction of the euro in 1999. However, not all EU countries have joined the euro area yet, reflecting a development which is often referred to as multi-speed integration. At present, after the Brexit, the EU consists of 27 member states. The euro as the common currency has been adopted by a subset of 19 countries.
From a political perspective, European integration is commonly considered a success, whereas the corresponding economic implications still represent a major challenge for the union. The member states of both the EU and the euro area have been characterized by fundamental heterogeneities over the last years. These cross-country differences complicate the coordination of economic policies at the union level and can lead to incentive problems such as moral hazard. For this reason, the ongoing economic integration has been accompanied by the gradual implementation of institutional arrangements that provide a framework for the conduct of economic policy in the member states. This framework is constantly subject to structural reforms which reflect the economic trends Europe has been confronted with over the last decades. In 2015, the Presidents of the European Commission, the Euro Summit, the Eurogroup, the European Central Bank and the European Parliament presented the so-called *Five President's Report* (Juncker et al., 2015) which outlines a longer-term vision for the completion of the EMU. The report identifies four

pillars for further integration. First, a deeper economic union with common standards for public administration, competitiveness and the labor market. Second, a financial union which consists of a banking union and integrated capital markets. Third, a fiscal union that ensures sound public finances and allows for a capacity for fiscal stabilization at the union level. Finally, a political union that involves a strengthening of democratic institutions of the EU. The roadmap for the implementation of these goals includes three stages and all pillars are scheduled to be fully in place by 2025 at the latest. While the banking union has made substantial progress over the last years, fiscal unification and the features of the fiscal architecture are still at the heart of the current policy debate (see, for example, Constâncio, 2020 and Tordoir et al., 2020).

In this thesis, I study different dimensions of the interaction between economic outcomes and EU economic governance with a specific emphasis on the framework for fiscal policy and fiscal stabilization. Each of the three chapters consists of a self-contained research article followed by the corresponding appendix. Chapters 1 and 2 refer to the institutional status quo and examine the impact of existing rules. By contrast, Chapter 3 takes a forward-looking perspective and considers the effects associated with a specific potential reform of the framework.

Specifically, in Chapter 1, I focus on the implementation of the Fiscal Compact, which represented a major reform of the European fiscal framework in the year 2012. Since the foundation of the EU, European treaties have contained fiscal rules designed to ensure fiscal discipline and sound public finances in the member states. In a monetary union, national fiscal policy is the main tool for macroeconomic stabilization and the response to idiosyncratic shocks. However, the rules of the EU fiscal framework put a strain on country-specific fiscal policies. The provisions of the Fiscal Compact further tightened these rules in response to the European sovereign debt crisis. In particular, the balanced-budget rule was refined and the fiscal framework was supplemented with a debt-brake rule. A major concern is that this might promote a procyclical fiscal stance and thereby constrain effective stabilization of business cycles. In addition, the rules could potentially hamper the free operation of automatic stabilizers.

In the empirical analysis, I evaluate whether the implementation of the Fiscal Compact has affected the conduct of fiscal policy in European countries. The provisions of the compact bind all euro area member states plus Bulgaria, Denmark and Romania which decided to opt in. In particular, I use a large quarterly panel of these countries to empirically investigate the cyclical stance of fiscal policy before and after the reform of the fiscal framework. Following Galí and Perotti (2003) and Fatás and Mihov (2010), I focus on the cyclicality of discretionary fiscal policy and the role of automatic stabilizers over the cycle. The empirical analysis does not provide evidence that the Fiscal Compact has impaired the conduct of stabilizing fiscal policy in

European countries. On the contrary, I find a significant increase in countercyclicality of discretionary fiscal policy, in particular for countries with weak fiscal positions. Moreover, I document that the tightening of fiscal rules has not constrained the free operation of automatic stabilizers. Overall, this reform can be considered successful since the provisions of the Fiscal Compact have not impaired the stabilization role of fiscal policy although stricter rules were implemented. The heterogeneities across member states, however, still represent a major challenge for a unitary fiscal framework.

Chapter 2 of this thesis, co-authored by Christopher Zuber, deals with the effects of the Excessive Deficit Procedure (EDP). The EDP is designed to ensure fiscal discipline in the EU member states and constitutes the corrective arm of the Stability and Growth Pact, which is one of the core elements of EU economic governance. If a member state runs an excessive deficit or accumulates excessive debt levels, the launch of the EDP triggers a series of measures aiming at appropriate fiscal policies and sound public finances. These measures constrain the scope of fiscal policy and could affect the impact of fiscal stimulus on economic activity, thereby reducing the effectiveness of public spending.

Following Auerbach and Gorodnichenko (2012, 2013a) and Ramey and Zubairy (2018), we estimate state-dependent impulse response functions and cumulative fiscal spending multipliers to identify how the EDP affects the transmission of fiscal spending shocks. More specifically, we screen official documents provided by the European Commission to construct a dummy variable indicating whether a country is in the EDP or not. This dummy variable is used as state variable in local projections for a panel of 17 EU countries to isolate the effect of the EDP on fiscal multipliers. We document that cumulative multipliers are larger in the EDP sample. That is, the procedure increases the effectiveness of fiscal stimulus. We find that this result is mainly driven by decreasing interest rates and a substantial crowding-in of private investment that go along with a reduction in public debt in response to a positive fiscal spending shock in the EDP sample. Multipliers are even larger in bad times, indicating that the procedure is particularly effective under these circumstances. Using alternative state variables, we show that being in the EDP is not simply a proxy for a weak fiscal position or recessionary episodes. In addition, we find that policy makers tend to underestimate fiscal multipliers in real time. The results suggest that the EDP is functional and that fiscal stimulus can help the countries in the procedure to return on a path towards sustainable public finances.

Chapter 3, co-authored by Zeno Enders, is dedicated to a potential structural reform. We evaluate whether transfer schemes and, in particular, a European unemployment benefit scheme (EUBS) can fulfill a stabilization function for the euro area member countries in the event of asymmetric shocks. This question is closely related to the main argument of the Theory of Optimum Currency Areas established by Mundell (1961) and McKinnon (1963). Accordingly, the surrender of monetary autonomy and, as a consequence, flexible exchange rates is costly. In order to compensate for this cost, members of a monetary union need alternative stabilization capacities. This requirement is already emphasized in the Five President's Report. The EUBS as a prominent example of such a capacity is currently at the center of the debate on alternative risk-sharing mechanisms for the euro area (see, for example, Beblavý and Lenaerts, 2017 and Bénassy-Quéré et al., 2018).

In the analysis, we proceed in two steps and put a special emphasis on the effects of the cross-country transfers triggered by the scheme. Specifically, we first develop a simple model with nominal rigidities to build intuition by deriving analytical results. We then use a rich dynamic stochastic general equilibrium model, mainly based on Enders et al. (2013) and calibrated to the Core and the Periphery of the euro area, to quantitatively analyze the changing dynamics that a EUBS brings about. We find that a EUBS can provide risk sharing by stabilizing relative consumption as well as unemployment differentials. Following supply shocks, however, the cross-country transfer embodied in the unemployment benefits is spent to a large degree on relatively inefficiently produced goods in the receiving countries. This increases the allocative inefficiencies even further, also in response to government-spending shocks. Yet, since this trade-off between allocative efficiency and consumption risk sharing does not exist after certain demand shocks, the welfare effects of a EUBS depend on the cause for international unemployment differentials. A EUBS that is only active after specific shocks would therefore maximize overall welfare. Even without this feature, a EUBS would raise Core's welfare in the quantitative model, leaving Periphery's welfare almost unchanged. We therefore conclude that a selective system that is only triggered in response to certain shocks would be an option for the euro area.

This thesis examines different aspects of EU economic governance and their effects on the economy. To summarize, I provide evidence that the Fiscal Compact and the EDP as the corrective arm of the Stability and Growth Pact are functional features of the European fiscal framework. A potential cross-country risk-sharing mechanism in the form of a EUBS needs to be carefully designed to accommodate different economic disturbances. Overall, the economic governance framework of the EU will require further structural reforms in the future to cope with the fundamental asymmetries across member states. The present roadmap towards a completion of the EMU provides a good starting point for this task.

# 1 European fiscal policy and the Fiscal Compact

## 1.1 Introduction

The EU treaties contain a broad set of rules designed to ensure sound public finances in the member countries. Well-known examples include the Maastricht convergence criteria or the Excessive Deficit Procedure laid down in the Stability and Growth Pact. These rules evolve dynamically over time and reflect the economic trends that Europe has been facing in the last decades. On the one hand, country-specific fiscal policy is the main instrument to stabilize the economy in a monetary union. Member states therefore need some leeway for idiosyncratic fiscal policies to cope with asymmetric shocks. On the other hand, the union needs to ensure a certain degree of budgetary discipline among its members to avoid fiscal externalities and moral hazard problems. This requirement is reflected in the European fiscal framework which imposes constraints on national policies. In this context, a main concern is that fiscal rules hamper effective countercyclical stabilization over the business cycle by fostering a procyclical fiscal stance. Besides, these rules could prevent automatic stablizers from operating freely, which would additionally undermine the stabilization function of fiscal policy. In response to the sovereign debt crisis, European fiscal rules were tightened further in the Fiscal Compact, which represented a major reform of the fiscal framework in the year 2012.

In this chapter, I evaluate whether the passing of the Fiscal Compact has changed the conduct of fiscal policy. More specifically, I exploit quarterly time series for a large panel of European countries to empirically examine the cyclical stance of fiscal policy before and after the passing of the Fiscal Compact. In the spirit of Galí and Perotti (2003) and Fatás and Mihov (2010), the analysis focuses on the cyclicality of discretionary fiscal policy and the role of automatic stabilizers over the cycle. To the best of my knowledge, this is the first attempt to evaluate the impact of the Fiscal Compact on realized fiscal outcomes in European countries.

The empirical analysis does not provide evidence that the Fiscal Compact has constrained the conduct of stabilizing fiscal policy in European countries. On the contrary, I document a significant increase in countercyclicality of discretionary fiscal policy after the implementation of the compact. This finding is especially pronounced for countries with weak fiscal positions. In addition, I find that the tightening of fiscal rules has not impaired the proper functioning of automatic stabilizers over the cycle.

The remainder of the chapter is structured as follows. Section 1.2 discusses the related literature and provides a brief overview of the evolution of European fiscal governance over time. In Section 1.3, I describe the empirical strategy and the panel dataset. Section 1.4 presents the empirical results. Finally, Section 1.5 concludes. Details on the data and various robustness checks are included in the appendix.

## 1.2 Background

### 1.2.1 Related literature

There is a large body of empirical literature on the cyclical properties of fiscal policy. In an influential study using a novel dataset, Gavin and Perotti (1997) document the procyclical stance of fiscal policy in Latin American countries. Kaminsky et al. (2004) explore the cyclical behavior of fiscal policy, capital flows and monetary policy for a large sample of countries and confirm that fiscal policies are procyclical in most developing countries. Talvi and Végh (2005) and Ilzetzki and Végh (2008), among others, also provide corresponding empirical evidence. These findings established the wide-spread view that developing countries are more inclined to procyclical fiscal policies, whereas industrial countries tend to conduct countercyclical policies. In the literature, this view is mostly rationalized by political-economy considerations. On the one hand, procyclical policies in developing countries are explained by political distortions. Alesina et al. (2008) analyze a political agency problem and demonstrate that procyclicality is induced by voters that mistrust corrupt governments and demand procyclical spending to prevent political rent seeking. Ilzetzki (2011) finds that conflicts of interest and, in particular, disagreement about the distribution of public expenditures can lead to fiscal procyclicality. On the other hand, Frankel et al. (2013) and, more recently, Jalles (2018) show that the quality of rules and institutions matters for the cyclicality of fiscal policy.

Focusing on the US fiscal framework, Bayoumi and Eichengreen (1995) demonstrate that the cyclical responsiveness of fiscal policy depends on the level of government. They find that fiscal stabilization is mainly provided through the federal and state budgets, not through local governments. Alesina and Bayoumi (1996) show that US fiscal rules successfully increase fiscal discipline, but limit the scope for countercyclical stabilization. Fatás and Mihov (2006) confirm that fiscal restrictions in the US impair the government's ability to conduct countercyclical fiscal policy.

In the EU, ongoing fiscal integration has been associated with the concern that the fiscal policy framework might limit the member states' room for stabilization through countercyclical fiscal policy. Galí and Perotti (2003) compare the conduct of fiscal policy in European countries before and after the passing of the Maastricht Treaty using annual data from 1980 to 2002 and do not find evidence in support of this concern. On the contrary, they document that discretionary fiscal policies have become more countercyclical in the post-Maastricht period, while ensuring the proper functioning of automatic stabilizers. These findings are confirmed by Wyplosz (2006) in a panel of 15 European countries for the period 1980 to 2005. Fatás and Mihov (2010) extend the analysis to the introduction of the euro in 1999 and, evaluating annual data from 1970 to 2009, do not find evidence for a significant change in the cyclicality of fiscal policy after the currency changeover. In a panel of 11 EMU countries for the 1980 to 2007 period, Bénétrix and Lane (2013) document an increase in countercyclicality of fiscal policy after the Maastricht Treaty, but a decrease in countercyclicality after the introduction of the euro.

Gootjes and Haan (2020) provide evidence that budgetary outcomes in the EU are procyclical although fiscal plans are mostly acyclical. In addition, they find that the strength of fiscal rules, as measured by an index constructed from qualitative institutional information, fosters fiscal countercyclicality. Larch et al. (2021) confirm that the quality of fiscal rules and compliance therewith increases the countercyclicality of fiscal policy using a panel of EU and non-EU countries. In contrast to the latter two contributions, the analysis in this chapter focuses on the effects of one specific major reform of the EU fiscal framework, i.e., the implementation of the Fiscal Compact, and the empirical analysis relies on a large panel with quarterly data.

### 1.2.2 European fiscal governance

In 1992, the 12 member states of the European Communities signed the Maastricht Treaty which was the foundation treaty of the European Union. The Maastricht criteria for the budget deficit ($\leq$ 3% of GDP) and the public debt level ($\leq$ 60% of GDP), which were initially part of the convergence criteria to be fulfilled before adopting the common currency, became the guiding principles for the EU fiscal framework. Building on these principles, the Stability and Growth Pact (SGP) introduced a set of fiscal rules to enforce the deficit and debt limits in 1997. The *preventive arm* of the SGP establishes close fiscal monitoring and requires EU member states to document compliance with the deficit and debt rules. Under the *corrective arm*, non-compliers enter an Excessive Deficit Procedure which prescribes policy responses to get the deficit and/or the debt level under control and, ultimately, imposes sanctions.

The first reform of the SGP in 2005 aimed at a more differentiated approach providing further flexibility. In particular, the attention of EU fiscal monitoring is directed towards the underlying budgetary position as measured by the *structural budget balance*. The EU methodology defines the structural balance as the headline budget balance adjusted by the cyclical component net of one-off and temporary policy measures (Mourre et al., 2014). This balance measure provides a non-cyclical reference for fiscal surveillance, allowing for the free functioning of automatic stabilizers. In 2011, the six-pack legislation (consisting of six reform packages) strengthened the corrective arm of the SGP by tightening sanctions. One of the reform packages introduced the Macroeconomic Imbalances Procedure which addresses macroeconomic imbalances by monitoring a broad range of indicators.

The next major step in the evolution of European fiscal governance was the passing of the Fiscal Compact in 2012. Specifically, the Fiscal Compact is the fiscal chapter of the *Treaty on Stability, Coordination and Governance in the Economic and Monetary Union* (European Union, 2012). In contrast to the preceding fiscal rules mostly implemented through secondary EU legislation, this treaty is an intergovernmental agreement embedded into national (ordinary or constitutional) law. The provisions are binding for all euro area countries plus Bulgaria, Denmark and Romania which decided to opt in.

The Fiscal Compact aims to tighten the rules laid down in the SGP in response to the European debt crisis. On the one hand, the balanced-budget rule is refined and allows for more flexibility regarding the structural budgetary position. More precisely, the structural deficit limit from then on depends on the public debt level. As a general rule, the lower limit is set to 0.5% of GDP, but this treshold is relaxed to 1% of GDP for countries with debt levels significantly below the 60% reference value. On the other hand, the framework is supplemented with a debt-brake rule which prescribes a specific adjustment path towards sustainable debt levels for countries exceeding the 60% treshold. Both provisions have to be implemented into domestic law, along with an automatic correction mechanism which defines concrete measures in case of non-compliance. The depth and frequency of fiscal monitoring was further increased by the two-pack regulations in 2013.

The most recent initiative towards a deeper European fiscal integration has been launched by the Five Presidents' Report in 2015 (Juncker et al., 2015). This report—presented by the Presidents of the European Commission, the Euro Summit, the Eurogroup, the European Central Bank and the European Parliament—outlines a plan for completing the European Economic and Monetary Union. As a result, the European Fiscal Board was founded as an independent advisory body to support fiscal monitoring and the execution of fiscal rules.

Overall, the European fiscal framework has become very elaborate over time and the complexity of the rules in force has increased substantially. For example, this is also reflected in the extensive Vade Mecum on the Stability and Growth Pact that outlines the methodology and procedures related to the fiscal policy provisions (European Commission, 2019). In spite of the increased complexity of the framework, the implementation still involves a lot a judgment and, hence, room for discretionary policies. Analyzing the impact of this framework on realized fiscal outcomes is therefore crucial to assess the effectiveness of EU fiscal governance.

## 1.3 Methodology and data

### 1.3.1 Empirical strategy

The evaluation of the change in the conduct of fiscal policy after the Fiscal Compact is based on the estimation of a simple quarterly fiscal reaction function of the form

$$Fiscal_t = \alpha + \beta\, Cycle_t + Controls + u_t, \tag{1.1}$$

where the coefficient of interest $\beta$ indicates the reponsiveness of fiscal policy to cyclical conditions which are captured by $Cycle_t$. The latter is typically measured using the output gap. In the baseline estimation presented below, I allow for a structural shift in the cyclical behavior of fiscal policy induced by the Fiscal Compact. The effect captured by the coefficient $\beta$ depends on the measure that is used for the fiscal policy indicator $Fiscal_t$. Since the analysis aims to identify the effect of the Fiscal Compact on fiscal policy outcomes, I use the government budget balance which is a measure for the realized outcome.

Following Galí and Perotti (2003) and Fatás and Mihov (2010), the headline government budget balance can be decomposed into two different components. First, the cyclical component of the balance which is a measure for the automatic stabilizers inherent to public spending behavior. It accounts for the short-term automatic reaction of fiscal policy over the business cycle due to spending rules, variations in the tax base or transfers that are tied to cyclical conditions. This component is non-discretionary in the sense that it is not directly controlled by policy makers. Automatic stabilizers are determined by the institutional framework, for example the tax system, and therefore change slowly over time. The second component of the budget balance is the non-cyclical component. This component can be interpreted as an indicator for the discretionary fiscal stance, i.e., the part of fiscal policy that is directly driven by decisions of policy makers.

Hence, the interpretation of the coefficient $\beta$ in the fiscal reaction function depends on the component of the budget balance that is used in the estimation. If the headline balance is used as fiscal policy indicator, $\beta$ measures the reaction of both discretionary policy and automatic stabilizers. Using the cyclical component of the balance implies that the coefficient captures the automatic stabilizers in the economy. Finally, if a measure for the non-cyclical budget balance is used, $\beta$ corresponds to the reponsiveness of discretionary fiscal policy. As discussed in Section 1.2.2, the EU fiscal framework relies on the structural balance to quantify discretionary policy. I use the cyclically-adjusted budget balance as a proxy because the structural balance is only available at annual frequency.[1] In line with Galí and Perotti (2003), I argue that the cyclically-adjusted *primary* budget balance is the most informative indicator for discretionary fiscal policy because it excludes predetermined interest payments on public debt which could be driven by the cyclicality of interest rates. Therefore, the primary balance quantifies the component of public spending that is under direct control of fiscal authorities. In the main specification for discretionary fiscal policy, the dependent variable is the cyclically-adjusted primary balance, but I also consider the cyclically-adjusted balance.

In order to capture the cyclicality of the budget balance over the whole sample period, I run the following panel regression:

$$Balance_{i,t} = \alpha_i + \beta\, Cycle_{i,t} + \gamma\, Debt_{i,t-1} + \delta\, Balance_{i,t-1} + u_{i,t}, \tag{1.2}$$

where $\alpha_i$ captures country-specific fixed effects, $\beta$ quantifies the cyclical reponsiveness of fiscal policy, $\gamma$ accounts for debt stabilization and $\delta$ allows for budget smoothing over time. Since positive values of the balance refer to a budget surplus, $\beta > 0$ indicates a countercyclical stance of fiscal policy, while $\beta < 0$ implies procyclicality.[2]

In the main specification, I allow for a structural shift in the conduct of discretionary fiscal policy after the Fiscal Compact by including a dummy variable and a corresponding interaction term. More specifically, I estimate the following regression:

$$\begin{aligned} Balance_{i,t} = \alpha_i + \alpha_{fc}\, Dfc_{i,t} + \beta\, Cycle_{i,t} + \beta_{fc}\, (Dfc_{i,t} \cdot Cycle_{i,t}) \\ + \gamma\, Debt_{i,t-1} + \delta\, Balance_{i,t-1} + u_{i,t}, \end{aligned} \tag{1.3}$$

where $Dfc_{i,t} = 1$ in the periods after the passing of the Fiscal Compact. The coefficient $\beta_{fc}$ captures the change in the responsiveness to cyclical conditions after the Fiscal Compact, whereas $\alpha_{fc}$ allows for an intercept shift. Accordingly, $\beta_{fc} > 0$ indicates an increase in the countercyclicality of fiscal policy. Note that the specification does not feature time fixed effects. I argue that

[1] One-off measures are usually small and the sample period starts after the UMTS license auctions.

[2] Using the budget balance as fiscal policy indicator is standard in the literature. Note, however, that this is an aggregate measure which does not differentiate between the cyclicality of the revenue and income side of the underlying government budget constraint, e.g., see Kaminsky et al. (2004) and Alesina et al. (2008).

exceptional periods like the European sovereign debt crisis should be explicitly included in the sample because the specific design of the EU fiscal governance framework reflects these episodes. However, the results are robust to the inclusion of time fixed effects, see Appendix 1.C.

I use the output gap as measure for the cyclical indicator $Cycle_{i,t}$. In order to address potential endogeneity issues, I use two alternative approaches. First, I estimate the fiscal reaction by OLS and replace the indicator with its lag, $Cycle_{i,t-1}$. Following Blanchard and Perotti (2002), the underlying identifying assumption excludes a contemporaneous response of the fiscal policy measure to the economic cycle due to decision and implementation lags. Second, I use an instrumental variable (IV) specification with the trade-weighted average rest-of-the-sample output gap and the lag $Cycle_{i,t-1}$ as instruments for the cyclical indicator $Cycle_{i,t}$. This approach, pioneered by Jaimovich and Panizza (2007) as a refinement of the instruments proposed in Galí and Perotti (2003) and Alesina et al. (2008), is widely used in the literature.[3]

### 1.3.2 Data description

The balanced panel includes quarterly data running from 2002Q1 through 2019Q4 for 21 countries bound by the Fiscal Compact (the euro area member states, excluding the Slovak Republic because of missing data, plus Bulgaria, Denmark and Romania).[4] I use seasonally-adjusted data for the headline budget balance, the primary budget balance, the debt-to-GDP ratio and real GDP. Appendix 1.A lists the exact series and the corresponding sources. In addition, I code a dummy variable to capture the periods in which the Fiscal Compact is in force. This dummy is country-specific since the entry into force of the compact differs across countries, see Appendix 1.A for the exact dates.

The cyclically-adjusted primary budget balance, denoted by $CAPB_{i,t}$, is constructed according to the methodology used by the European Commission (Mourre et al., 2014). More specifically, the $CAPB_{i,t}$ for each country $i$ is given by the difference between the primary balance $PB_{i,t}$ and an estimated cyclical component:

$$CAPB_{i,t} = PB_{i,t} - \varepsilon_i \cdot Gap_{i,t}, \tag{1.4}$$

where $Gap_{i,t}$ denotes the output gap and $\varepsilon_i$ corresponds to the country-specific semi-elasticity of the headline budget balance to the economic cycle reported in Mourre et al. (2019) and listed in Appendix 1.A. Mourre et al. (2019) derive the budgetary semi-elasticities $\varepsilon_i$ based

[3] See, for example, Lane (2003), Bénétrix and Lane (2013) or Eyraud et al. (2017).

[4] Heterogeneous monetary policy reactions in Bulgaria, Denmark and Romania could affect fiscal policies in these countries. However, the results remain unchanged if Bulgaria, Denmark and Romania are excluded from the sample, see Appendix 1.C.

on the semi-elasticities of revenues and expenditures, which are in turn weighted aggregates of the elasticities associated with the corresponding components. The cyclically-adjusted balance, denoted by $CAB_{i,t}$, is constructed accordingly, using the difference between the budget balance and the cyclical component.[5]

The output gap, which is used as cyclical indicator and for the construction of the cyclically-adjusted budget balance, is measured as the percentage deviation of GDP from its trend. I employ the standard HP filter with a smoothing parameter of 1600 to extract the trend component of GDP.[6] The trade-weighted output gap that is used as an instrument in the IV specification is constructed with export weights, see Appendix 1.A for details.

## 1.4 Results

### 1.4.1 Cyclical behavior of discretionary fiscal policy

Table 1.1 displays the estimates for the discretionary component of fiscal policy measured by the cyclically-adjusted primary budget balance (CAPB). For each specification, I report the results of both the OLS estimation and the IV approach discussed in Section 1.3.1. The first and second column show the estimates for the specification which abstracts from the shift in the institutional framework, see Equation (1.2).

**Table 1.1:** Discretionary fiscal policy

| $Balance:$ | CAPB (OLS) | CAPB (IV) | CAPB (OLS) | CAPB (IV) |
|---|---|---|---|---|
| $Cycle$ | −0.06 | −0.04 | −0.12** | −0.09** |
| | (0.04) | (0.04) | (0.04) | (0.04) |
| $Debt(t-1)$ | 0.01* | 0.02*** | 0.01 | 0.01 |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| $Balance(t-1)$ | 0.49*** | 0.49*** | 0.48*** | 0.48*** |
| | (0.08) | (0.02) | (0.08) | (0.02) |
| $Dfc$ | | | 0.58* | 0.56*** |
| | | | (0.31) | (0.21) |
| $Dfc \cdot Cycle$ | | | 0.30* | 0.38*** |
| | | | (0.17) | (0.14) |

*Notes*: Panel estimates including country fixed effects with robust standard errors in parentheses. Asterisks denote statistical significance level: * 10%, ** 5%, *** 1%. $N = 1491$ across all specifications. 'OLS' estimation uses $Cycle_{i,t-1}$. 'IV' refers to 2SLS estimation with trade-weighted average rest-of-the-sample output gap and $Cycle_{i,t-1}$ as instruments.

[5] The estimates for the budgetary semi-elasticities are revised on a regular basis. Appendix 1.C shows that the results are not affected if the old estimates reported in Mourre et al. (2014) are used.
[6] The results are robust to using polynomials of order $k = \{2, 3, 4\}$ to extract trend GDP, see Appendix 1.C.

**Table 1.2:** Discretionary fiscal policy

| *Balance* : | CAB (OLS) | CAB (IV) | CAB (OLS) | CAB (IV) |
|---|---|---|---|---|
| *Cycle* | −0.04 | −0.02 | −0.12** | −0.09** |
| | (0.04) | (0.04) | (0.04) | (0.04) |
| $Debt(t-1)$ | 0.01 | 0.01** | −0.01 | 0.00 |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| $Balance(t-1)$ | 0.51*** | 0.51*** | 0.48*** | 0.48*** |
| | (0.08) | (0.02) | (0.08) | (0.02) |
| $Dfc$ | | | 1.07*** | 1.05*** |
| | | | (0.34) | (0.22) |
| $Dfc \cdot Cycle$ | | | 0.35* | 0.48*** |
| | | | (0.19) | (0.14) |

*Notes*: Panel estimates including country fixed effects with robust standard errors in parentheses. Asterisks denote statistical significance level: * 10%, ** 5%, *** 1%. $N = 1491$ across all specifications. 'OLS' estimation uses $Cycle_{i,t-1}$. 'IV' refers to 2SLS estimation with trade-weighted average rest-of-the-sample output gap and $Cycle_{i,t-1}$ as instruments.

Discretionary fiscal policy is found to be acyclical on average for the whole sample period. However, the estimates from specification (1.3) reported in the third and fourth column reveal that fiscal policy was indeed procyclical in the period prior the Fiscal Compact. Afterwards, there was a significant increase in countercyclicality. This result is even more pronounced for the IV estimates. As expected, the estimates document significant autocorrelation of the budget balance, i.e., there is considerable budget smoothing. Furthermore, the Fiscal Compact led to an improvement in average balances as indicated by the shift in the intercept. This is consistent with the tightening of fiscal rules laid down in the compact.

Table 1.2 reports the estimates of the same specifications for discretionary fiscal policy as measured by the cyclically-adjusted budget balance (CAB). The results are in line with the findings discussed above. In particular, the estimates confirm the strong increase in countercyclicality after the implementation of the Fiscal Compact.

### 1.4.2 Countries with weak fiscal positions

So far, the analysis finds no evidence for an increase in the procyclicality of fiscal policy after the Fiscal Compact. In fact, the provisions of the Fiscal Compact seem to foster a countercyclical fiscal stance, thereby supporting effective cyclical stabilization. However, the panel includes 21 countries characterized by a high degree of asymmetry. Fiscal policy in countries with weak fiscal positions is obviously most constrained by the tightening of rules. In order to account for this dimension of cross-country heterogeneity, I consider different country subsamples. First, I split the sample into the GIPS countries (Greece, Italy, Portugal, Spain), which were particularly badly affected by the European sovereign debt crisis, and the remaining countries. Second, using

**Table 1.3:** Subsamples of countries with weak fiscal positions

| | # Countries | Sample Size |
|---|---|---|
| Full sample | 21 | 1491 |
| Non-GIPS countries | 17 | 1207 |
| GIPS countries | 4 | 284 |
| Deficit $\geq$ 3% of GDP | 11 | 781 |
| Debt-to-GDP ratio $\geq$ 60% | 9 | 639 |
| Debt and deficit above limit | 6 | 426 |

a straightforward indicator for a weak fiscal position, I select the countries that on average did not comply with the Maastricht criteria in the sample period prior to the implementation of the Fiscal Compact. For these countries, I further differentiate between average non-compliance with the deficit criterion, the debt criterion and both criteria at the same time. Table 1.3 summarizes the aggregate sample size and the number of countries included in each of the subsamples.[7]

In Figure 1.1, I present the results of the subsample analysis. More specifically, the plot shows the point estimates for the change in the cyclical responsiveness of the cyclically-adjusted primary balance induced by the Fiscal Compact, denoted by $\beta_{fc}$ in Equation (1.3), along with the corresponding 90% confidence intervals. For comparison purposes, the first line of the figure displays the full-sample estimate as reported in Table 1.1. The second line refers to a group of all countries excluding the GIPS states. The estimate is not significantly different from zero, suggesting that the compact did not considerably alter the conduct of discretionary fiscal policy in these countries. In the GIPS states, however, discretionary fiscal policy became much more countercyclical after the implementation of the Fiscal Compact, with a point estimate for the change in cyclical responsiveness of 0.81.

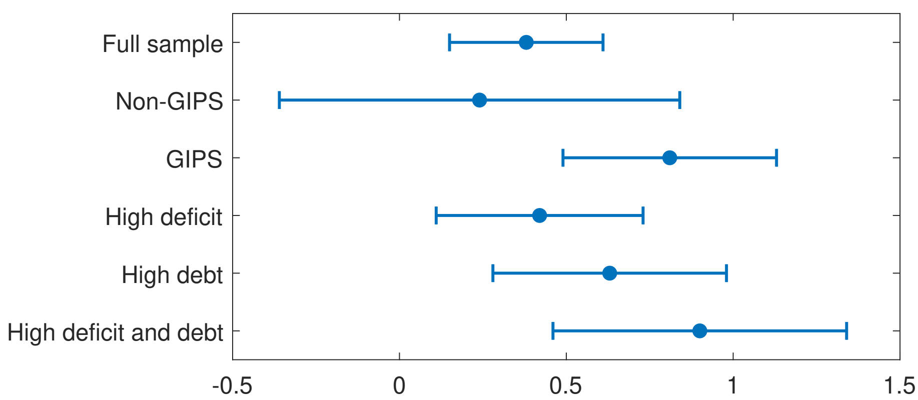


**Figure 1.1:** Change in cyclical responsiveness after Fiscal Compact

*Notes:* Point estimates for $\beta_{fc}$ from IV specification of Equation (1.3) with 90% confidence intervals. Dependent variable: CAPB. See Appendix 1.B for full set of estimation results.

[7] Appendix 1.B lists the countries included in each subsample.

Focusing on the countries with a high deficit (i.e., the non-compliers with the Maastricht deficit criterion), the point estimate is only slightly larger than the full-sample estimate. For the high-debt countries (i.e., the countries with public debt levels exceeding the Maastricht threshold), the change in the cyclical responsiveness is found to be more pronounced. In the subsample restricted to countries breaching both the deficit and debt criteria, the Fiscal Compact induced a large shift in the cyclical behavior. The point estimate amounts to 0.90 and is even higher than the estimate associated with the GIPS subsample.

Overall, the subsample analysis leads to the conclusion that the provisions of the Fiscal Compact do not impair the ability of countries with weak fiscal positions to conduct countercyclical fiscal policy. The increase in countercyclicality after the implementation of the compact is even stronger in these countries, allowing for a more effective cyclical stabilization.

### 1.4.3 Debt stabilization

Besides the balanced-budget rule, the Fiscal Compact also aims at improving the sustainability of public debt levels. Following Wyplosz (2006) and Bénétrix and Lane (2013), I account for this motive by allowing for a shift in the responsiveness of the budget balance to the debt level with the implementation of the Fiscal Compact. In particular, I estimate the following reaction function:

$$\begin{aligned} Balance_{i,t} = \alpha_i + \alpha_{fc}\, Dfc_{i,t} + \beta\, Cycle_{i,t} + \beta_{fc}\,(Dfc_{i,t} \cdot Cycle_{i,t}) \\ + \gamma\, Debt_{i,t-1} + \gamma_{fc}\,(Dfc_{i,t} \cdot Debt_{i,t-1}) + \delta\, Balance_{i,t-1} + u_{i,t}, \end{aligned} \tag{1.5}$$

where $\gamma_{fc}$ captures the change in the responsiveness to the debt level. Table 1.4 reports the estimation results.

First, all specifications show that there was a significant but small increase in the debt stabilization coefficient after the Fiscal Compact. This implies a higher priority on debt sustainability. However, the ongoing accumulation of public debt observed in some European countries underlines that this finding reflects an average effect across all countries included in the panel. Second, the coefficients for the intercept shift after the implementation of the Fiscal Compact are negative, although statistically not significant. These estimates stand in contrast to the positive shift in the intercept reported in Table 1.1 and Table 1.2. The baseline specification, however, does not account for a change in the responsiveness to the debt level. Since debt levels are strictly positive for all countries in the panel, this is consistent with an improvement of the average balance after the Fiscal Compact.

**Table 1.4:** Debt stabilization

| *Balance* : | CAB (OLS) | CAB (IV) | CAPB (OLS) | CAPB (IV) |
|---|---|---|---|---|
| *Cycle* | −0.14*** | −0.11** | −0.13*** | −0.10** |
| | (0.05) | (0.04) | (0.04) | (0.04) |
| $Debt(t-1)$ | −0.03** | −0.02*** | −0.01 | 0.00 |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| $Balance(t-1)$ | 0.45*** | 0.45*** | 0.46*** | 0.47*** |
| | (0.08) | (0.02) | (0.08) | (0.02) |
| $Dfc$ | −0.24 | −0.25 | −0.25 | −0.25 |
| | (0.45) | (0.35) | (0.39) | (0.35) |
| $Dfc \cdot Cycle$ | 0.40* | 0.55*** | 0.33* | 0.42*** |
| | (0.20) | (0.14) | (0.18) | (0.14) |
| $Dfc \cdot Debt(t-1)$ | 0.02*** | 0.02*** | 0.01** | 0.01*** |
| | (0.01) | (0.01) | (0.01) | (0.00) |

*Notes*: Panel estimates including country fixed effects with robust standard errors in parentheses. Asterisks denote statistical significance level: * 10%, ** 5%, *** 1%. $N = 1491$ across all specifications. 'OLS' estimation uses $Cycle_{i,t-1}$. 'IV' refers to 2SLS estimation with trade-weighted average rest-of-the-sample output gap and $Cycle_{i,t-1}$ as instruments.

### 1.4.4 Automatic stabilizers

Finally, I focus on the effect of the implementation of the Fiscal Compact on the automatic stabilizers in the economy. Following Galí and Perotti (2003) and Fatás and Mihov (2010), the cyclical (or non-discretionary) component of the budget balance is used as a measure for the automatic stabilizers, see Section 1.3.1. The cyclical component is given by the difference between the headline (primary) balance and the cyclically-adjusted (primary) balance, i.e., the discretionary component. In line with Fatás and Mihov (2010), I estimate specification (1.3) by OLS using the contemporaneous cycle measure in order to account for the inherent simultaneity. The automatic response of the non-discretionary component to cyclical conditions is a built-in feature of the budget. For instance, movements in the tax revenues or state-contingent public transfers are merely driven by the economic cycle and independent of discretionary policy decisions, at least in the short run. Moreover, reverse causality is not an issue due to the nature of the cyclical component of the budget balance.

Table 1.5 reports the results for the cyclical balance (CB) and the cyclical primary balance (CPB). As expected, automatic stabilizers are clearly countercyclical for the whole sample period and the implementation of the Fiscal Compact reinforced this pattern.[8] The estimates for the intercept shift show that the Fiscal Compact did not affect the average cyclical balance.

[8] Fatás and Mihov (2010) point out that the cyclical responsiveness of the automatic stabilizers should reflect the semi-elasticities used for the cyclical adjustment of the budget balance. This is indeed the case for the estimates. The average semi-elasticity of the countries included in the panel amounts to 0.51 (see Appendix 1.A), which is close to the values shown in Table 1.5.

**Table 1.5:** Automatic stabilizers

| $Balance:$ | CB | CB | CPB | CPB |
|---|---|---|---|---|
| $Cycle$ | 0.44*** | 0.42*** | 0.44*** | 0.42*** |
| | (0.03) | (0.03) | (0.03) | (0.03) |
| $Debt(t-1)$ | 0.00* | 0.00 | 0.00* | 0.00 |
| | (0.00) | (0.00) | (0.00) | (0.00) |
| $Balance(t-1)$ | 0.06* | 0.06** | 0.06* | 0.06** |
| | (0.03) | (0.03) | (0.03) | (0.03) |
| $Dfc$ | | 0.00 | | 0.00 |
| | | (0.01) | | (0.01) |
| $Dfc \cdot Cycle$ | | 0.07*** | | 0.07*** |
| | | (0.02) | | (0.02) |

*Notes*: Panel estimates including country fixed effects with robust standard errors in parentheses. Asterisks denote statistical significance level: * 10%, ** 5%, *** 1%. $N = 1491$ across all specifications.

Thus, the change in the fiscal framework has not impaired the proper functioning of automatic stabilizers. Galí and Perotti (2003) draw the same conclusion for the change in fiscal rules induced by the Maastricht Treaty.

The strongly countercyclical stance of the automatic stabilizers is also reflected in the cyclical behavior of the headline budget balance. Table 1.6 shows the estimates for the headline balance (B) and the primary balance (PB) as dependent variables. Both are slightly countercyclical prior to the implementation of the Fiscal Compact, indicating that the strong automatic stabilizers dominate the cyclicality of the balance. In line with the previous results, countercyclicality increased afterwards.

**Table 1.6:** Headline balance

| $Balance:$ | B (OLS) | B (IV) | PB (OLS) | PB (IV) |
|---|---|---|---|---|
| $Cycle$ | 0.05 | 0.13*** | 0.05 | 0.14*** |
| | (0.04) | (0.04) | (0.04) | (0.04) |
| $Debt(t-1)$ | −0.01 | −0.01 | 0.00 | 0.01 |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| $Balance(t-1)$ | 0.50*** | 0.48*** | 0.50*** | 0.48*** |
| | (0.08) | (0.02) | (0.08) | (0.02) |
| $Dfc$ | 1.05*** | 1.05*** | 0.59* | 0.57*** |
| | (0.34) | (0.22) | (0.32) | (0.21) |
| $Dfc \cdot Cycle$ | 0.25 | 0.41*** | 0.20 | 0.31** |
| | (0.21) | (0.14) | (0.19) | (0.14) |

*Notes*: Panel estimates including country fixed effects with robust standard errors in parentheses. Asterisks denote statistical significance level: * 10%, ** 5%, *** 1%. $N = 1491$ across all specifications. 'OLS' estimation uses $Cycle_{i,t-1}$. 'IV' refers to 2SLS estimation with trade-weighted average rest-of-the-sample output gap and $Cycle_{i,t-1}$ as instruments.

## 1.5 Conclusion

Fiscal policy is the main stabilization tool for countries in monetary unions. The European fiscal framework includes a broad set of rules that could potentially put a strain on national fiscal policies. In this chapter, I provide evidence that the Fiscal Compact, signed in 2012, has not constrained the conduct of country-specific policy. On the contrary, the tightening of rules increased countercyclicality of discretionary fiscal policy, especially in countries with weak fiscal positions, and still allows automatic stabilizers to function properly over the cycle.

The implications for the further evolution of European fiscal governance are evident. First, the provisions of the Fiscal Compact are functional in the sense that the stabilization role of fiscal policy is not impaired although stricter rules were implemented. Second, the provisions are particularly successful in reducing procyclicality in countries with weak fiscal positions which are the main target of the rules. Third, monitoring based on cyclically-adjusted budget balance measures, i.e., the structural balance in the EU case, seems to provide a suitable framework for effective fiscal surveillance. However, EU economic governance will continue to be faced with different requirements of heterogeneous member states in the future, representing a key challenge for a unitary fiscal framework.

# Appendix

## 1.A Data

**Table 1.A-1:** Data sources

| Series | Source |
|---|---|
| Net lending (in % of GDP) | Eurostat |
| Government primary deficit (in % of GDP) | ECB SDW |
| Government consolidated gross debt (in % of GDP) | Eurostat |
| Real GDP (chain linked volumes, 2010) | Eurostat |
| Exports (in US Dollars) | IMF DOTS |

**Table 1.A-2:** Fiscal Compact dummy by member state

| Member state | Entry into force |
|---|---|
| Austria, Cyprus, Denmark*, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Portugal, Romania*, Slovenia, Spain | 01/01/2013 |
| Luxembourg | 01/06/2013 |
| Malta | 01/07/2013 |
| Netherlands | 01/11/2013 |
| Bulgaria*, Latvia | 01/01/2014 |
| Belgium | 01/04/2014 |
| Lithuania | 01/01/2015 |

*Notes*: Countries marked with * are not part of the euro area but decided to opt in. The Slovak Republic is not included in the sample due to missing data.

**Table 1.A-3:** Budgetary semi-elasticities

| | Source | |
|---|---|---|
| Country | Mourre et al. (2019) | Mourre et al. (2014) |
| Belgium | 0.615 | 0.605 |
| Bulgaria | 0.298 | 0.308 |
| Denmark | 0.589 | 0.619 |
| Germany | 0.504 | 0.551 |
| Estonia | 0.486 | 0.443 |
| Ireland | 0.522 | 0.528 |
| Greece | 0.524 | 0.483 |
| Spain | 0.597 | 0.539 |
| France | 0.630 | 0.603 |
| Italy | 0.544 | 0.539 |
| Cyprus | 0.504 | 0.523 |
| Latvia | 0.378 | 0.380 |
| Lithuania | 0.399 | 0.413 |
| Luxembourg | 0.462 | 0.445 |
| Malta | 0.479 | 0.456 |
| Netherlands | 0.605 | 0.646 |
| Austria | 0.571 | 0.580 |
| Portugal | 0.538 | 0.506 |
| Romania | 0.321 | 0.339 |
| Slovenia | 0.468 | 0.477 |
| Finland | 0.582 | 0.574 |
| Average | 0.506 | 0.503 |
| EU | 0.554 | 0.563 |

*Notes*: 'Average' refers to the arithmetic mean over the countries inclucted in the sample. 'EU' denotes the aggregate semi-elasticity of EU countries reported in Mourre et al. (2019) and Mourre et al. (2014).

**Calculation of trade-weighted output gaps:**

Following Alesina et al. (2008), Galí and Perotti (2003), and Jaimovich and Panizza (2007), I use the trade-weighted average output gap of the other countries in the sample as instrument for the output gap of country $i$:

$$Gap_{i,t} \; = \; \sum_{j} \omega_{ij,t} \, Gap_{j,t}$$

where $\omega_{ij,t}$ denotes the fraction of exports from country $i$ going to country $j$.

## 1.B Countries with weak fiscal positions

**Table 1.B-1:** Overview of subsamples

| Subsample | Included countries |
|---|---|
| Deficit $\geq$ 3% of GDP | Ireland, Greece, Spain, France, Italy, Cyprus, Lithuania, Malta, Portugal, Romania, Slovenia |
| Debt-to-GDP ratio $\geq$ 60% | Belgium, Germany, Greece, France, Italy, Cyprus, Malta, Austria, Portugal |
| Debt and deficit above limit | Cyprus, Greece, France, Italy, Malta, Portugal |

**Table 1.B-2:** Detailed estimation results (Dependent variable: CAPB)

| | No-GIPS | GIPS | High deficit | High debt | High deficit and debt |
|---|---|---|---|---|---|
| $Cycle$ | −0.09** | −0.16 | −0.14* | −0.07 | −0.29* |
| | (0.05) | (0.15) | (0.09) | (0.11) | (0.16) |
| $Debt(t-1)$ | 0.00 | 0.01 | −0.01 | 0.02*** | 0.01 |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) |
| $Balance(t-1)$ | 0.44*** | 0.58*** | 0.44*** | 0.30*** | 0.26*** |
| | (0.03) | (0.05) | (0.03) | (0.04) | (0.05) |
| $Dfc$ | 0.59*** | 0.94 | 1.58*** | 0.85*** | 1.43*** |
| | (0.23) | (0.72) | (0.43) | (0.32) | (0.51) |
| $Dfc \cdot Cycle$ | 0.24 | 0.81*** | 0.42** | 0.63*** | 0.90*** |
| | (0.16) | (0.30) | (0.19) | (0.22) | (0.27) |
| $N$ | 1207 | 284 | 781 | 639 | 426 |

*Notes*: Panel estimates including country fixed effects with robust standard errors in parentheses. Asterisks denote statistical significance level: * 10%, ** 5%, *** 1%. 2SLS estimation with trade-weighted average rest-of-the-sample output gap and $Cycle_{i,t-1}$ as instruments.

## 1.C Robustness checks

**Table 1.C-1:** Estimation with time fixed effects

| *Balance* : | CAPB | CAPB | CAPB | CPB |
|---|---|---|---|---|
| *Cycle* | −0.29*** | −0.38*** | −0.38*** | 0.39*** |
| | (0.00) | (0.00) | (0.06) | (0.03) |
| $Debt(t-1)$ | 0.02*** | 0.02*** | 0.01 | 0.00 |
| | (0.01) | (0.00) | (0.01) | (0.00) |
| $Balance(t-1)$ | 0.36*** | 0.35*** | 0.34*** | 0.08* |
| | (0.00) | (0.00) | (0.02) | (0.04) |
| *Dfc* | | −0.63 | −1.32* | 0.05 |
| | | (0.40) | (0.79) | (0.04) |
| $Dfc \cdot Cycle$ | | 0.51*** | 0.53*** | 0.09*** |
| | | (0.01) | (0.18) | (0.02) |
| $Dfc \cdot Debt(t-1)$ | | | 0.01** | |
| | | | (0.00) | |

*Notes*: Panel estimates including country fixed effects with robust standard errors in parentheses. Asterisks denote statistical significance level: * 10%, ** 5%, *** 1%. $N = 1491$ across all specifications. 2SLS estimation with trade-weighted average rest-of-the-sample output gap and $Cycle_{i,t-1}$ as instruments.

**Table 1.C-2:** Restricting the sample to euro area countries

| *Balance* : | CAPB | CAPB | CAPB | CPB |
|---|---|---|---|---|
| *Cycle* | −0.03 | −0.08* | −0.10** | 0.44*** |
| | (0.04) | (0.05) | (0.05) | (0.03) |
| $Debt(t-1)$ | 0.01*** | 0.00 | −0.01 | 0.00 |
| | (0.01) | (0.01) | (0.01) | (0.00) |
| $Balance(t-1)$ | 0.49*** | 0.47*** | 0.46*** | 0.04* |
| | (0.02) | (0.03) | (0.03) | (0.02) |
| *Dfc* | | 0.78*** | −0.15 | 0.00 |
| | | (0.24) | (0.41) | (0.01) |
| $Dfc \cdot Cycle$ | | 0.36** | 0.40*** | 0.06** |
| | | (0.14) | (0.15) | (0.02) |
| $Dfc \cdot Debt(t-1)$ | | | 0.01*** | |
| | | | (0.01) | |

*Notes*: Panel estimates including country fixed effects with robust standard errors in parentheses. Asterisks denote statistical significance level: * 10%, ** 5%, *** 1%. $N = 1278$ across all specifications. 2SLS estimation with trade-weighted average rest-of-the-sample output gap and $Cycle_{i,t-1}$ as instruments.

**Table 1.C-3:** Using semi-elasticities reported in Mourre et al. (2014)

| *Balance* : | CAPB | CAPB | CAPB | CPB |
|---|---|---|---|---|
| *Cycle* | −0.04 | −0.08* | −0.10** | 0.42*** |
| | (0.04) | (0.04) | (0.04) | (0.02) |
| *Debt*$(t-1)$ | 0.02*** | 0.01 | 0.00 | 0.00 |
| | (0.01) | (0.01) | (0.01) | (0.00) |
| *Balance*$(t-1)$ | 0.49*** | 0.48*** | 0.47*** | 0.05** |
| | (0.02) | (0.02) | (0.02) | (0.02) |
| *Dfc* | | 0.57*** | −0.25 | 0.00 |
| | | (0.21) | (0.35) | (0.01) |
| $Dfc \cdot Cycle$ | | 0.38*** | 0.42*** | 0.07*** |
| | | (0.14) | (0.14) | (0.02) |
| $Dfc \cdot Debt(t-1)$ | | | 0.01*** | |
| | | | (0.00) | |

*Notes*: Panel estimates including country fixed effects with robust standard errors in parentheses. Asterisks denote statistical significance level: * 10%, ** 5%, *** 1%. $N = 1491$ across all specifications. 2SLS estimation with trade-weighted average rest-of-the-sample output gap and $Cycle_{i,t-1}$ as instruments.

**Table 1.C-4:** Using polynomial of order $k$ to extract GDP trend

| | $k=2$ | | | $k=3$ | | | $k=4$ | | |
|---|---|---|---|---|---|---|---|---|---|
| *Balance* : | CAPB | CAPB | CPB | CAPB | CAPB | CPB | CAPB | CAPB | CPB |
| *Cycle* | −0.20*** | −0.21*** | 0.35*** | −0.14*** | −0.15*** | 0.41*** | −0.16*** | −0.18*** | 0.41*** |
| | (0.02) | (0.02) | (0.05) | (0.03) | (0.03) | (0.03) | (0.03) | (0.04) | (0.03) |
| *Debt*$(t-1)$ | 0.01 | 0.00 | 0.00* | 0.00 | 0.00 | −0.01 | 0.00 | −0.01 | 0.00 |
| | (0.01) | (0.01) | (0.00) | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) | (0.00) |
| *Balance*$(t-1)$ | 0.47*** | 0.46*** | 0.23*** | 0.48*** | 0.47*** | 0.10** | 0.49*** | 0.48*** | 0.09*** |
| | (0.02) | (0.02) | (0.07) | (0.02) | (0.02) | (0.04) | (0.02) | (0.02) | (0.03) |
| *Dfc* | 0.57*** | −0.19 | 0.04 | 0.50** | −0.27 | −0.01 | 0.55*** | −0.23 | 0.00 |
| | (0.21) | (0.34) | (0.03) | (0.21) | (0.35) | (0.02) | (0.21) | (0.35) | (0.01) |
| $Dfc \cdot Cycle$ | 0.09** | 0.10** | 0.04*** | 0.14* | 0.17** | 0.05*** | 0.24** | 0.26*** | 0.06*** |
| | (0.04) | (0.04) | (0.01) | (0.08) | (0.08) | (0.01) | (0.09) | (0.09) | (0.02) |
| $Dfc \cdot Debt(t-1)$ | | 0.01*** | | | 0.01*** | | | 0.01*** | |
| | | (0.00) | | | (0.00) | | | (0.00) | |

*Notes*: Panel estimates including country fixed effects with robust standard errors in parentheses. Asterisks denote statistical significance level: * 10%, ** 5%, *** 1%. $N = 1491$ across all specifications. 2SLS estimation with trade-weighted average rest-of-the-sample output gap and $Cycle_{i,t-1}$ as instruments.

# 2 The effect of the European Excessive Deficit Procedure on fiscal spending multipliers

## 2.1 Introduction

The Stability and Growth Pact is one of the core elements of European fiscal governance. Implemented in 1997, it provides a rule-based framework for fiscal policy to ensure sound public finances and fiscal discipline in the European Union. The Excessive Deficit Procedure (EDP) is the corrective arm of this framework. If a member state runs an excessive deficit or accumulates high levels of public debt, an EDP is launched. The adjustments prescribed by the EDP provisions aim to ensure appropriate fiscal policies and, as a consequence, sustainable public finances. These measures put an additional strain on public budgets and fiscal spending behavior. This may interfere with the impact of government spending on economic activity and, in particular, the effectiveness of fiscal stimulus in bad times. In this chapter, we explore whether the EDP affects fiscal spending multipliers. Specifically, we estimate state-dependent impulse response functions and cumulative multipliers for a panel of European countries using local projection methods to identify how the EDP alters the transmission of fiscal spending shocks.

In the literature on the determinants of fiscal multipliers, the recent debate has revolved around potential state dependence. In particular, a growing number of studies explores how economic conditions affect the output response to fiscal stimulus. Regarding the impact of the business cycle position, the empirical evidence is mixed. Auerbach and Gorodnichenko (2012, 2013a) document that fiscal multipliers in recessions are larger than in expansions. By contrast, Owyang et al. (2013) and Ramey and Zubairy (2018) do not find evidence that public spending is more effective during times of slack measured by high levels of the unemployment rate.

Ilzetzki et al. (2013) evaluate how multipliers vary across different economic environments and find larger multipliers under fixed exchange rate regimes and smaller multipliers in high-debt countries. The latter finding is confirmed by Nickel and Tudyka (2014) and, more recently, Banerjee and Zampolli (2019). Corsetti et al. (2012b) document lower fiscal multipliers for countries with weak fiscal positions as measured by high debt levels and excessive deficits. This finding is driven by significant crowding-out of private investment. Huidrom et al. (2020) identify two channels through which high public debt has an effect on the size of fiscal multipliers. First, Ricardian households decrease consumption in response to fiscal stimulus because they anticipate adjustments in the future. Second, public spending raises sovereign risk and puts upward pressure on interest rate, which reduces private demand. Thus, lower multipliers in weak fiscal positions are rationalized by crowding-out of private consumption.

We contribute to this literature by evaluating the specific impact of the EDP on fiscal spending multipliers. More precisely, we screen official documents provided by the European Commission to construct a dummy variable indicating whether a country is in the EDP or not. We use this dummy as state variable in the estimation of cumulative spending multipliers and the corresponding impulse response functions. We document that cumulative multipliers for countries in the EDP are significantly larger, suggesting that government spending in these countries is more effective. The inspection of the underlying transmission mechanisms reveals that this finding is mainly driven by a decrease in interest rates and substantial crowding-in of private investment in response to fiscal stimulus. At the same time, we observe a decrease in public debt. We find that the EDP is especially effective in bad times, as indicated by larger multipliers for countries with weak fiscal positions, in recessions or during banking crises. In addition, the comparison with alternative state variables provides evidence that the EDP is not simply a proxy for a weak fiscal position, recessionary episodes and banking crises. Finally, we show that fiscal multipliers are significantly understated if estimated in real time.

These results have some important policy implications. First, and most importantly, the EDP seems to be functional. The output response to fiscal spending is stronger and public debt decreases in response to a positive spending shock in countries under the procedure. Thus, fiscal stimulus could help these countries to return on a path towards more sustainable public finances. By contrast, fiscal consolidation would have substantial contractionary and therefore harmful effects in these economies. Second, the EDP is especially effective in bad times which is the purpose it is designed for. Third, policy makers could underestimate the effects of fiscal stimulus due to lower multipliers in real time.

The remainder of the chapter is structured as follows. In Section 2.2, we describe the EDP and explain the construction of the EDP dummy variable. Section 2.3 introduces the empirical strategy and the data. We discuss the estimation results in Section 2.4 and compare these results with multipliers based on alternative state variables in Section 2.5. In Section 2.6, we present results for real-time multipliers. Section 2.7 concludes.

## 2.2 The Excessive Deficit Procedure

The EDP is a multi-step procedure with the objective to correct imbalances of public finances by urging the affected member states to reduce excessive deficits and/or debt levels. Despite the name of the procedure, the EDP always takes into account both criteria. The details of the EDP provisions are laid down in Article 126 of the *Treaty on the Functioning of the European Union* (European Union, 2008). An EDP can be launched in two cases. First, for countries with headline budget deficits exceeding, or being at risk to exceed, the limit of 3% of GDP. Second, for countries with public debt levels above 60% of GDP which do not decrease at a sufficient pace, defined as 1/20th of the gap between the actual level and the 60% reference value per year. The initial step is a report by the European Commission notifying the non-compliance of a member state with the requirements for deficit and/or debt. In the next step, the Commission proposes whether or not an excessive deficit should be declared, taking into account "all other relevant factors, including the medium-term economic and budgetary position" (European Union, 2008) of the country. Based on this proposal, the European Council officially decides on the existence of an excessive deficit. If the Council declares that an excessive deficit exits, this decision formally opens the EDP and triggers a series of actions. Commission and Council issue recommendations on how to correct the excessive deficit and set a deadline. The measures undertaken by the member states are continuously monitored and, in case of non-effective action, the Council can impose sanctions. The first stage is a compulsory non-interest-bearing deposit of 0.2% of GDP, which can be converted into a fine in the second stage. In practice, sanctions have never been imposed so far. The EDP is closed when the Council, on a recommendation by the Commission, decides that the excessive deficit has been corrected.

For our analysis, we use the official documents on all ongoing and closed EDPs provided by the European Commission. Out of the 28 EU countries (incl. the United Kingdom), 25 countries have been at least once in the procedure between 2000 and 2019. Estonia, Luxembourg and Sweden are the only countries which have never been in an EDP. Table 2.1 lists the EDPs that are included in our sample.[1] Twelve of these EDPs were opened during the Great Recession or

[1] We cannot include all EDPs which have been opened by the Council in the period 2000–2019 because of missing data for some European countries.

**Table 2.1:** EDPs included in the sample

| # | Country | 1st Neg. report | Comm. rec. | Start | End |
|---|---|---|---|---|---|
| 1 | Belgium | – | 11 Nov 2009 | 2 Dec 2009 | 20 Jun 2014 |
| 2 | Czech Republic | – | 24 Jun 2004 | 5 Jul 2004 | 3 Jun 2008 |
| 3 | Czech Republic | 7 Oct 2009 | 11 Nov 2009 | 2 Dec 2009 | 20 Jun 2014 |
| 4 | Denmark | 12 May 2010 | 15 Jun 2010 | 13 Jul 2010 | 20 Jun 2014 |
| 5 | Finland | 12 May 2010 | 15 Jun 2010 | 13 Jul 2010 | 12 Jul 2011 |
| 6 | France | 2 Apr 2003 | 7 May 2003 | 3 Jun 2003 | 30 Jan 2007 |
| 7 | France | 18 Feb 2009 | 24 Mar 2009 | 27 Apr 2009 | 22 Jun 2018 |
| 8 | Germany | 19 Nov 2002 | 8 Jan 2003 | 21 Jan 2003 | 5 Jun 2007 |
| 9 | Germany | 7 Oct 2009 | 11 Nov 2009 | 2 Dec 2009 | 22 Jun 2012 |
| 10 | Hungary | 12 May 2004 | 24 Jun 2004 | 5 Jul 2004 | 21 Jun 2013 |
| 11 | Ireland | 18 Feb 2009 | 24 Mar 2009 | 27 Apr 2009 | 17 Jun 2016 |
| 12 | Italy | 7 Oct 2009 | 11 Nov 2009 | 2 Dec 2009 | 21 Jun 2013 |
| 13 | Netherlands | 28 Apr 2004 | 19 May 2004 | 2 Jun 2004 | 7 Jun 2005 |
| 14 | Netherlands | 7 Oct 2009 | 11 Nov 2009 | 2 Dec 2009 | 20 Jun 2014 |
| 15 | Portugal | 22 Jun 2005 | 20 Jul 2005 | 20 Sep 2005 | 3 Jun 2008 |
| 16 | Portugal | 7 Oct 2009 | 11 Nov 2009 | 2 Dec 2009 | 16 Jun 2017 |
| 17 | Slovak Republic | 7 Oct 2009 | 11 Nov 2009 | 2 Dec 2009 | 20 Jun 2014 |
| 18 | Spain | 18 Feb 2009 | 24 Mar 2009 | 27 Apr 2009 | 14 Jun 2019 |
| 19 | United Kingdom | 21 Sep 2005 | 11 Jan 2006 | 24 Jan 2006 | 9 Oct 2007 |
| 20 | United Kingdom | 11 Jun 2008 | 2 Jul 2008 | 8 Jul 2008 | 5 Dec 2017 |

*Notes:* "1st Neg. report" refers to the date at which the European Commission filed the first negative report on the non-compliance of the country. "Comm. rec." refers to the date the Commission recommends to the European Council that the EDP should be declared. "Start" and "End" denote the date of the opening and closing of the EDP as decided by the Council. For EDPs no. 1 and 2, the Commission proposed the EDP without a 1st negative report.

in its aftermath. At the end of 2019, there was no ongoing EDP. The last procedure was closed in summer 2019 after ten years of monitoring Spain. This is also the longest EDP in our sample where the average EDP duration is five years. The table shows that Commission and Council act rather swiftly with an average duration of two months between the first negative report of the Commission, the following Commission's recommendation on the opening of the EDP and the decision of the Council on that matter. After the Commission recommends an opening, the Council opens the EDP usually within one month.

We code a dummy variable that captures the periods in which a country was in an EDP. Since we use semi-annual data from OECD Economic Outlook (EO) editions, we have to make sure that changes in the dummy variable correspond to the EO editions. More specifically, the EDP dummy variable is set to 1 from period $t$ onwards if the procedure was opened between the forecast cut-off date of EO edition $t-1$ and the forecast cut-off date of edition $t$. Accordingly, the dummy variable is set to 0 from period $t+1$ onwards if the procedure was closed between the forecast cut-off date of EO edition $t$ and the forecast cut-off date of edition $t+1$. By doing so, we carefully account for the information set which is available at the time each EO edition is published. This approach provides us with country-specific EDP dummies which we use as state variables in the panel estimation of state-dependent fiscal multipliers presented in the next section.

## 2.3 Methodology and data

### 2.3.1 Empirical strategy

We use the local projection method proposed by Jordà (2005) to estimate impulse response functions and fiscal multipliers directly. This method allows for a flexible specification of state dependence and does not implicitly restrict the model dynamics. In particular, we follow Auerbach and Gorodnichenko (2013b) and estimate state-dependent local projections using panel data for European countries. The state-dependent responses $\beta_{0,h}$ and $\beta_{1,h}$ of the variable of interest $Z_{i,t+h}$ to an exogenous change in fiscal spending for each horizon $h = 0, ..., H$ are estimated from the following regression model:

$$\begin{aligned} Z_{i,t+h} &= \alpha_{i,h} + (1 - \mathcal{I}_{i,t-1})\left[\beta_{0,h} G_{i,t} + \Phi_{0,h}(L) X_{i,t-1}\right] \\ &\quad + \mathcal{I}_{i,t-1}\left[\beta_{1,h} G_{i,t} + \Phi_{1,h}(L) X_{i,t-1}\right] + \sum_{k=1}^{2} \psi_k T_t^k + \varepsilon_{i,t+h}, \end{aligned} \tag{2.1}$$

where $\alpha_{i,h}$ measures unobserved fixed effects specific to country $i$, $\mathcal{I}_{i,t-1}$ indicates the state of the economy in the period before the change in government spending, $G_{i,t}$ represents government spending in the current period, $L$ refers to the lag operator, $X_{i,t-1}$ is a vector of controls and the series of $\psi_k$ captures a time trend. In our baseline specification, the state indicates whether a country is in an ongoing EDP. The set of control variables includes output, government spending, private consumption, private investment, the interest-rate spread, the marginal tax rate and the public debt-to-GDP ratio. The variable of interest $Z_{i,t+h}$ is a variable from this set. The units of all variables measured in levels (i.e., output, goverment spending, private consumption and private investment) are normalized by an estimate of trend GDP (Gordon and Krenn, 2010; Ramey and Zubairy, 2018) rather than lagged GDP (as done by, e.g., Barro and Redlick, 2011; Hall, 2009). The latter produces fiscal multipliers which vary over the business cycle. We obtain trend GDP from a polynomial of order 3.[2]

In order to address potential endogeneity issues in our regressions, we use an instrumental variable (IV) approach: Normalized government spending $G_{i,t}$ is instrumented by the forecast error of fiscal spending (Auerbach and Gorodnichenko, 2012, 2013a). We discuss the details on the identification of fiscal spending shocks in Section 2.3.3. Finally, we use robust standard errors that account for cross-sectional dependence and autocorrelation as proposed by Driscoll and Kraay (1998).

[2] Ramey and Zubairy (2018) use a polynomial of order 6. We justify our choice by the smaller sample period which makes less turning points necessary.

The impulse response function for each of the states is constructed using the sequence of responses $\{\beta_h\}_{h=0}^{H}$. The impulse responses trace the impact of the exogenous shock on the path of specific variables and reveal the underlying transmission mechanisms. Following Mountford and Uhlig (2009) and Ramey and Zubairy (2018), we argue that the policy-relevant measure for the aggregate effect of fiscal spending shocks on the economy is given by the cumulative fiscal spending multiplier. The cumulative multiplier compares the cumulative output response (i.e, the integral of the output response) to the cumulative path (i.e., the integral) of fiscal spending, thereby providing a measure for the impact of fiscal stimulus over time. Note that this definition is different from the one in Blanchard and Perotti (2002) and Auerbach and Gorodnichenko (2012, 2013a) who report multipliers given by the peak response of output relative to the initial fiscal spending impulse. Peak multipliers, however, do not take into account the underlying response of government spending and therefore complicate the comparison across estimations. Specifically, we follow Ramey and Zubairy (2018) and Bernardini and Peersman (2018) and estimate state-dependent cumulative fiscal multipliers for horizon $h$ in one step using the following regression:[3]

$$\begin{aligned}\sum_{j=0}^{h} Y_{i,t+j} &= \alpha_{i,h} + (1-\mathcal{I}_{i,t-1})\left[M_{0,h}\sum_{j=0}^{h} G_{i,t+j} + \Phi_{0,h}(L)X_{i,t-1}\right] \\ &\quad + \mathcal{I}_{i,t-1}\left[M_{1,h}\sum_{j=0}^{h} G_{i,t+j} + \Phi_{1,h}(L)X_{i,t-1}\right] + \sum_{k=1}^{2}\psi_k T_t^k + \varepsilon_{i,t+h},\end{aligned} \tag{2.2}$$

where $Y_{i,t+j}$ denotes normalized output and all other variables are defined as explained above. We instrument $\sum_{j=0}^{h} G_{i,t+j}$ by the forecast error of fiscal spending. Hence, the instrument is independent of the horizon $h$, see Ramey and Zubairy (2018). In this specification, the estimated coefficients $M_{0,h}$ and $M_{1,h}$ provide direct measures for the cumulative fiscal multiplier for each state.

### 2.3.2 Data

The sample covers the period 2000H1–2019H1 and 17 European countries.[4] Our main data source is the OECD EO published on a biannual basis (spring and autumn of each year). We use this dataset for two reasons. First, because of its large coverage. It includes macroeconomic variables along with forecasts of up to two years ahead for most European countries. Hence,

[3] Ramey and Zubairy (2018) argue that the one-step estimation procedure is identical to a three-step procedure in which the sum of the output responses is divided by the sum of fiscal spending responses if all responses are estimated on the same sample.

[4] Our sample includes Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Slovakia, Spain, Sweden and the United Kingdom.

this provides us with a consistent dataset. Second, this source additionally provides us with government spending forecasts from each EO edition which we use to identify fiscal spending shocks, see Section 2.3.3 for details. Since the EO reports quarterly values only starting from edition 73 (published in spring 2003) and semiannual values before, we harmonize the frequency of all variables to consistently use semiannual data in the analysis.

We mainly use data from EO edition 106 published in autumn 2019. We take real data for output, government spending (government consumption plus—if available—government investment), private consumption and private investment.[5] We construct semiannual levels for these variables by aggregating the values from Q1 and Q2 (Q3 and Q4) for H1 (H2).[6] For the interest-rate spread, we take the 10-year government bond spread vis-à-vis Germany (in percent). The value for the semester is given by the average over its two quarters. In addition, we take the public debt-to-GDP ratio (in percent) which is measured at the end of the year and reported at annual frequency only. Therefore, we use the annual value of year $t$ for H2 in $t$ and H1 in $t+1$ and scale it by the level of contemporaneous GDP.

Finally, we take the annual marginal personal income tax rate (in percent) from Table I.4 of the OECD Tax Database at an income level of 100% of the average wage. This rate includes the central government and sub-central income tax plus the employee social security contributions. We use this value for H1 and H2.

### 2.3.3 Shock identification

We define government spending shocks as the forecast error of government spending growth. By doing so, goverment spending shocks aim to measure the unexpected change in government spending growth and can be used as an instrument for government spending. This identification was put forward by Auerbach and Gorodnichenko (2012, 2013a) and has been widely used since then.

The approach can be divided into two steps. First, we calculate government spending growth from real government consumption plus—if available—real government investment for all countries and all EO editions between edition 67 (published in spring 2000) and edition 106 (published in autumn 2019). The inclusion of government investment is important because investment multipliers are much smaller as shown by Boehm (2020). Solely using government consumption could

[5] Government and private investment are only reported for seven countries separately. For the other ten countries in our sample the sum of the two is reported. We therefore include government investment where it is available and proxy private investment by the sum of the annual shares of household and corporate investment multiplied by semiannual total investment. The latter approach is valid. The correlation between implied private investment and reported private investment is very high (above 0.85 for each of the seven countries).

[6] We replace government investment for the United Kingdom in 2005Q2 by the average of the previous quarter and the following quarter before aggregation because government investment is highly negative due to the transfer of nuclear reactors to the government.

consequently exaggerate the fiscal multipliers. We refer to the calculated growth rates by $g_{i,t}^{s}$. This is the semiannual government spending growth rate for country $i$ between semesters $t-1$ and $t$ based on data from the EO edition published in semester $s$. Second, we calculate the forecast error of government spending growth by:

$$FE_{i,t} = g_{i,t}^{2019H2} - g_{i,t}^{t-1}, \tag{2.3}$$

where $g_{i,t}^{2019H2}$ is the realized growth rate from EO edition 106 and $g_{i,t}^{t-1}$ is the one-step-ahead forecast for semester $t$ published in semester $t-1$. We make sure that the growth rates are comparable in terms of the inclusion of government investment, i.e., either both growth rates contain government investment or both do not.

There are several alternative choices for the realized growth rate as the first release of the growth rate is obviously published in $t+1$ and one can consider realizations from $t+1$ to the latest available semester.[7] The OECD continuously revises government consumption and government investment also back to the past such that one can hardly determine which should be the realized growth rate for the forecast error calculation. We do not want to make a stand on which growth rate should be considered as the final release. By using the growth rate from the latest available semester, we are agnostic about which growth rate represents the final realization.

## 2.4 Fiscal multipliers in the Excessive Deficit Procedure

In this section, we report the results of our baseline estimation, discuss the underlying mechanisms and evaluate the EDP multiplier in bad times.

### 2.4.1 Baseline results

Figure 2.1 shows the estimates for the cumulative fiscal multipliers from our baseline specification given by Equation (2.2). The left panel displays the linear cumulative multipliers for the whole sample, i.e., the multiplier estimates for the case without state dependence. We plot a horizon of five semesters and the shaded area refers to the 90% confidence intervals calculated from Driscoll-Kraay standard errors. The point estimates for the linear multipliers are positive and smaller than one across all horizons. The fiscal multiplier is 0.2 on impact and slightly increases over time reaching 0.7 after two years ($h = 4$), which is in the range of unconditional estimates for European countries commonly reported in the literature, see Mineshima et al. (2014) for an extensive survey.

[7] For example, Auerbach and Gorodnichenko (2013a) use the realization published in $t+4$.

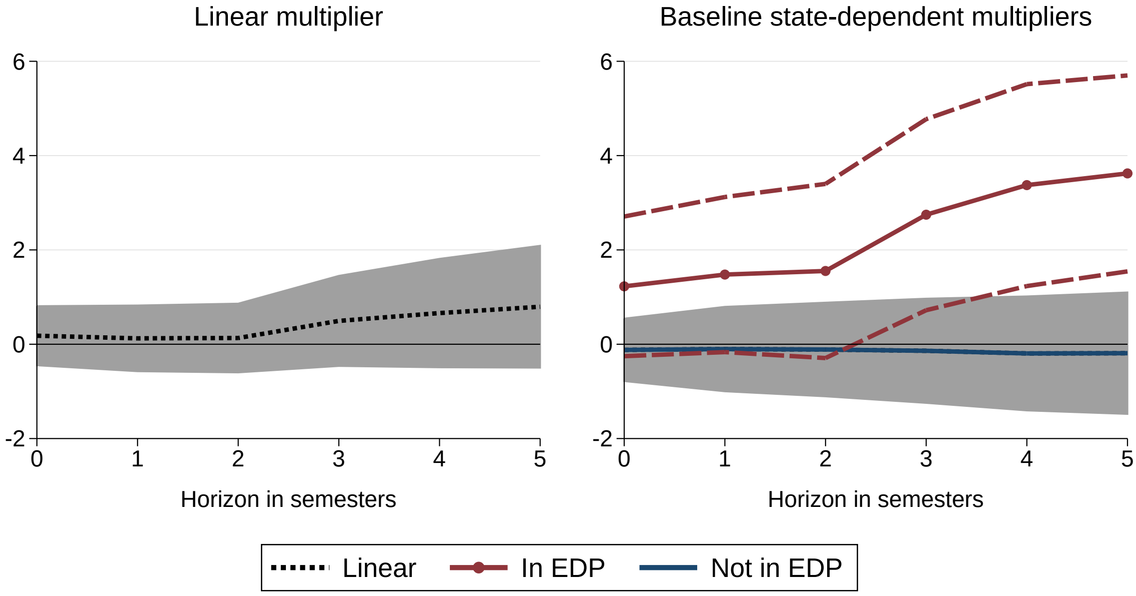


**Figure 2.1:** Linear and state-dependent cumulative fiscal multipliers

*Notes:* Estimates in both panels are based on the full sample with 463 observations. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

The right panel of Figure 2.1 displays the cumulative state-dependent multipliers. The state indicates whether a country has been in an ongoing EDP in the period before the change in government spending. The red line refers to episodes in which countries are in an EDP, whereas the blue line is associated with countries which are not. The red dashed lines and the shaded area again indicate the 90% confidence intervals. The state-dependent multipliers for the EDP sample are positive and larger than one across all horizons. In other words, the cumulative GDP gain is larger than the underlying cumulative fiscal spending following the impulse in period $t$. On impact, the fiscal multiplier is already 1.2 and further increases to 3.4 after two years. The multipliers for non-EDP episodes are essentially zero across all horizons.[8]

In the first part of Table 2.2, we report the point estimates of the cumulative multipliers and the associated Driscoll-Kraay standard errors. In addition, we report the first-stage F-statistic (based on the test of Montiel Olea and Pflueger, 2013) which can be used to assess whether our instrument is a relevant IV in each state separately. Indeed, we find that the F-statistic is above the 5% critical value across all horizons and in each state. We therefore conclude that our instrument is relevant. Further, we report the point estimate for the difference and associated p-values which are heteroskedasticity and autocorrelation consistent (Driscoll-Kraay, DK) and

[8] These results are neither driven by the trend specification nor the method for the identification of fiscal spending shocks. We obtain very similar multipliers if we use a trend obtained from polynomials of order 2 and 4 or the HP filter with a smoothing parameter of $\lambda = 1600$. In addition, results are very similar if we identify the shocks as proposed by Blanchard and Perotti (2002) or if the realization in Equation (2.3) is defined as in Auerbach and Gorodnichenko (2013a). See Appendix 2.A for details.

**Table 2.2:** Detailed results for the baseline specification

| $h$ | Not in EDP $M_0^h$ | SE | F-stat. | In EDP $M_1^h$ | SE | F-stat. | Difference P. E. | p (DK) | p (AR) |
|---|---|---|---|---|---|---|---|---|---|
| Baseline (463 observations) | | | | | | | | | |
| 0 | −0.12 | (0.40) | 209.50 | 1.23 | (0.90) | 74.23 | 1.35 | 0.20 | 0.22 |
| 1 | −0.10 | (0.55) | 163.86 | 1.48 | (1.00) | 61.13 | 1.58 | 0.22 | 0.24 |
| 2 | −0.11 | (0.61) | 73.70 | 1.55 | (1.12) | 45.36 | 1.67 | 0.28 | 0.30 |
| 3 | −0.14 | (0.67) | 54.67 | 2.75 | (1.23) | 33.30 | 2.89 | 0.08 | 0.12 |
| 4 | −0.19 | (0.74) | 44.26 | 3.37 | (1.30) | 26.15 | 3.57 | 0.04 | 0.07 |
| 5 | −0.19 | (0.78) | 42.13 | 3.62 | (1.26) | 24.10 | 3.81 | 0.02 | 0.05 |
| Strict state definition (286 observations) | | | | | | | | | |
| 0 | 0.08 | (0.40) | 115.04 | 0.64 | (0.52) | 136.27 | 0.56 | 0.27 | 0.33 |
| 1 | 0.02 | (0.58) | 95.56 | 0.95 | (0.66) | 132.56 | 0.93 | 0.19 | 0.26 |
| 2 | −0.06 | (0.60) | 70.32 | 1.22 | (0.76) | 58.15 | 1.28 | 0.14 | 0.20 |
| 3 | −0.25 | (0.66) | 51.25 | 2.74 | (1.09) | 41.84 | 2.98 | 0.01 | 0.05 |
| 4 | −0.38 | (0.69) | 39.25 | 3.48 | (1.19) | 31.07 | 3.86 | 0.00 | 0.03 |
| 5 | −0.34 | (0.72) | 37.78 | 3.59 | (1.07) | 26.68 | 3.93 | 0.00 | 0.02 |

*Notes:* We refer to the horizon by $h$. $M_s^h$ denotes the point estimate of the multiplier in state $s$, "SE" the associated Driscoll-Kraay standard error, and "F-stat." the associated first-stage F-statistic. The critical values for the F-statistic are always 23.1 and 19.7 at the 5% and 10% significance level, respectively. We also report the point estimate of the difference between the two multipliers, "P. E.", and the associated Driscoll-Kraay (DK) and weak instrument robust Anderson-Rubin (AR) p-values.

which are robust in the presence of weak instruments (Anderson-Rubin, AR).[9] Both p-values confirm our visual observation from Figure 2.1. The difference is statistically significant at the 10% level from horizon three (four) onwards according to the DK (AR) p-values.

The baseline multipliers shown in Figure 2.1 are based on our full sample and the estimation does not account for countries entering or leaving the EDP. Thus, the estimation does not necessarily include the same countries across all horizons. This could of course produce misleading estimates. For example, the GDP reaction could be always strongly positive just after the EDP ended. Figure 2.2 underlines that this is not the case. The left panel displays once again the baseline multipliers for comparison purposes. The right panel shows the multipliers for a specification with a strict definition of the state: We restrict the sample to countries remaining in the same state (EDP/non-EDP) across all horizons used in the estimation. The estimates are based on a smaller sample size, but the result remains robust. Multipliers for EDP episodes are positive across all horizons and larger than one after one semester. The second part of Table 2.2 shows that the difference between EDP and non-EDP states becomes even slightly more pronounced and is now statistically significant at the 10% level for $h \geq 3$ according to the DK and AR p-values. The F-statistics for the state-dependent multipliers still show strong evidence that our IV is relevant.

[9] In our implementation of the AR test, we follow Bernardini and Peersman (2018) and Ramey and Zubairy (2018).

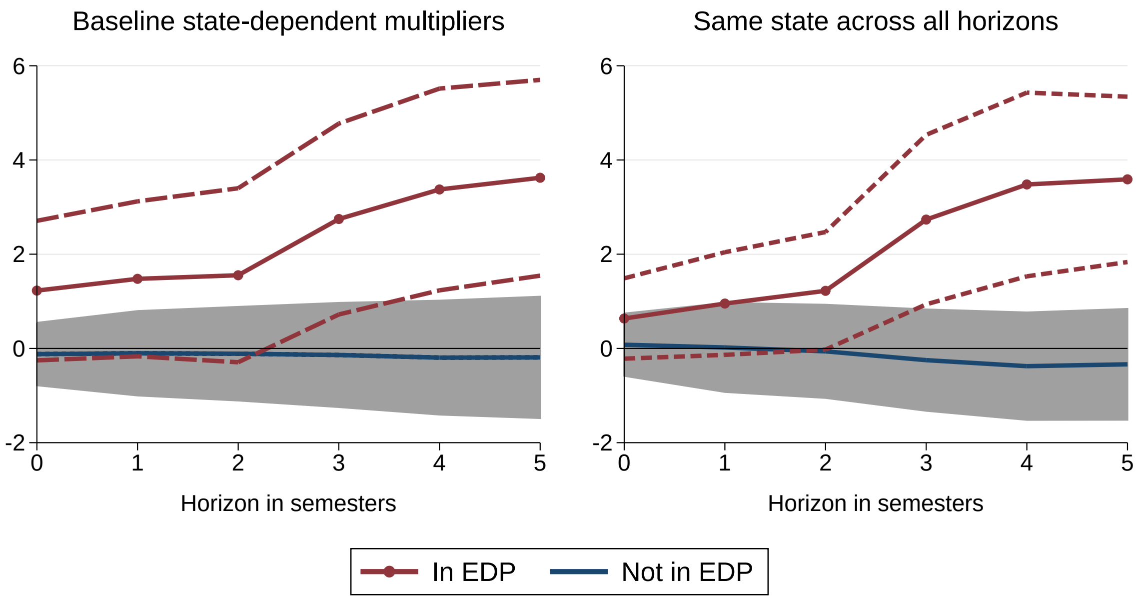


**Figure 2.2:** Cumulative fiscal multipliers being in the same state across all horizons

*Notes:* Estimates in the left panel are based on the full sample. Estimates in the right panel are based on 286 observations covering 15 countries. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

One could be concerned that higher state-dependent fiscal spending multipliers in EDP are driven by significantly less government spending in the EDP and/or an asymmetric distribution of shocks across the two states. A simple approach to test the first concern is to regress the share of government spending over GDP on the EDP dummy including country-specific constants. We find little evidence that the share is substantially different in the two states. In addition, we find little evidence that the shock distributions for the two states are a possible driver of the higher multipliers. The mean of shocks occurring in the EDP (0.19 percentage points) is smaller than the mean of the shocks outside the EDP (0.35 percentage points) while the standard deviation is roughly the same (1.25 in the EDP and 1.18 outside the EDP). Restricting the sample only to the negative (positive) shocks indeed shows that the shock mean is always smaller in the EDP. Negative shocks occur as often in the EDP (40%) as outside the EDP (38%).

The results obtained from our baseline specification show that the fiscal multipliers are significantly larger for countries that are in an ongoing EDP. The multipliers in these countries are strictly larger than one, implying that fiscal spending is more effective in the sense that the cumulative GDP gain exceeds the underlying cumulative fiscal spending. We explore the mechanisms behind these results in the next section.

### 2.4.2 Mechanisms

The size of fiscal spending multipliers is determined by many factors and depends in particular on the dynamics of other macroeconomic variables. Our baseline estimates suggest that fiscal

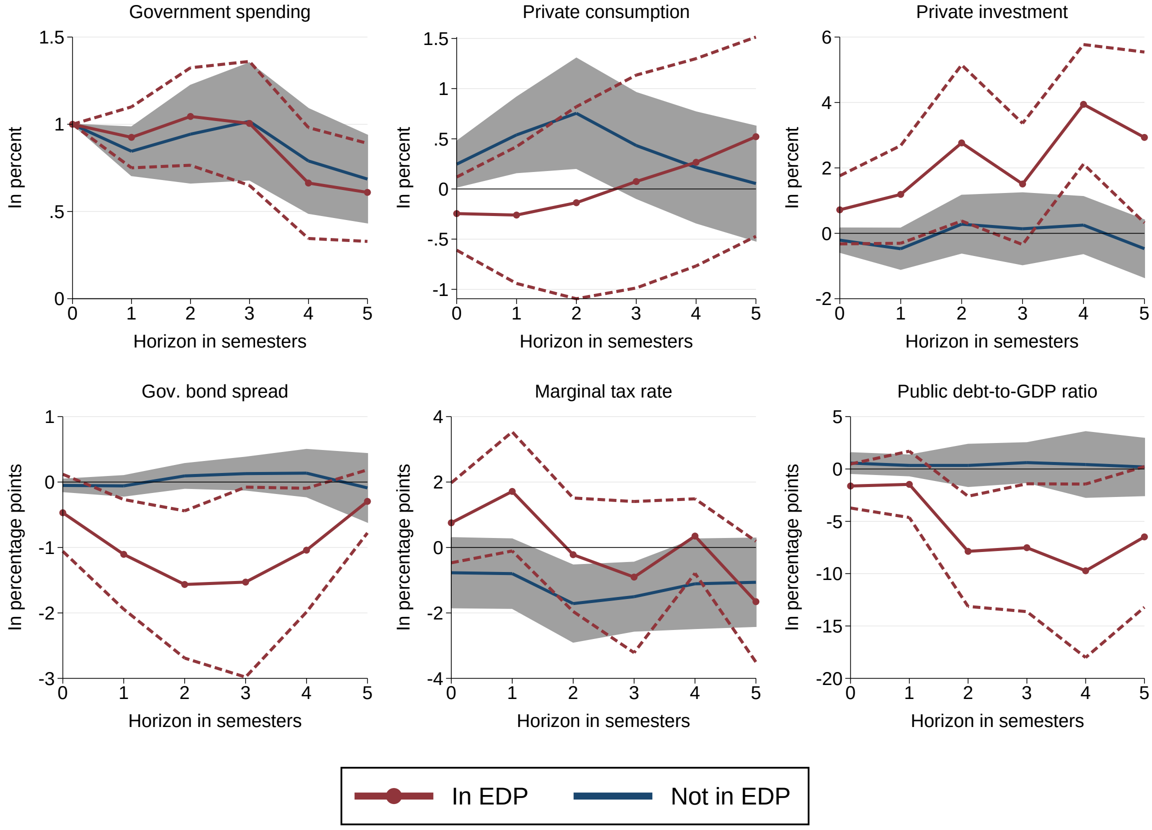


**Figure 2.3:** Impulse response functions

*Notes:* In each panel, estimates are based on the full sample. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

spending is more effective for countries in EDP. In order to rationalize this finding, we investigate the dynamics of the other variables included in our empirical model.

Figure 2.3 shows the impulse response functions of these variables to a 1% increase in fiscal spending, as estimated from Equation (2.1). The first row displays the responses of government spending, private consumption and private investment (measured in percent). The second row shows the responses of the government bond spread, the marginal tax rate and the public debt-to-GDP ratio (measured in percentage points).

The responses provide evidence that the difference in fiscal multipliers between the EDP and non-EDP samples is mainly driven by diverging investment dynamics. In the EDP sample, we observe a substantial (and mostly significant) positive response of private investment to a positive fiscal spending shock. Private investment in the non-EDP sample, however, is essentially not reacting to the shock. The path of government spending is similar across states, while we observe a significant positive response of consumption in non-EDP episodes at shorter horizons.[10] The

[10] We do not observe government spending reversals, which is consistent with the reaction of the debt level in our sample, see Corsetti et al. (2012a).

government bond spread (vis-à-vis Germany), as a measure for long-term interest rates, shows a clearly negative reaction for the EDP sample. This is in line with the observed response of private investment: lower interest rates stimulate investment. Bond spreads do not respond to the fiscal spending shock in non-EDP episodes. The initial rise in the marginal tax rate in the EDP sample reflects the reaction of the financing side of the government budget balance to the increase in fiscal spending induced by the shock. Finally, we observe that countries significantly reduce their public debt-to-GDP ratio in response to the fiscal impulse during EDP episodes. This reaction is in accordance with the EDP's objective of encouraging countries to bring debt levels under control. There is no response of the debt-to-GDP ratio in the non-EDP sample. If we use the strict state definition from the previous section, we observe even more pronounced reactions of private investment, the bond spread and the debt-to-GDP ratio during EDP episodes, see Appendix 2.A.

Overall, we find evidence that fiscal multipliers are larger for countries in EDP because government spending provides a stronger stimulus to economic activity. In response to a positive spending shock, countries in EDP achieve a significant reduction of public debt and long-term interest rates decrease, signaling a stable fiscal outlook. This boosts private investment and gives rise to substantial crowding-in, which is in line with the credibility effect described by Alesina et al. (1998). Being in the EDP demonstrates credible commitment to fiscal discipline and leads to lower risk premia. Thus, the EDP fulfills its task as corrective arm of the EU fiscal framework, while at the same time ensuring the effectiveness of fiscal stimulus.

### 2.4.3 Multipliers in bad times

The sample used in our baseline estimation includes a broad set of countries which might differ in many dimensions. For example, countries have varying fiscal position or face different cyclical fluctuations over time. The EDP is designed to ensure stable public finances, which is more likely to be an issue in member countries going through bad times. Thus, the measures implemented by the EDP are supposed to be especially effective for these countries. In order to isolate the effect of the EDP on the multiplier, we estimate Equation (2.2) for different subsamples focusing on episodes of bad times. For all subsamples, the relevant state variable is again the EDP dummy. The estimates of the corresponding cumulative fiscal multipliers are shown in Figure 2.4. The full set of estimation results and the corresponding tests are reported in Appendix 2.B. The left panel of Figure 2.4 considers a subsample with episodes of countries which do not fulfill the Maastricht criteria for either deficit only (15% of the observations) or debt only (68%) or both (17%). These countries have in common that they are in a weak fiscal position with a special

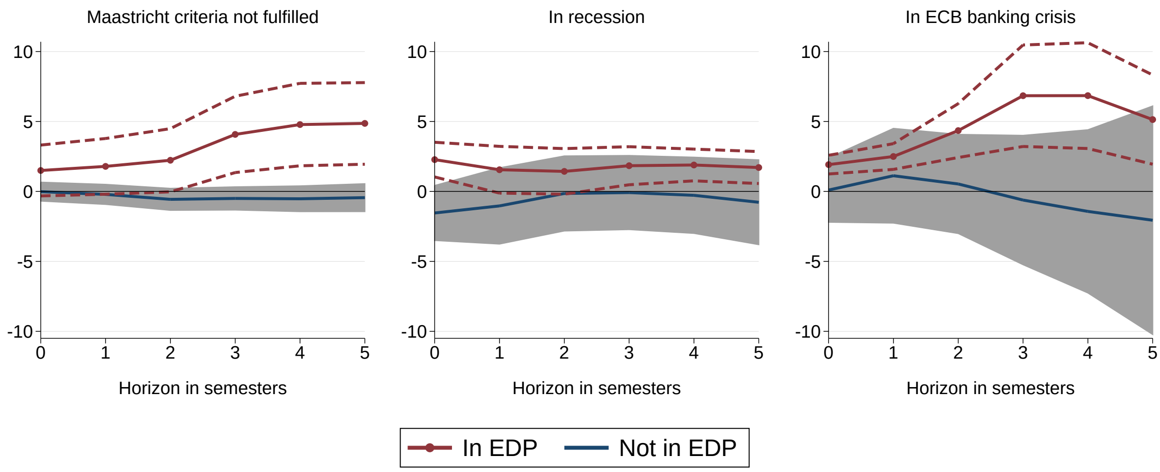


**Figure 2.4:** Cumulative fiscal multipliers in bad times

*Notes:* Estimates in the left panel are based on 249 observations covering 14 countries. Estimates in the middle panel are based on 92 observations covering 15 countries. Estimates in the right panel are based on 122 observations covering 14 countries. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

emphasis on unsustainable debt levels as the debt exceeds the Maastricht criterion for 85% of the observations. The estimates of the fiscal multipliers indicate that the EDP multipliers are statistically different from the non-EDP multipliers at the 10% level for $h > 1$. This shows that the EDP indeed increases the effectiveness of government spending in this subsample. Multipliers for the EDP sample are even larger than in the specification using the full sample as shown in the right panel of Figure 2.1. This is due to a more pronounced reaction of interest rates and private investment. The first-stage F-statistic exceeds the 5% critical value at all horizons in the non-EDP state and the 10% critical value for $h \leq 4$ in the EDP state, suggesting that our results do not suffer from a weakly identified instrument. The results are similar if we condition the subsample only on the observations for which debt exceeds the Maastricht criterion.

The middle panel focuses on a subsample with recessionary episodes. We identify recessions using the simple and transparent algorithm proposed by Harding and Pagan (2002) based on quarterly real GDP growth from the OECD Main Economic Indicators 2020–01.[11] The EDP multipliers are significantly positive for countries in a recession, but considerably smaller than the baseline multipliers at longer horizons. This can be rationalized by a more persistent increase in government spending in response to the shock, along with a crowding-in of consumption and a slight crowding-out of private investment in this subsample. Note that the EDP/non-EDP multipliers are not statistically different and the first-stage F-statistic suggests that the IV is less relevant at longer horizons.

[11] As originally suggested by Harding and Pagan (2002), we require that complete cycles have a length of at least five quarters and that a cycle phase lasts at least two quarters. We list the identified recessions which are included in the baseline sample in Appendix 2.B.

Finally, the right panel shows the multipliers for periods in which countries are hit by a banking crisis, as defined in the European Financial Crises Database provided by the European Central Bank (ECB) and the European Systemic Risk Board (Lo Duca et al., 2017).[12] Fiscal multipliers in the EDP sample are significantly positive and even larger than in the baseline estimation at longer horizons due to strong crowding-in of private investment. At the same time, the IV is less relevant for these horizons. Multipliers for the non-EDP sample are not significantly different from zero across all horizons. However, the difference between the two states is only statistically significant at the 10% level for horizons three and four.

The cumulative fiscal multiplier estimates for these subsamples confirm that the EDP is successful in increasing effectiveness of government spending for countries in bad times. In particular, the EDP seems to be fully functional for countries with a weak fiscal position (as indicated by non-compliance with the Maastricht criteria). This indicates that the procedure fulfills the purpose it was designed for.

## 2.5 Alternative state variables

We have so far implicitly assumed that the indicator whether a member state is in the EDP or not has explanatory power for the differences in fiscal multipliers across countries. However, countries in the EDP could tend to have weak fiscal positions or to experience recessions more frequently than other countries, both of which could in turn explain the variations in fiscal multipliers. Potentially, the EDP/non-EDP states could simply be a proxy for different underlying state variables. In Figure 2.5, we present fiscal multipliers for various alternative state variables. That is, we re-estimate Equation (2.2) using different indicator variables $\mathcal{I}_{i,t-1}$. The estimates refer to cumulative two-year multipliers (horizon $h = 4$) with the corresponding 90% confidence intervals. For comparison purposes, the first row shows the two-year multipliers from our baseline specification. The other rows report the multipliers if different combinations of non-compliance with the Maastricht criteria, recessions or banking crises are used as state variables. The recession and banking crisis dummy variables are constructed as described in the previous section. We provide corresponding impulse response functions in Appendix 2.B.

Again, non-compliance with the Maastricht criteria is interpreted as a signal for a weak fiscal position. We observe that the corresponding multipliers are smaller than the EDP multiplier, but still positive. This stands in contrast to the findings reported in the literature. Corsetti et al. (2012b), Nickel and Tudyka (2014) and Banerjee and Zampolli (2019) find that crowding-

[12] The most recent version of the database was published in 2017. We extend the data using the warnings issued by the European Systemic Risk Board. In fact, the European Systemic Risk Board did not identify any banking crises in 2018 and the first half of 2019.

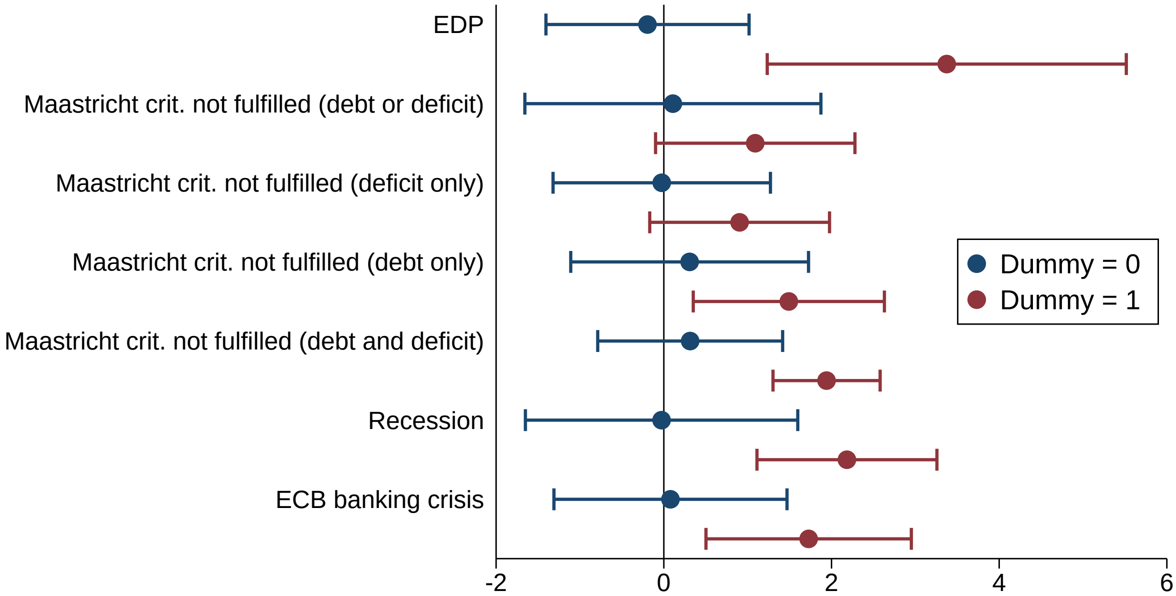


**Figure 2.5:** Cumulative two-year fiscal multipliers ($h = 4$)

*Notes:* Full sample for each state dependency. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

out of private investment leads to lower multipliers in countries with weak fiscal positions, while Huidrom et al. (2020) explains the lower multipliers in these countries by a decrease in consumption. In this context, Banerjee and Zampolli (2019) and Huidrom et al. (2020) document the relevance of the transmission via the interest rate channel: Interest rates in high-debt countries rise in response to fiscal stimulus, reducing investment and consumption. By contrast, we observe a decrease in interest rates after a positive fiscal spending shock for non-compliers with the Maastricht criteria which leads to crowding-in of private investment, thereby rationalizing positive multipliers.

In line with Auerbach and Gorodnichenko (2012, 2013a), we find significantly positive multipliers in recessions driven by crowding-in of private consumption and investment. We also find positive multipliers during banking crises. As in Corsetti et al. (2012b), we observe a positive reaction of investment for these episodes. Note that the multipliers associated with these states are smaller than the EDP multipliers.

The fiscal multipliers for all these alternative states are positive, suggesting that these state variables play a role. However, the multipliers are not significantly different from the respective other state (except for our baseline, the EDP state variable) and the estimated magnitudes are at most half the size of the EDP multiplier. These results confirm that the EDP is not only a proxy for different underlying factors. The EDP seems to be a suitable state variable for explaining variations in fiscal multipliers.

## 2.6 Fiscal multipliers in real time

Using the rich availability of forecasts in different EO editions, we want to explore in this section how fiscal spending multipliers are observed in real time. This is relevant because policy makers may plan government spending based on the size of future fiscal spending multipliers implied by the projected paths of real GDP and real government spending at a specific time. For example, policy makers expect that an additional unit of government spending pays off more if the forecast of the multiplier is large.

There is little evidence on how state-dependent fiscal multipliers are observed in real time. Blanchard and Leigh (2013, 2014) and Górnicka et al. (2020) investigate fiscal multipliers for European countries in the period of the European sovereign debt crisis. Both find that multipliers tend to be larger than initially forecasted which they attribute to the learning of the forecasters during the crisis. While Blanchard and Leigh (2013, 2014) provide evidence that the multiplier exceeds one, Górnicka et al. (2020) cannot confirm this finding. To our knowledge, we are the first to present evidence on how multipliers are observed in real-time in different states. In particular, we can thereby investigate whether forecasters learn in a similar fashion in each state.

We use a version of Equation (2.2) in which we estimate real-time multipliers $M^s_{0,h}$ and $M^s_{1,h}$ by including real-time data from EO edition $s$:

$$\begin{aligned}\sum_{j=0}^{h} Y^s_{i,t+j} \;&=\; \alpha^s_{i,h} + (1-\mathcal{I}_{i,t-1})\left[M^s_{0,h}\sum_{j=0}^{h} G^s_{i,t+j} + \Phi^s_{0,h}(L)X^s_{i,t-1}\right] \\ &+ \mathcal{I}_{i,t-1}\left[M^s_{1,h}\sum_{j=0}^{h} G^s_{i,t+j} + \Phi^s_{1,h}(L)X^s_{i,t-1}\right] + \sum_{k=1}^{2}\psi^s_k T^k_t + \varepsilon^s_{i,t+h},\end{aligned} \tag{2.4}$$

Our approach features three distinct dimensions which explicitly account for the available information set of the forecasters at time $s$. First, the variables $Y^s_{i,t}$ and $G^s_{i,t}$ are now forecasts (nowcasts) if $t > s$ ($t = s$). Variables, for which $t < s$ is true, are ex-post values. Second, the instrument should contain only the information available up to time $s$, too. We therefore, compute the forecast error in Equation (2.3) by using the realized growth rate as of time $s$, $g^s_{i,t}$, instead of the realized growth rate reported in EO edition 106, $g^{2019H2}_{i,t}$. Hence, the forecast error comparing the forecast and the realization is well defined for $s = t + k$, with $k \geq 1$:

$$FE^s_{i,t} = g^s_{i,t} - g^{t-1}_{i,t}, \tag{2.5}$$

Third, several studies show that trend estimates are unreliable in real time (e.g., Orphanides, 2003; Orphanides and van Norden, 2002). Given this uncertainty around the trend estimates, especially at the sample end, it is sensitive to scale level variables by a lag of the estimated trend

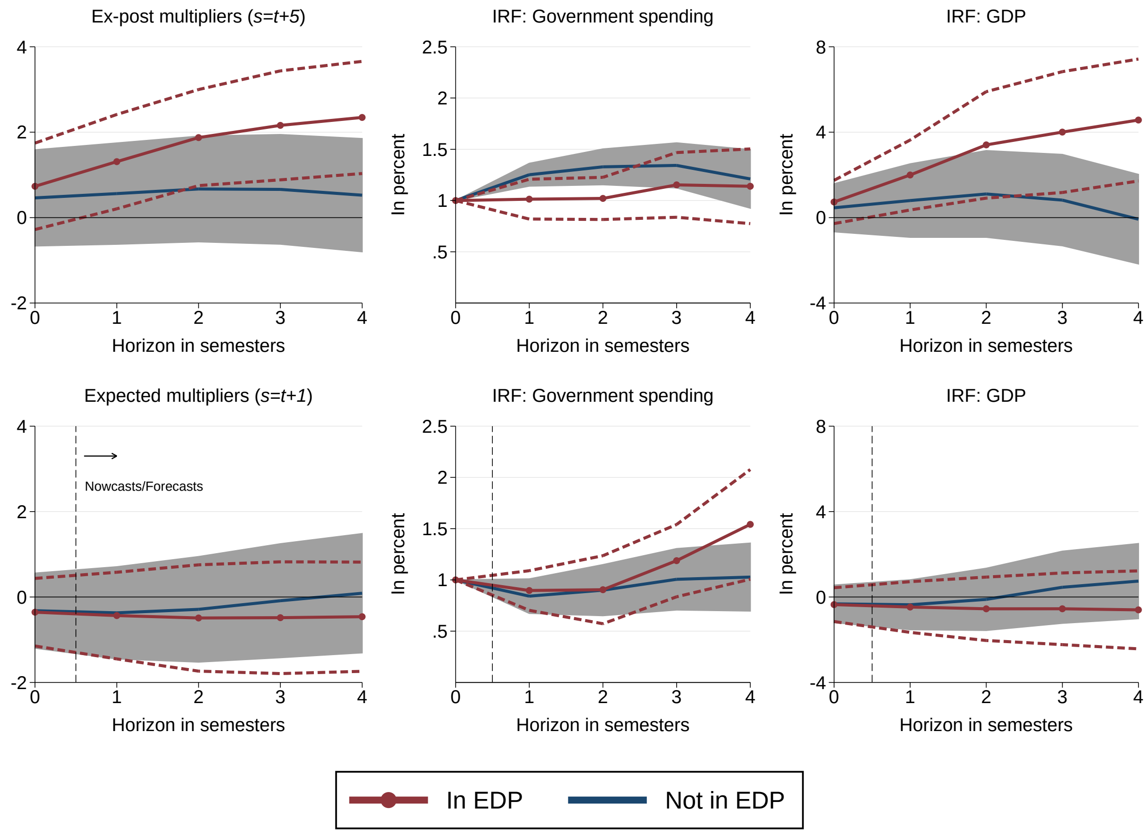


**Figure 2.6:** Real-time multipliers

*Notes:* Estimates are based on 373 observations covering 15 countries in all panels. Multipliers and impulse responses always depend on ex-post real-time data in the upper panels. In the lower panels, multipliers and impulse responses to the left (right) of the vertical dashed line depend on ex-post real-time data (nowcasts/forecasts). 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

rather than by the contemporaneous estimated trend.[13]

Figure 2.6 shows the real-time fiscal multipliers for $s = t + 5$ (upper left panel) and $s = t + 1$ (lower left panel). We further include the impulse responses of government spending and GDP for each specification. Our choice of $s$ implies that the vector of control variables $X^s_{i,t-1}$ always contains past values.[14] Multipliers in the upper left panel are based entirely on ex-post values. In the lower left panel, only the multipliers to the left of the dashed line are based on past values, while the multipliers to the right of the dashed line are partially based on nowcasts ($h = 1$) or on nowcasts and forecasts ($h \geq 2$). The detailed estimation results are reported in Appendix 2.B.

Multipliers in the upper left panel are similar to the multipliers from Figure 2.1 because both rely on ex-post values. One possible reason for the smaller EDP multiplier in Figure 2.6 is that the

[13] This approach is valid as long as the trend does not fluctuate with the business cycle. Indeed, we show in Appendix 2.A that our baseline results from Figure 2.1 remain if we re-estimate the multipliers with level variables scaled by different lags of the estimated trend.

[14] As the marginal tax rate is not available in real-time, we include observations from EO edition 106 and thereby ignore possible revisions of past values. Given the nature of the variable, we believe that these revisions are negligible.

levels of GDP and government spending at $h = 4$ are still based on the first release and can be subject to further revisions. The EDP multiplier is still larger than one and significantly positive after one semester. The non-EDP multiplier is smaller than one and not significantly different from zero again. In the lower left panel, multipliers at horizons $h \geq 1$ depend on nowcasts and forecasts for GDP and government spending. The state-dependent multipliers are not very different from each other, confidence intervals overlap and both are not significantly different from zero. The two very distinct EDP multipliers in the upper and lower left panels indicate that fiscal multipliers in the EDP are underestimated in real time. Hence, fiscal stimulus is expected to be less effective than it turns out ex post. The multipliers outside the EDP, however, do not depend on the time of the estimation.

With respect to the impulse responses of government spending and GDP in the EDP, we can trace the underestimation of the multiplier to a lower-than-expected government spending path and a larger-than-expected GDP path. The revisions of the GDP path seem larger than the revisions of the government spending path between the two specifications.

## 2.7 Conclusion

We estimate state-dependent fiscal multipliers to evaluate the effect of the EDP for 17 EU countries between 2000 and 2019. We show that fiscal multipliers in the EDP are larger than one and significantly different from the multipliers outside the EDP. The analysis of the underlying mechanisms shows that the higher multipliers are mainly driven by the crowding-in of investment which goes along with a significant reduction of public debt and a decrease of long-term interest rates in response to a positive spending shock. The latter two reactions signal a stable fiscal outlook. Thus, the EDP fulfills its task as corrective arm of the EU fiscal framework, while at the same time ensuring the effectiveness of fiscal stimulus. In addition, we find that the EDP is especially successful in bad times. Furthermore, we show that it is not just a proxy for other underlying factors. Finally, we provide evidence that forecasters underestimate the fiscal multiplier in the EDP in real time.

Our results have important policy implications. First, the EDP fulfills the function it was designed for. The output response to fiscal spending is stronger in countries under the procedure. Second, the large EDP multipliers for a country in a weak fiscal position show that the EDP is more effective in bad times. Third, the underestimation of fiscal multipliers in real time masks the ex-post effect of fiscal stimulus.

# Appendix

## 2.A Robustness of results

### Different trend specifications:

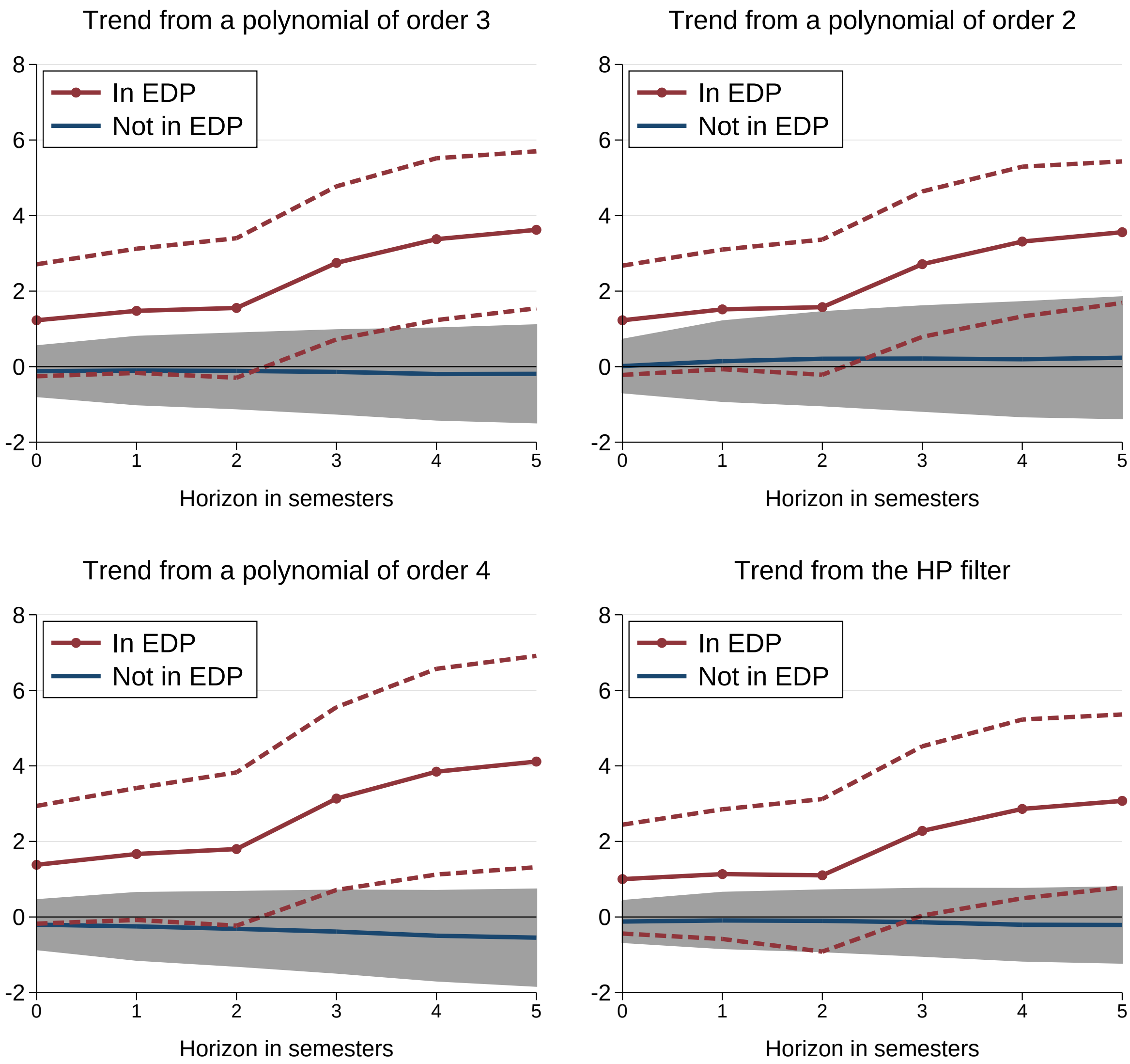


**Figure 2.A-1:** Comparison of multipliers using different trend specifications

*Notes:* The upper left panel repeats the multipliers from Figure 2.1. The other panels estimate the multipliers using different trend specifications to estimate trend GDP. Estimates in all panels are based on the full sample with 463 observations. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

**Different identification schemes:**

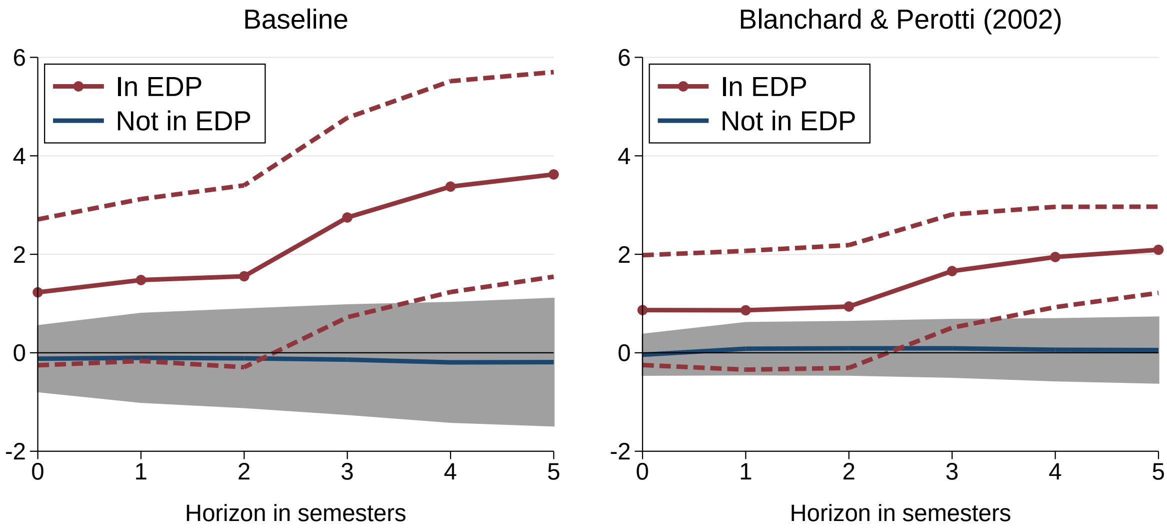


**Figure 2.A-2:** Comparison of multipliers obtained from our baseline identification and from the identification of Blanchard and Perotti (2002)

*Notes:* The left panel repeats the multipliers from Figure 2.1. The right panel estimates the multipliers using the shock identification of Blanchard and Perotti (2002). Estimates in both panels are based on the full sample with 463 observations. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

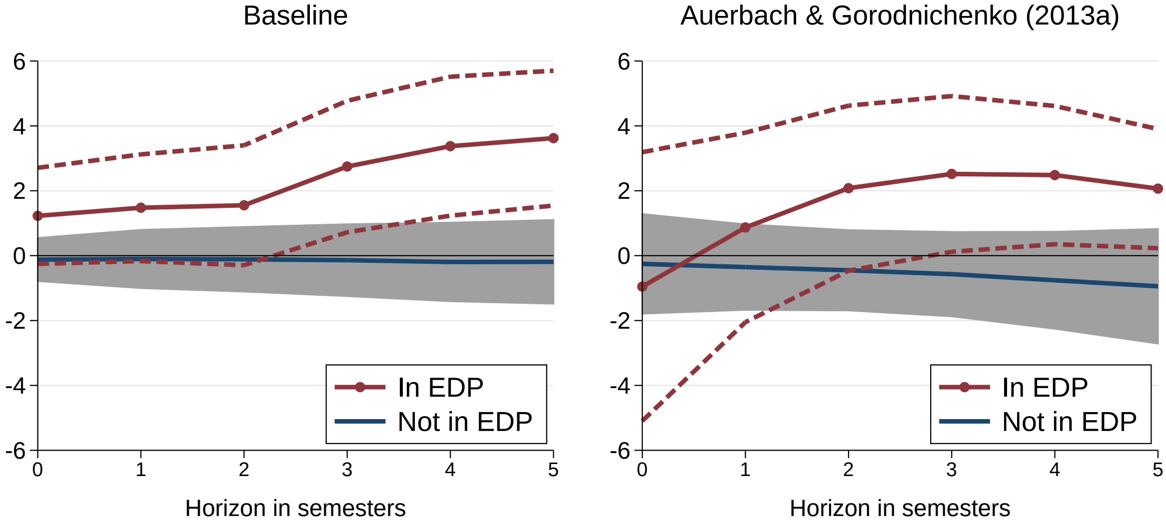


**Figure 2.A-3:** Comparison of multipliers obtained from our baseline identification and from the identification of Auerbach and Gorodnichenko (2013a)

*Notes:* The left panel repeats the multipliers from Figure 2.1. The right panel estimates the multipliers using the shock identification of Auerbach and Gorodnichenko (2013a). Estimates in the left panel are based on the full sample with 463 observations. Estimates in the right panel are based on 406 observations covering 15 countries. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

**Strict state definition:**

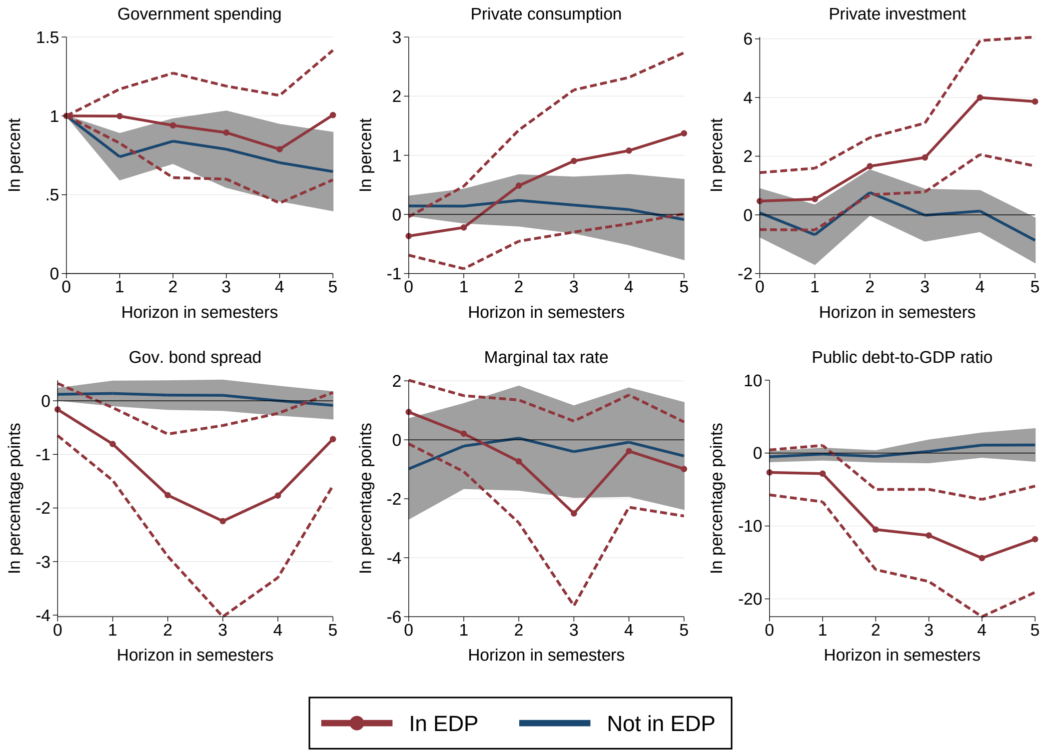


**Figure 2.A-4:** IRFs for strict-state definition

*Notes:* In each panel, estimates are based on 286 observations. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

**Scaling with different lags of trend:**

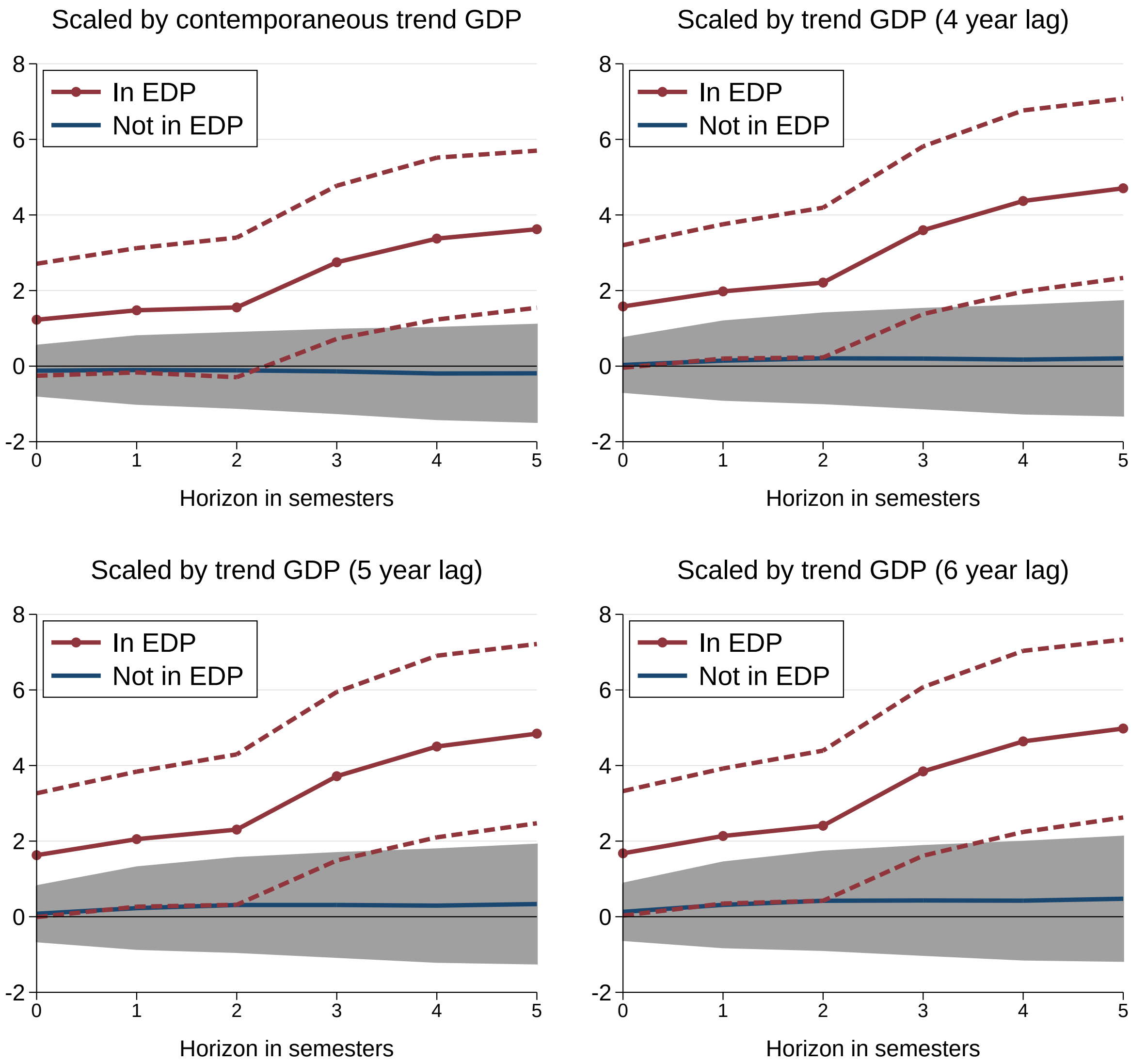


**Figure 2.A-5:** Comparison of multipliers using different lags of trend GDP

*Notes:* The upper left panel repeats the multipliers from Figure 2.1. The other panels estimate the multipliers using different lags of trend GDP to scale level variables. Estimates in all panels are based on the full sample with 463 observations. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

## 2.B Detailed results

**Multipliers in bad times:**

**Table 2.B-1:** Detailed estimation results

| | Not in EDP | | | In EDP | | | Difference | | |
|---|---|---|---|---|---|---|---|---|---|
| $h$ | $M_0^h$ | SE | F-stat. | $M_1^h$ | SE | F-stat. | P. E. | p-val (DK) | p-val (AR) |
| Maastricht criteria not fulfilled (debt or deficit) (249 observations) | | | | | | | | | |
| 0 | −0.01 | (0.41) | 375.84 | 1.50 | (1.11) | 58.97 | 1.51 | 0.19 | 0.20 |
| 1 | −0.21 | (0.43) | 251.18 | 1.79 | (1.21) | 64.34 | 2.00 | 0.11 | 0.12 |
| 2 | −0.56 | (0.48) | 74.40 | 2.23 | (1.37) | 42.58 | 2.80 | 0.05 | 0.05 |
| 3 | −0.50 | (0.50) | 56.55 | 4.08 | (1.66) | 30.96 | 4.58 | 0.01 | 0.01 |
| 4 | −0.52 | (0.56) | 43.84 | 4.78 | (1.79) | 22.74 | 5.31 | 0.00 | 0.01 |
| 5 | −0.44 | (0.60) | 36.69 | 4.87 | (1.77) | 19.14 | 5.31 | 0.00 | 0.00 |
| Maastricht debt criterion not fulfilled (210 observations) | | | | | | | | | |
| 0 | 0.79 | (0.60) | 135.81 | 1.66 | (0.96) | 114.82 | 0.87 | 0.46 | 0.45 |
| 1 | 0.68 | (0.72) | 107.29 | 2.44 | (1.27) | 64.44 | 1.75 | 0.21 | 0.22 |
| 2 | 0.14 | (0.90) | 66.29 | 3.49 | (1.70) | 23.54 | 3.35 | 0.05 | 0.06 |
| 3 | 0.35 | (1.11) | 43.32 | 5.88 | (2.26) | 13.24 | 5.53 | 0.01 | 0.02 |
| 4 | 0.33 | (1.20) | 28.59 | 6.09 | (2.33) | 9.61 | 5.76 | 0.00 | 0.01 |
| 5 | 0.28 | (1.15) | 23.25 | 5.14 | (1.87) | 8.27 | 4.86 | 0.00 | 0.00 |
| In recession (92 observations) | | | | | | | | | |
| 0 | −1.54 | (1.19) | 50.98 | 2.28 | (0.75) | 34.06 | 3.82 | 0.02 | 0.15 |
| 1 | −1.03 | (1.66) | 41.95 | 1.55 | (1.02) | 22.55 | 2.59 | 0.25 | 0.33 |
| 2 | −0.14 | (1.63) | 50.32 | 1.44 | (0.99) | 13.47 | 1.58 | 0.46 | 0.47 |
| 3 | −0.08 | (1.61) | 28.28 | 1.84 | (0.83) | 9.76 | 1.92 | 0.31 | 0.31 |
| 4 | −0.27 | (1.65) | 12.30 | 1.89 | (0.69) | 8.03 | 2.17 | 0.20 | 0.18 |
| 5 | −0.77 | (1.84) | 6.03 | 1.71 | (0.70) | 7.52 | 2.48 | 0.13 | 0.11 |
| In ECB banking crisis (122 observations) | | | | | | | | | |
| 0 | 0.10 | (1.40) | 96.05 | 1.92 | (0.41) | 46.85 | 1.82 | 0.19 | 0.24 |
| 1 | 1.13 | (2.06) | 81.63 | 2.50 | (0.56) | 30.32 | 1.37 | 0.50 | 0.51 |
| 2 | 0.54 | (2.15) | 20.97 | 4.35 | (1.17) | 12.92 | 3.82 | 0.12 | 0.15 |
| 3 | −0.61 | (2.81) | 13.93 | 6.85 | (2.21) | 11.16 | 7.46 | 0.06 | 0.07 |
| 4 | −1.42 | (3.55) | 6.27 | 6.85 | (2.30) | 9.97 | 8.28 | 0.06 | 0.06 |
| 5 | −2.06 | (4.97) | 2.00 | 5.14 | (1.94) | 9.38 | 7.20 | 0.14 | 0.10 |

*Notes:* We refer to the horizon by $h$. $M_s^h$ denotes the point estimate of the multiplier in state $s$, "SE" the associated Driscoll-Kraay standard error, and "F-stat." the associated first-stage F-statistic. The critical values for the F-statistic are always 23.1 and 19.7 at the 5% and 10% significance level, respectively. We also report the point estimate of the difference between the two multipliers, "P. E.", and the associated Driscoll-Kraay (DK) and weak instrument robust Anderson-Rubin (AR) p-values.

**Table 2.B-2:** Identified recessions in our sample

| # | Country | Start | Length | Depth | # | Country | Start | Length | Depth |
|---|---|---|---|---|---|---|---|---|---|
| 1 | AUT | 2001q1 | 2 | −0.21 | 20 | FRA | 2008q2 | 5 | −3.87 |
| 2 | AUT | 2012q2 | 4 | −1.10 | 21 | FRA | 2012q4 | 2 | −0.12 |
| 3 | BEL | 2001q3 | 2 | −0.29 | 22 | GBR | 2008q2 | 5 | −6.04 |
| 4 | BEL | 2008q3 | 3 | −3.69 | 23 | IRL | 2007q2 | 10 | −10.87 |
| 5 | BEL | 2012q4 | 2 | −0.32 | 24 | IRL | 2012q3 | 3 | −1.80 |
| 6 | CZE | 2008q4 | 3 | −5.86 | 25 | ITA | 2001q2 | 4 | −0.65 |
| 7 | DEU | 2001q2 | 4 | −0.85 | 26 | ITA | 2003q1 | 3 | −0.57 |
| 8 | DEU | 2002q4 | 10 | −0.47 | 27 | ITA | 2008q2 | 5 | −7.46 |
| 9 | DEU | 2008q2 | 4 | −7.03 | 28 | ITA | 2011q3 | 10 | −5.33 |
| 10 | DEU | 2012q4 | 2 | −0.88 | 29 | LUX | 2002q3 | 3 | −2.40 |
| 11 | DNK | 2001q4 | 3 | −0.24 | 30 | LUX | 2008q1 | 6 | −8.00 |
| 12 | DNK | 2006q3 | 4 | −1.05 | 31 | LUX | 2011q2 | 4 | −1.57 |
| 13 | DNK | 2008q1 | 6 | −7.07 | 32 | NLD | 2008q3 | 3 | −4.35 |
| 14 | DNK | 2011q3 | 6 | −0.50 | 33 | NLD | 2011q2 | 7 | −1.97 |
| 15 | ESP | 2008q3 | 4 | −4.36 | 34 | PRT | 2002q2 | 5 | −2.43 |
| 16 | ESP | 2011q1 | 11 | −5.28 | 35 | PRT | 2008q2 | 4 | −4.33 |
| 17 | FIN | 2008q1 | 6 | −9.49 | 36 | PRT | 2010q4 | 9 | −7.87 |
| 18 | FIN | 2012q1 | 4 | −2.49 | 37 | SWE | 2008q1 | 7 | −5.86 |
| 19 | FIN | 2013q3 | 4 | −0.96 | 38 | SWE | 2011q4 | 5 | −1.59 |

*Notes:* "Start" refers to the first quarter of the recession, i.e., the quarter following the peak of the business cycle. "Length" states the duration of a recession in quarters. "Depth" refers to the deviation from the pre-recession peak level of output to the trough (in %).

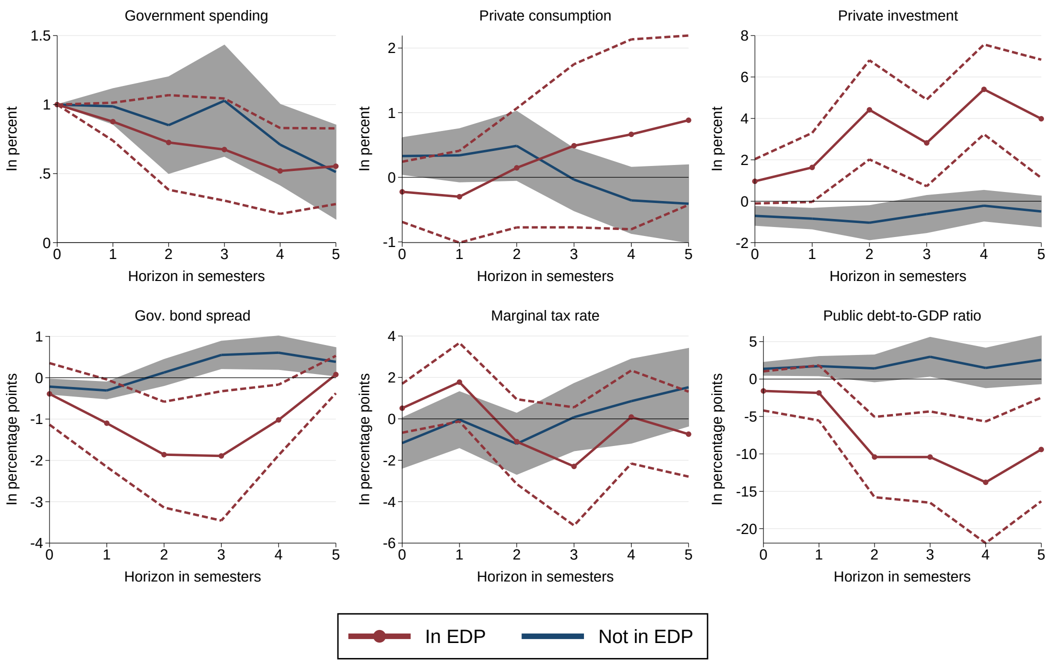


**Figure 2.B-1:** IRFs in bad times – Maastricht criteria not fulfilled (debt or deficit)

*Notes:* In each panel, estimates are based on 249 observations. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

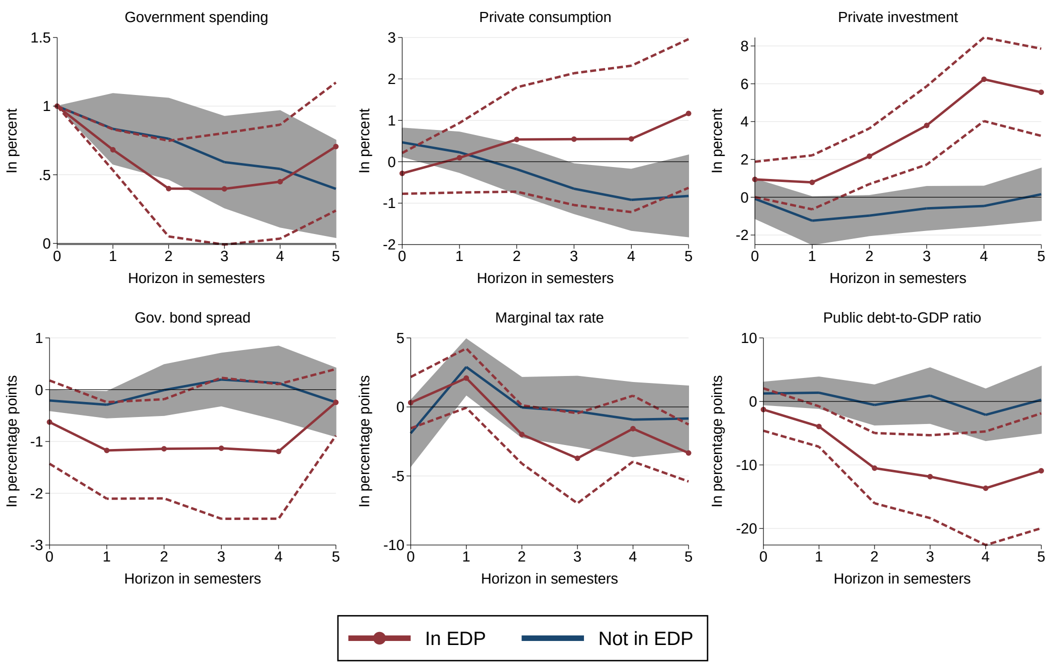


**Figure 2.B-2:** IRFs in bad times – Maastricht debt criterion not fulfilled

*Notes:* In each panel, estimates are based on 210 observations. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

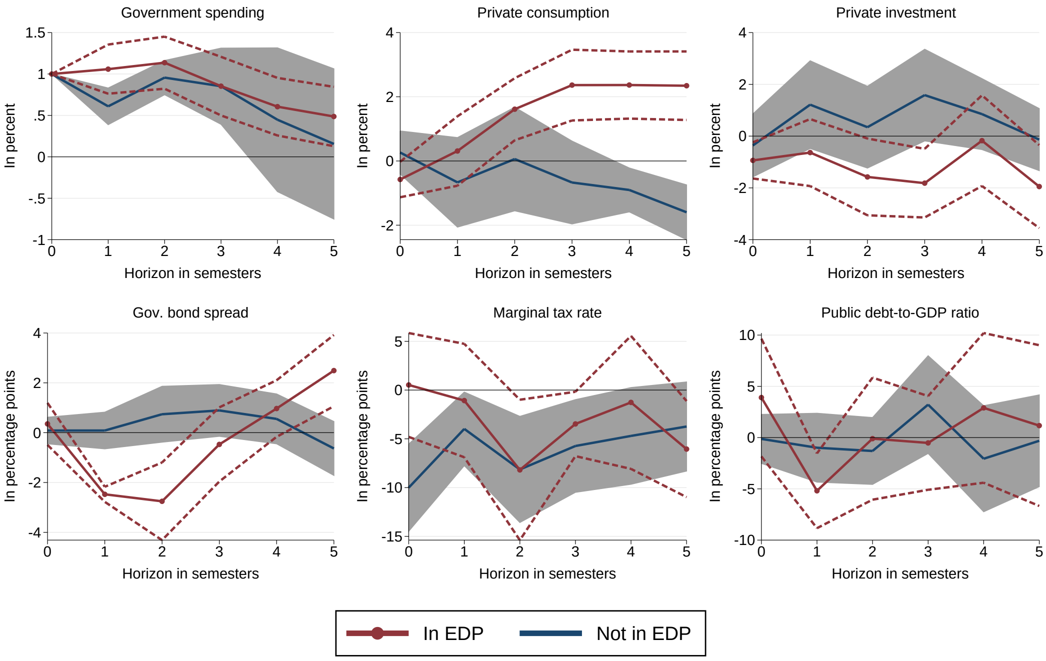


**Figure 2.B-3:** IRFs in bad times – In recession

*Notes:* In each panel, estimates are based on 92 observations. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

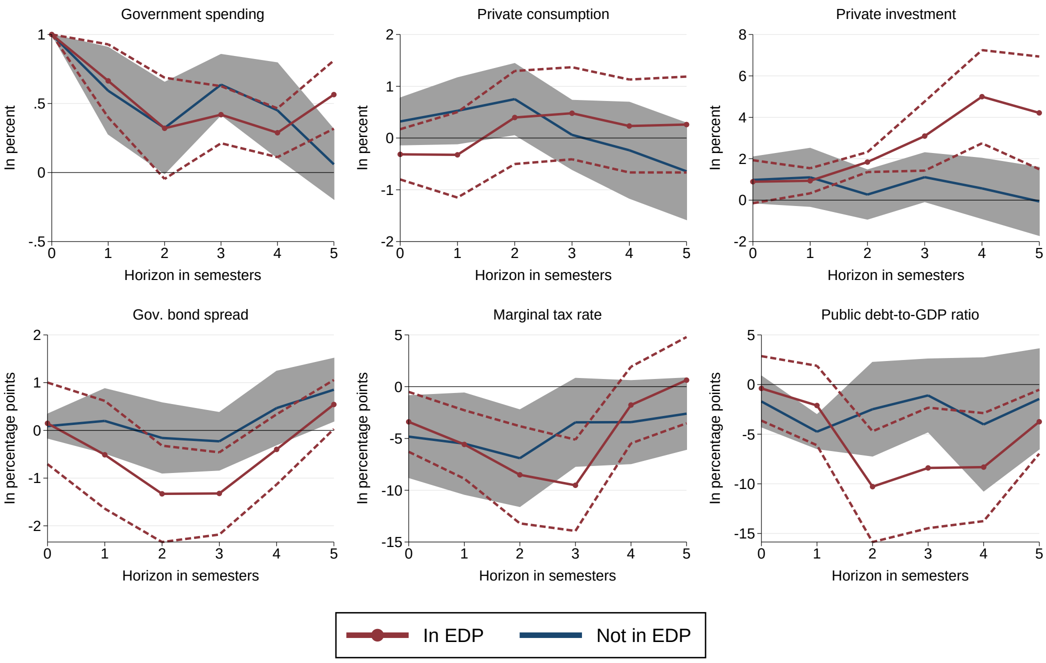


**Figure 2.B-4:** IRFs in bad times – In ECB banking crisis

*Notes:* In each panel, estimates are based on 122 observations. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

**Alternative state variables:**

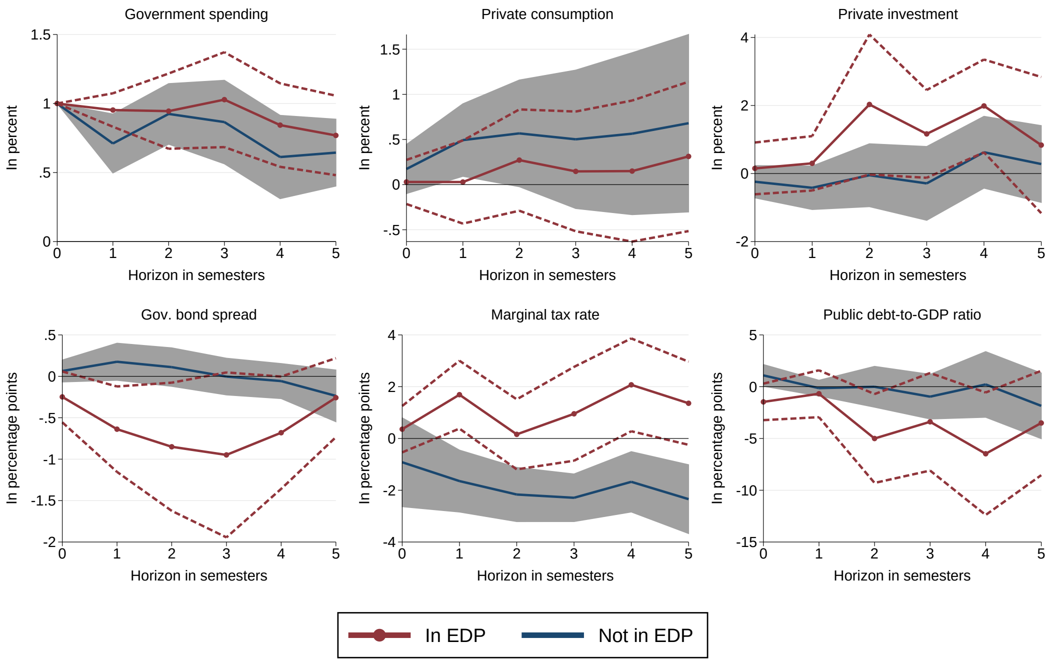


**Figure 2.B-5:** IRFs for alternative states – Maastricht criteria not fulfilled (debt or deficit)

*Notes:* In each panel, estimates are based on the full sample. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

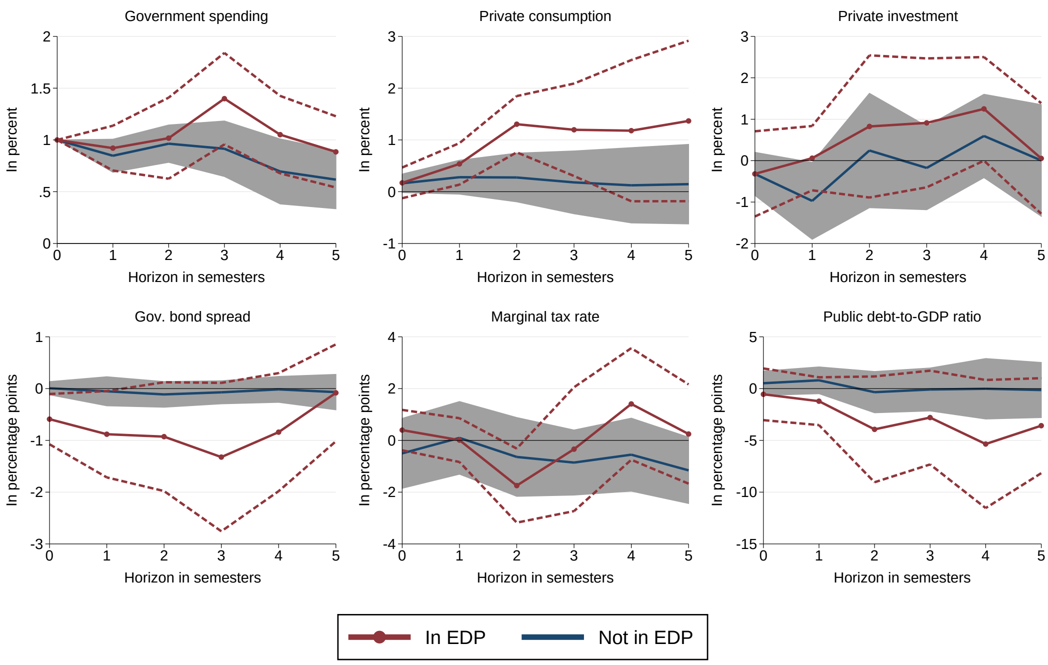


**Figure 2.B-6:** IRFs for alternative states – Maastricht criteria not fulfilled (deficit only)

*Notes:* In each panel, estimates are based on the full sample. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

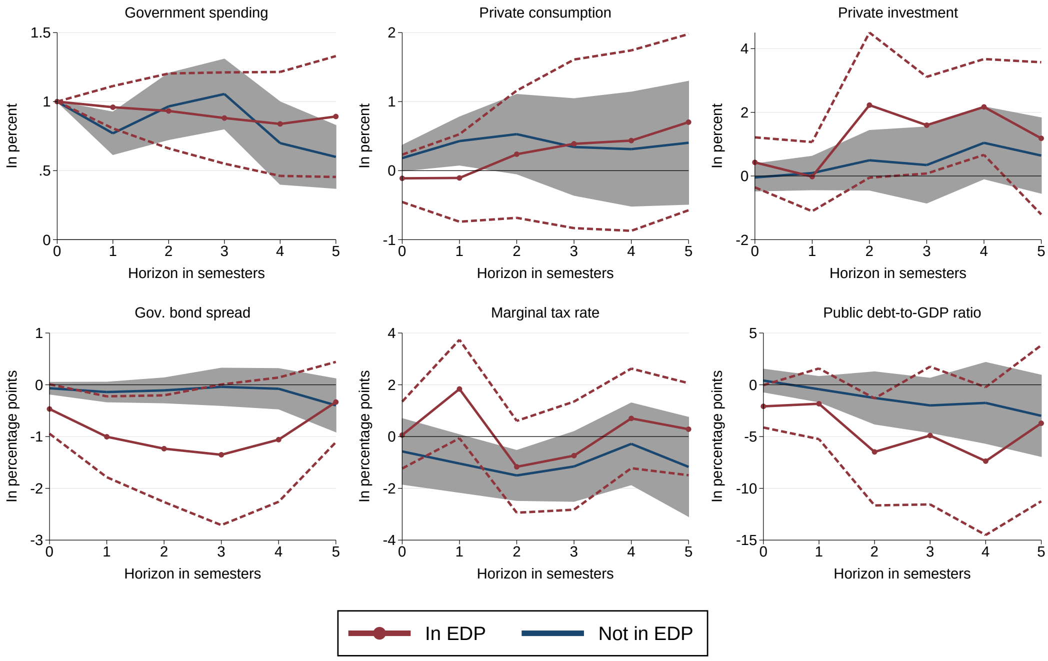


**Figure 2.B-7:** IRFs for alternative states – Maastricht criteria not fulfilled (debt only)

*Notes:* In each panel, estimates are based on the full sample. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

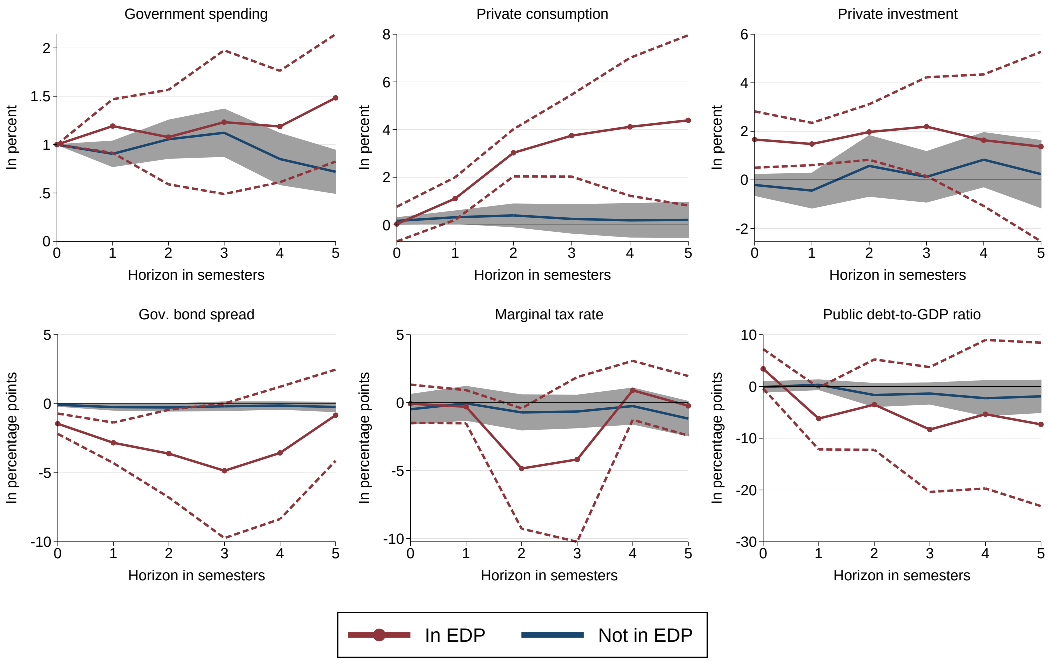


**Figure 2.B-8:** IRFs for alternative states – Maastricht criteria not fulfilled (debt and deficit)

*Notes:* In each panel, estimates are based on the full sample. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

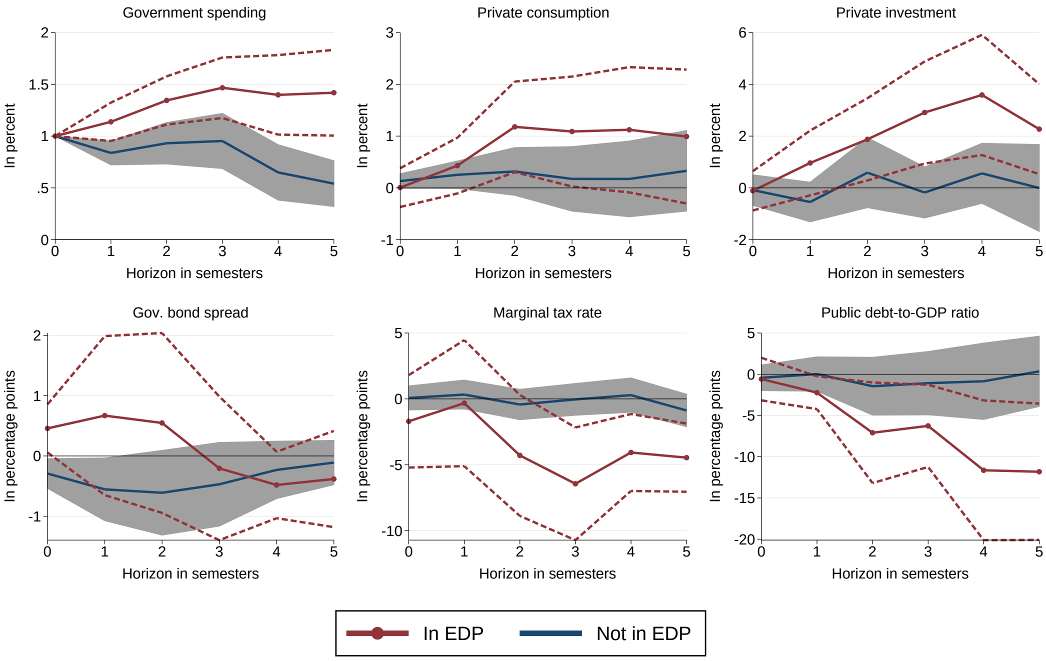


**Figure 2.B-9:** IRFs for alternative states – Recession

*Notes:* In each panel, estimates are based on the full sample. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

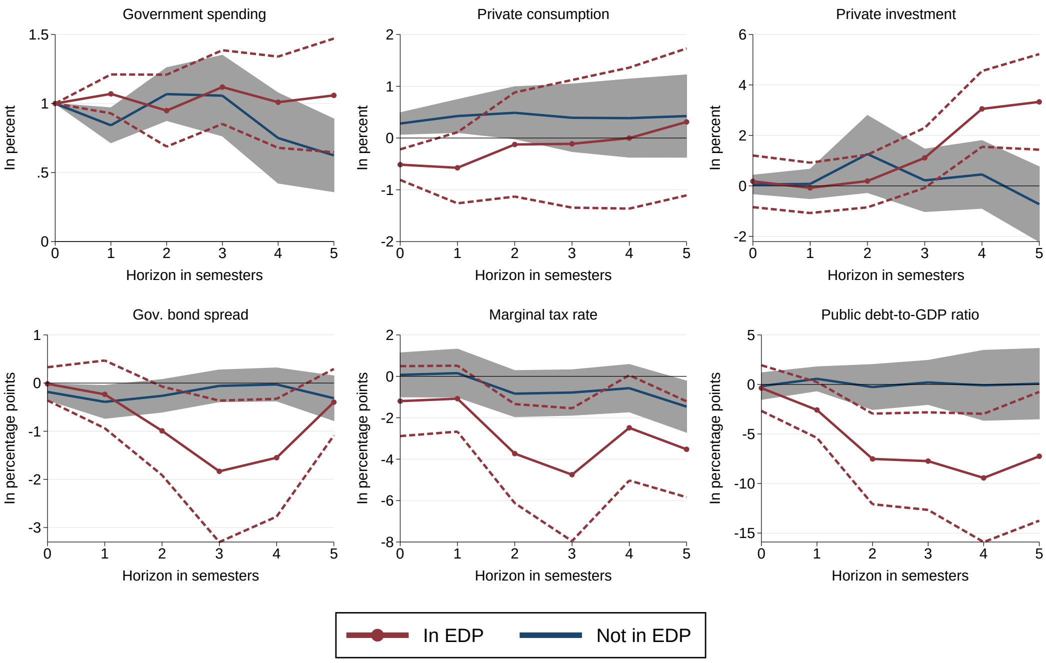


**Figure 2.B-10:** IRFs for alternative states – ECB banking crisis

*Notes:* In each panel, estimates are based on the full sample. 90% confidence intervals are calculated from Driscoll-Kraay standard errors.

**Multipliers in real time:**

**Table 2.B-3:** Detailed results for multipliers in real time

| | Not in EDP | | | In EDP | | | Difference | | |
|---|---|---|---|---|---|---|---|---|---|
| $h$ | $M_0^h$ | SE | F-stat. | $M_1^h$ | SE | F-stat. | P. E. | p-val (DK) | p-val (AR) |
| Ex-post multipliers for $s = t + 5$ | | | | | | | | | |
| 0 | 0.46 | (0.68) | 358.18 | 0.73 | (0.62) | 114.06 | 0.27 | 0.80 | 0.80 |
| 1 | 0.56 | (0.72) | 285.62 | 1.31 | (0.67) | 55.67 | 0.75 | 0.48 | 0.50 |
| 2 | 0.67 | (0.75) | 200.73 | 1.87 | (0.68) | 48.25 | 1.20 | 0.28 | 0.29 |
| 3 | 0.66 | (0.78) | 146.49 | 2.16 | (0.78) | 39.65 | 1.50 | 0.21 | 0.21 |
| 4 | 0.53 | (0.81) | 104.98 | 2.35 | (0.80) | 33.66 | 1.82 | 0.13 | 0.13 |
| Real-time multipliers for $s = t + 1$ | | | | | | | | | |
| 0 | −0.32 | (0.53) | 70.73 | −0.36 | (0.48) | 112.26 | −0.04 | 0.96 | 0.96 |
| 1 | −0.37 | (0.66) | 40.05 | −0.43 | (0.62) | 47.41 | −0.06 | 0.94 | 0.94 |
| 2 | −0.29 | (0.75) | 26.46 | −0.49 | (0.76) | 26.79 | −0.20 | 0.83 | 0.83 |
| 3 | −0.09 | (0.81) | 21.23 | −0.48 | (0.80) | 24.17 | −0.40 | 0.70 | 0.70 |
| 4 | 0.09 | (0.85) | 18.58 | −0.46 | (0.78) | 23.91 | −0.55 | 0.60 | 0.60 |

*Notes:* We refer to the horizon by $h$. $M_s^h$ denotes the point estimate of the multiplier in state $s$, “SE” the associated Driscoll-Kraay standard error, and “F-stat.” the associated first-stage F-statistic. The critical values for the F-statistic are always 23.1 and 19.7 at the 5% and 10% significance level, respectively. We also report the point estimate of the difference between the two multipliers, “P. E.”, and the associated Driscoll-Kraay (DK) and weak instrument robust Anderson-Rubin (AR) p-values.

# 3 Cross-country unemployment insurance, transfers, and trade-offs in international risk sharing

## 3.1 Introduction

After the creation of the EMU in 1992, European integration culminated in the introduction of the euro in 1999. Today, 19 countries in Europe share the same currency and delegate monetary policy for the euro area to the European System of Central Banks. The surrender of monetary autonomy at the member-state level involves the loss of a powerful capacity to stabilize the economy in the face of asymmetric shocks.[1]

The lack of a stabilizing mechanism became evident in the so-called 'euro crisis' that was characterized by strongly diverging developments among the member states. As a result, many policy makers and academics have called for a completion of the euro zone to prevent this episode from happening again in the future (see, for example, Bénassy-Quéré et al., 2018). Various theoretical contributions propose risk-sharing mechanisms that are designed to compensate for the costs of a monetary union.[2] The most prominent example that is taken up in policy circles is a European unemployment benefit scheme (EUBS in the following). The effects of stabilizing workers' income via an unemployment insurance in a closed-economy setting are well documented in the literature.[3] Cross-country individual insurance schemes additionally imply international transfers when business cycles are asynchronous. However, analyzing their impact on allocative efficiency and consumption risk sharing has been neglected so far.

[1] This is the main argument of the Theory of Optimum Currency Areas, which was first coined by Mundell (1961) and McKinnon (1963). This literature contrasts the costs of the surrender of flexible exchange rates with the benefits from lower transaction costs.

[2] Dixit and Lambertini (2003), Evers (2015), Galí and Monacelli (2008), and Galí and Perotti (2003), among others, study the conduct of fiscal policy in monetary unions and the introduction of a fiscal authority at the European level. European fiscal unification, however, is currently not feasible from a political perspective. Hence, other mechanisms for automatic stabilization in the face of asymmetric shocks are on the agenda. Kenen (1969) already noted that a transfer scheme might serve such a purpose. The effects of international transfers were subject of the famous discussion between Keynes (1929) and Ohlin (1929).

[3] See, for instance, Blanchard and Tirole (2008), Jung and Kuester (2015), or McKay and Reis (2016).

In this chapter, we evaluate whether transfer schemes, such as a EUBS, can provide a stabilizing role for a monetary union in which member states face asymmetric shocks. We find that fluctuations of international consumption and unemployment differentials would indeed be reduced by a EUBS. Yet, this stabilization comes at the cost of a more inefficient international allocation of factor inputs following supply and government spending shocks. Thus, whether a EUBS is beneficial depends on the reason for international unemployment differentials.

In our analysis, we particularly focus on the impact of cross-country transfers induced by the scheme and proceed in two steps. First, to build intuition, we develop a simple two-country model of a monetary union with incomplete markets, dynamic distortions, and shocks to technology, government spending, financial-frictions, and monetary policy. Using this model, we show analytically that a transfer which is (directly or indirectly) tied to relative economic performance can increase production efficiency only after some disturbances, while it necessarily reduces efficiency after the remaining shocks. For example, a transfer that flows *towards* the country hit by a contractionary financial-friction shock enhances efficiency in both countries. Rigid prices in combination with a consumption home bias, however, cause the optimal transfer to flow *out* of the country hit by a contractionary supply shock. That is, the direction of the optimal transfer depends on the level of price rigidities, such that sticky prices give rise to a trade-off between consumption risk sharing and production efficiency.

To explain these findings, we derive deviations from the first-order conditions of the corresponding social-planner solution, so-called 'wedges'. A transfer that flows to the less productive country following supply shocks boosts consumption and thus enhances risk sharing. With rigid prices, however, a relatively large part of the additional demand is spent on inefficiently produced goods, that is domestic goods from the perspective of the receiving country. These increased inefficiencies are visible by an opening of the wedges. We show that this trade-off exists for shocks to technology and government spending, but not for financial-friction shocks (which are equivalent to shocks to household preferences or expectations in the model and take the role of 'pure' demand shocks in our analysis).

Second, to explore where the euro zone stands in this trade-off, we investigate the introduction of a EUBS in a comprehensive two-country DSGE model. The model is carefully calibrated to match key asymmetries between Core and Periphery countries of the EMU. We find, in line with the intuition from the small model, that a EUBS increases international co-movements of consumption, output, and unemployment at the cost of aggravating the inefficient distribution of factor inputs after supply and government-spending shocks. The increase in international asymmetries can—by construction—not be eliminated fully by a EUBS: cross-border transfers only flow if unemployment rates are unequal across countries. Overall, results from the quantitative model suggest that a EUBS improves welfare for the Core, while it has almost no impact on Periphery's welfare. With a EUBS that is only active after certain shocks, both countries clearly gain in welfare. Our analysis hence shows that it can be beneficial to trigger the EUBS only after specific demand shocks, such as disturbances to monetary policy or financial-friction shocks. Furthermore, it reinforces calls for structural reforms in case of international productivity asymmetries to avoid a 'zombification' of inefficient sectors.

In the quantitative model, we aim to capture the European situation in detail and consider important aspects of the market structure that are likely to impact on risk sharing. That is, our model incorporates a more detailed goods market structure than other models in the related literature. Intermediate firms in both countries produce differentiated exports goods, which are traded within the union. In addition, we include a non-tradeable intermediate goods sector in each country. Thus, we account for risk sharing (or amplification) via changes in relative purchasing power and movements in the terms of trade (see Chari et al., 2002; Stockman and Tesar, 1995). Moreover, we include a labor market with search-and-matching frictions along the lines of Mortensen and Pissarides (1994) and credible wage bargaining following Hall and Milgrom (2008).

This chapter contributes to the literature that deals with transfers in a monetary union in general settings and to the studies of a specific European unemployment insurance scheme. Farhi and Werning (2017) show that transfer schemes can enhance welfare even if international financial markets are complete. In particular, they analytically demonstrate in a dynamic setting that the optimal transfer flows to countries that experience an improvement in their technology.[4] In our analysis, we extend, on the one hand, this analytical finding of Farhi and Werning (2017) to non-technology shocks and non-unitary values of the intertemporal elasticity of substitution, thereby deviating from the 'Cole-Obstfeld case'. On the other hand, we demonstrate that their result no longer holds for a broad range of combinations of price rigidities and the home bias. Furthermore, we show that following specific demand shocks the trade-off between risk sharing and efficiency disappears.

There are only few papers so far that also consider the effects of a European unemployment insurance in dynamic stochastic general equilibrium (DSGE) models. Jung et al. (2020) study a federal unemployment insurance in a DSGE model featuring a union of small open economies and search-and-matching labor markets. Their focus is on a setting where the member states can

[4] Similarly, using a quantitative model of a monetary union, Evers (2012) finds that a transfer rule that targets regional fiscal deficits enhances consumption risk sharing but has negative welfare effects, while the opposite is true for a rule that targets regional differences in labor income. In the QUEST III model of the euro area, Roeger and Vogel (2017) find that fiscal transfers alone tend to crowd out alternative risk-sharing mechanisms, leading to small stabilization gains.

adjust country-specific labor-market polices in response to the federal insurance scheme. They conclude that coordination of the federal and country-specific schemes could provide insurance against fluctuations and increase welfare. Their analysis abstracts from structural cross-country differences, effects of monetary policy, and trade patterns. Different to them, we neglect political and moral hazard aspects of international risk sharing.

Moyen et al. (2019) develop a two-country DSGE model with search-and-matching frictions and a cross-country unemployment insurance system. The authors first derive an analytical solution for a tractable one-period version, which abstracts from private bond trading and assumes a homogeneous international consumption good. Their focus lies on optimal replacement rates, which turn out to be countercyclical. They also run simulations in a calibrated dynamic version of the model and find that sizeable cross-country transfers in a EUBS can stabilize consumption mainly in the Periphery. The production side of their model, however, does not account for capital formation or a non-tradeable goods sector.

Abrahám et al. (2019) analyze the flows between employment, unemployment, and inactivity in a DSGE model with search frictions in the labor market, which is based on the model of worker flows set out in Krusell et al. (2011). The authors find only limited space for insurance at the European level and stress the role of country-specific labor-market policies. Importantly, their analysis focuses only on the extensive margin of labor supply.

The remaining literature is mostly restricted to simulation exercises based on micro data, using static models that do not account for aggregate dynamics and general-equilibrium effects of the introduction of a EUBS. For example, Beblavý et al. (2017) present a comprehensive report for the European Commission on the design features of a EUBS. The authors document legal and operational implications of different schemes as well as their strengths and weaknesses. Based on micro-simulations, they find that the introduction of a EUBS has potential for automatic stabilization. This is in line with the conclusions of other policy papers, for example Andor et al. (2014) and Dullien and Fichtner (2013). Dolls et al. (2015) and Jara et al. (2016) run quantitative simulations with micro data using the EUROMOD tax-benefit model and find that a EUBS could have provided significant risk sharing during the global financial crisis.

The remainder of this chapter is organized as follows. Section 3.2 presents the tractable two-country model. In Section 3.3 we introduce the quantitative model, with the calibration and model simulations in Section 3.4. We discuss the effects of an introduction of a EUBS in Section 3.5 and resulting policy implications in Section 3.6. Section 3.7 concludes. Data sources, a detailed description of the analytical model, and all proofs are included in the appendix.

## 3.2 Analytical model

In this section, we derive a simple and analytically tractable model of a monetary union, consisting of two symmetric countries. Only a fraction of firms can change prices in reaction to shocks in the same period (as in Fischer, 1977). In this setup, agents in both countries expect to arrive at a new steady state in the period after a temporary shock (similar to Obstfeld and Rogoff, 1995). We consider four disturbances: a supply shock (technological innovations), a 'pure' demand shock (changes in financial frictions, expectations or preferences), an expansionary shock that reduces available resources for consumption (disturbances to government spending), and a union-wide monetary-policy shock. These shocks cover a broad enough range of developments to arrive at our main insights regarding the role of transfers in a monetary union. In particular, we analytically investigate whether international transfers can mitigate the negative effects of the two dynamic distortions in the economy, namely rigid prices cum monetary union and incomplete markets. We will then show that the intuition obtained in this simplified version of the full model developed in Section 3.3 carries over to the large model featuring a European unemployment benefit system.

### 3.2.1 Setup

We will outline only the domestic side of the model, the Home economy, with symmetric structures existing in the Foreign economy. Foreign variables are denoted with an asterisk. Both countries are populated by a representative household each. The household maximizes lifetime utility

$$\sum_{t=0}^{\infty} \beta^t \mathcal{U}_t,$$

with the instantaneous utility function

$$\mathcal{U}_t = \ln C_t - \frac{H_t^2}{2},$$

where $C_t$ is consumption and $H_t$ are hours worked in the production of the domestic good. The corresponding budget constraint is

$$W_t H_t + \Theta_t + \Upsilon_t = P_t C_t + R_t^{-1} \Theta_{t+1} + T_t + P_{A,t} G_t,$$

with $W_t$ denoting the nominal wage, $\Upsilon_t$ stands for potential profits or losses of the domestic firms, and $T_t$ is a cross-country transfer flowing to Foreign (if positive) or Home (if negative), i.e., $T_t = -T_t^*$. The household can engage in lending or borrowing international bonds $\Theta_{t+1}$, which pay one dollar in period $t+1$ and cost $R_t^{-1}$ in period $t$. The household also has to pay lump-sum taxes that are then used for wasteful government spending $G_t$, which falls on domestic goods with the price index $P_{A,t}$. Government spending follows a white-noise process. In the above budget constraint, the balanced budget rule of the government is already inserted. Finally, $P_t$ is the price of the final consumption good in the domestic market. This consumption good consists of a domestically produced good, $A_t$, and an imported good, $B_t$, as follows

$$C_t = \left[\omega^{\frac{1}{\sigma}} A_t^{\frac{\sigma-1}{\sigma}} + (1-\omega)^{\frac{1}{\sigma}} B_t^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \tag{3.1}$$

with $\omega$ determining the home bias, i.e., the fraction of total expenditures falling on domestic goods in case of equal prices. We assume that $0.5 < \omega < 1$, such that we have open economies with at least a small degree of home bias. The parameter $\sigma \geq 1$ is the trade-price elasticity. As standard in models with monopolistic competition, $A_t$ and $B_t$ are constant-elasticity-of-substitution bundles of a continuum of domestically produced and imported varieties, respectively. Given that demand for each variety plays only a marginal role for the linearized system analyzed below, we omit a more detailed discussion. A unit mass of domestic firms sell the amount $A_t$ to the domestic market and export $A_t^*$ to the Foreign economy. Total output $Y_t$ is produced according to a simple aggregate production function with labor and technology $Z_t$ as the only input factors, where technology follows a white-noise process with a mean of unity,

$$Y_t = Z_t H_t = A_t + A_t^*.$$

For our analysis, we assume that both economies are in a steady state up until period $t$. Price setting of monopolistic-competitive firms is then constrained in the sense that only a random fraction $\xi$ with $0 \leq \xi \leq 1$ of all firms in both countries can set a new price after observing potential shocks in period $t$. All firms can schedule new prices for the period $t+1$. We hence obtain the following equations determining the price of the domestic good in period $t$ and the expected price in $t+1$

$$P_{A,t} = \xi(\mathcal{M}\, W_t/Z_t) + (1-\xi)P_{A,t-1}, \qquad E_t P_{A,t+1} = \mathcal{M} E_t\, W_{t+1}/Z_{t+1},$$

where $P_{A,t-1}$ is the steady-state price, as we only consider shocks occurring in period $t$. The optimal markup $\mathcal{M}$ depends on the elasticity of substitution between the varieties produced by the individual firms.

Additional to the technology and government-spending shock, we also introduce a white-noise financial-friction shock $\Delta_t$. Following Smets and Wouters (2007) and Christiano et al. (2015), this reduced-form shock is introduced as a 'consumption wedge' in the first-order condition regarding savings, i.e., the Euler equation reads as

$$\mathcal{U}_{C,t} = \beta E_t \mathcal{U}_{C,t+1} \frac{R_t \Delta_t}{\Pi_{t+1}},$$

where $\mathcal{U}_{C,t}$ and $\Pi_t$ refer to marginal utility of consumption and inflation, respectively.
Fisher (2015) shows that $\Delta_t$ can be interpreted as a disturbance to the demand for safe and liquid assets. Since the Euler equation determines current consumption based on the interest rate, the discount factor, and expected future consumption, it can equivalently represent a shock to household's time preferences or expectations. Our preferred interpretation, however, is a wedge between the nominal central-bank rate and the one offered to households.[5] A positive spread, i.e., $\Delta_t > 1$, lowers current consumption, all else equal. Ultimately, it serves as pure demand shock in our context: given fundamentals, it changes demand for consumption goods.
In order to close the model, we need to pin down the union-wide real interest rate $E_t R_t \overline{P}_t / \overline{P}_{t+1}$ between the period of the shock and the following period, where $\overline{P}_t$ is the union-wide price index. We assume that the central bank can set this rate, simplifying the solution. The corresponding nominal rate can then be backed out via a Taylor-type feedback rule.
We define deviations from the first-order conditions of the corresponding social-planner solution regarding the optimal labor input as 'wedges', see also Farhi and Werning (2017). However, we define the wedges in a slightly different way compared to these authors and introduce several labor wedges. First, the difference between the marginal disutility from producing the Home good and the marginal utility derived from its consumption in the Home economy (the 'Home@Home' wedge), the difference between these costs and the marginal utility derived from the consumption of the Home good in the Foreign economy (the 'Home@Foreign' wedge), and the corresponding Foreign wedges (called 'Foreign@Foreign' and 'Foreign@Home' wedges). Second, we combine the Home@Home and the Home@Foreign wedges by calculating a quantity-weighted average of the marginal utilities derived from the Home good in both countries to obtain an overall Home labor wedge; similarly for Foreign. Finally, we also calculate the deviations from the so-called risk-sharing condition (Backus and Smith, 1993). This gives us the following wedges, with corresponding labor wedges for Foreign (all variables refer to the period of the shock, time indices are omitted for the sake of exposition):

Home@Home: $\dfrac{-\mathcal{U}_H}{MP} - \mathcal{U}_C C_A$

Home@Foreign: $\dfrac{-\mathcal{U}_H}{MP} - \mathcal{U}_C^* C_A^*$

[5] As such it is related to the loan-deposit spread. The interpretation plays a role for the dynamics in the complete-markets case and the determination of the risk-sharing condition. With our interpretation, perfect risk sharing is achieved if the standard risk-sharing condition is fulfilled, see below.

Overall Home: $\dfrac{-\mathcal{U}_H}{MP} - \left[\dfrac{A}{Y}\mathcal{U}_C^{\sigma} C_A^{\sigma} + \dfrac{A^*}{Y}\mathcal{U}_C^{*\sigma} C_A^{*\sigma}\right]^{\frac{1}{\sigma}}$

Risk Sharing: $\dfrac{\mathcal{U}_C}{\mathcal{U}_C^*} - \dfrac{P}{P^*}$,

where $C_A$ denotes the derivative of the consumption bundle (3.1) with respect to good $A$. $MP$ stands for the marginal product of labor and $\mathcal{U}_H$ for the marginal disutility of labor. The wedges are defined such that a positive value corresponds either to 'too large' values of hours worked and production, relative to the marginal utility derived from consuming the produced goods, or to 'too high' consumption in the Foreign country in the case of the risk-sharing wedge. In the social-planner solution, these wedges are zero. Because of the frictions in the economy, this is not the case in the decentralized equilibrium. Below we will explore if a transfer scheme between the two countries can alleviate the distortions introduced by the dynamic frictions.[6] To this end, we analytically solve the model by linearizing the relevant first-order conditions around the symmetric, zero-inflation steady state. The resulting linear equations are listed in Appendix 3.A. We only consider Foreign shocks throughout, with symmetric results for Home shocks. For demonstrational purposes, we set $\sigma = 1$ in the main text. The proofs for all propositions and Lemma 1 for $\sigma \geq 1$ can also be found in Appendix 3.A.[7] The lemma and the propositions are valid for both cases.

Because it will be important for the interpretation of the direction of the transfer, we first define the terms 'boom' and 'recession' countries before analyzing the effects of the individual shocks. Specifically, we define the recession (boom) country to be the one with a relatively low (high) output, compared to the other country (before policy interventions). This definition is different to that in Farhi and Werning (2017), who define the recession country to be the one with a negative output gap. For example, experiencing a negative technology shock leads to falling output but a positive output gap under rigid prices. In our definition, such a country is labelled recession country, in line with the terminology in policy debates. With this definition, we obtain the following lemma.[8]

[6] Due to monopolistic competition, labor wedges are not zero in steady state. To combat this distortion, however, other instruments than dynamic cross-country transfers should be employed. For this reason and to simplify the description of the analysis, although not entirely correct, we refer to the situation with wedges at their steady-state values as optimal throughout.

[7] For very low values of $\sigma$ (below unity), the effects of a cross-country transfer are mirrored. However, similar to what will be shown for $\sigma \geq 1$, the transfer that closes the labor wedges changes direction depending on the value of $\xi$.

[8] Note that a positive financial-friction shock $\Delta^*$ in Foreign is always contractionary for Foreign. If prices are relatively flexible (high $\xi$) and/or the consumption home bias is low (low $\omega$), however, Periphery output falls by less compared to Home, due to labor-supply and expenditure-switching effects.

**Lemma 1 (Boom and recession countries)** *Following negative Foreign technology or government-spending shocks, Foreign is a 'recession country', while Home is a 'boom country' (with fully rigid prices, outputs are unaffected after technology shocks). After financial-friction shocks, it depends on parameter values whether Foreign is a recession or boom country.*

*Proof for $\sigma = 1$:* The difference between Home and Foreign output in the period of the shock is

$$y_t - y_t^* = -\frac{2\xi}{1+\xi} z_t^* - \frac{1}{1+\xi} g_t^* - \frac{\xi - 2\omega + 1}{(r_s + 1)(1+\xi)} \hat{\Delta}_t^*,$$

where lower-case letters, or $\hat{\Delta}_t$ in the case of $\Delta_t$, denote percentage deviations from steady state. The exceptions are $t_t$ and $g_t^*$, which equal the transfer $T_t$ and Foreign government spending over steady-state output of a single country, as well as $r_s$, the gross steady-state interest rate on bond holdings ($r_t$ is the percentage deviation from this value). This difference increases after negative technology or government-spending shocks in Foreign. Only with fully rigid prices ($\xi = 0$), outputs are unaffected after technology shocks. For contractionary Foreign financial-friction shocks ($\Delta^* > 0$), the reaction depends on whether $\xi$ is larger (output difference decreases) or smaller (difference increases) than $2\omega - 1$. ■

### 3.2.2 Supply shocks

In this section, we focus on Foreign supply shocks, i.e., unexpected changes in Foreign technology in period $t$, such that $g_t^* = \hat{\Delta}_t^* = 0$. Section 3.2.3 deals with demand disturbances.

#### Analytical results

With $\sigma = 1$, we obtain the solutions for the overall labor wedges and the risk-sharing wedge in the period of the shock as

$$\text{Overall Home:} \quad -\frac{2\xi}{1+\xi} z_t^* + \frac{\xi - 2\omega + 1}{(1+\xi)(1-\omega)} \frac{r_s}{1+r_s} t_t - 2r_t \tag{3.2}$$

$$\text{Overall Foreign:} \quad -\frac{2}{1+\xi} z_t^* - \frac{\xi - 2\omega + 1}{(1+\xi)(1-\omega)} \frac{r_s}{1+r_s} t_t - 2r_t \tag{3.3}$$

$$\text{Risk Sharing:} \quad \frac{1}{1-\omega} \frac{r_s}{1+r_s} t_t. \tag{3.4}$$

Note the differential impact of Foreign technology on the Home and Foreign labor wedges. Assume for illustrational purposes that $\xi = 0$, that is, completely fixed prices. After a deterioration of Foreign technology $z_t^*$, the Home labor wedge remains constant: since prices do not move, consumption and production patterns are left unchanged. In Foreign, however, the reduction in $z_t^*$ calls for a lower labor input, seen from an efficiency perspective. Since prices stay constant, this reduction does not take place: the Foreign labor wedge becomes positive. Put differently, marginal disutility of working is too high relative to the utility derived from consumption of the produced goods. As also visible, the transfer that closes the risk-sharing gap for $\sigma = 1$ is zero (Cole and Obstfeld, 1991). Hence, the outcome without a transfer corresponds to the complete-market allocation in this case. It is then straightforward to derive the following propositions.

**Proposition 1 (Flexible prices)** *In the case of flexible prices ($\xi = 1$), overall labor wedges and the risk-sharing wedge can be closed following technology shocks by setting the real interest rate to $\check{r}_t = -z_t^*/2$. The corresponding transfer is either zero ($\sigma = 1$) or flows to the recession country ($\sigma > 1$).*

*Proof for $\sigma = 1$:* Set $\xi = 1$ in equations (3.2)-(3.4) with $t_t = 0$ to obtain

$$\begin{aligned} &\text{Overall Home:} && -z_t^* - 2r_t \\ &\text{Overall Foreign:} && -z_t^* - 2r_t \\ &\text{Risk Sharing:} && 0. \end{aligned}$$

■

If prices are sticky, matters become more complicated. At most two of the three wedges can then be closed simultaneously.[9]

**Proposition 2 (Rigid prices)** *In the case of rigid prices ($0 \leq \xi < 1$), a trade-off between closing the overall labor wedges and the risk-sharing wedge arises following technology shocks, as no combination of the transfer and the real interest rate can close both overall labor wedges and the risk-sharing wedge simultaneously.*

*Proof for $\sigma = 1$:* If $\xi \neq 2\omega - 1$, solve for the value of $\check{t}_t$ and $\check{r}_t$ that close the overall labor wedges of Home and Foreign. Inserting these values into the risk-sharing wedge yields

$$\text{Risk sharing:} \qquad \frac{\xi - 1}{\xi - 2\omega + 1}.$$

If $\xi = 2\omega - 1$, the transfer has no impact on the overall labor wedges. The risk-sharing wedge is then closed for $t_t = 0$ and monetary policy can close only one labor wedge, see equations (3.2)-(3.4). ■

[9] A closely related observation was made by Farhi and Werning (2017) in a similar model: under complete markets, which imply a closed risk-sharing wedge, the constrained optimum is generally not reached. However, below we show that this not the case for specific demand shocks.

In contrast to the flexible-price case, the labor-wedge-closing transfer may now flow *away* from the recession country.

**Proposition 3a (Direction of wedge-closing transfer)** *For weak price rigidities (high $\xi$), the transfer that closes both labor wedges flows from the boom country to the recession country following technology shocks. For strong price rigidities (low $\xi$), the direction of this transfer reverses. This opens the risk-sharing wedge (for $\sigma > 1$: opens the risk-sharing wedge even further). The stronger the home bias (high $\omega$), the weaker the price rigidities need to be for the transfer to reverse.*

*Proof for $\sigma = 1$:* For $\xi \neq 2\omega - 1$, the transfer that closes both labor wedges, given that the real interest rate equals $\check{r}_t = -z_t^*/2$, results as

$$\check{t}_t = -\frac{(1-\omega)(1-\xi)}{\xi - 2\omega + 1}\frac{1+r_s}{r_s}z_t^*.$$

For $\xi > (<) 2\omega - 1$, we obtain $\check{t} > (<) 0$ for $z_t^* < 0$. For $\xi = 2\omega - 1$, we get $\check{t}_t = 0$. ■

We can furthermore derive the optimal transfer by maximizing a second-order approximation of the equally-weighted sum of country-specific welfare, where welfare of a single country is its utility in the period of the shock plus the discounted expected utility of all following periods.[10] This measure hence takes the future effects of today's transfer into account and uses a non-linear approximation of the welfare function. Details and the proof of the following Proposition 3b are given in Appendix 3.A. The approach confirms that also the welfare-maximizing transfer changes direction for high price rigidities.[11]

**Proposition 3b (Direction of optimal transfer)** *With flexible prices, the transfer that maximizes equally weighted welfare flows from the boom country to the recession country following technology shocks. With rigid prices, the direction of this transfer reverses.*

[10] Note that the solution to this problem does not necessarily correspond to the social-planner outcome, as the effects of the transfer depend on (distorted) prices. Put differently, it might be not feasible to implement the social-planner solution with the transfer alone.

[11] The correspondence between Proposition 3a and 3b is in line with the finding of Farhi and Werning (2017) that at a constrained Pareto-efficient equilibrium, labor wedges are zero (in the absence of uncertainty). Yet, the content of Propositions 3a and 3b, i.e., the transfer reversal, seems to stand in contradiction to Farhi and Werning (2017), who do not find such a reversal. In their dynamic model, which comes closest to our model since it features production in a tradeable sector, they derive analytical results for the cases of fully rigid prices ($\xi = 0$, translated to our notation) and complete home bias ($\omega = 1$), both for $\sigma = 1$ and technology shocks only. Our derivations confirm their finding, extended to $\sigma \geq 1$, that the transfer flows to the country with a negative output gap, as $\xi < 2\omega - 1$ holds in both cases. Moreover, we generalize this finding for different types of shocks below. Deviating from these extreme parameterizations, however, reveals that the transfer may flow the other way around.

To build intuition for the simulation of the large model in Section 3.3, however, we are primarily interested in the effects on efficiency and risk sharing in the period of the shock (Proposition 3a). Finally, the following proposition is helpful for the same purpose.

**Proposition 4 (Reason for transfer reversal)** *The labor wedge that corresponds to the domestic good consumed in the recession country (Foreign@Foreign, if Foreign is the recession country) depends negatively on domestic technology and positively on transfers towards the recession country.*

*Proof for $\sigma = 1$:* Assume, without loss of generality, that Foreign is the recession country. The Foreign@Foreign wedge results as

$$\text{Foreign@Foreign:} \qquad \frac{\omega(1-\xi)}{(1-\omega)(1+\xi)}\frac{r_s}{1+r_s}t_t - \frac{2}{1+\xi}z_t^* - 2r_t.$$

Remember that $t_t$ is positive if the transfer flows to Foreign. ■

This shows that a negative technology shock at Foreign opens up the Foreign@Foreign wedge: since prices are rigid, they fail to reflect the true costs of production. Thus, Foreign households consume an inefficiently large amount of the Foreign good, given the disutility that its production causes. With at least some price stickiness, a transfer to Foreign tends to open the Foreign@Foreign wedge even further, as Foreign consumption of the Foreign good rises. At the same time, Home consumers spend less on the Foreign good, which exerts a downward pressure on the Foreign@Home wedge. For a high home bias (high $\omega$), the first effect is large and the second small. Additionally, with high price stickiness (low $\xi$), relative prices change little and expenditure switching away from the Foreign good is small. Taken together, the opening of the Foreign@Foreign wedge following a transfer towards the recession country dominates the reaction of its overall labor wedge if price rigidities and the home bias are high.

**Numerical examples**

In this section, we illustrate the above findings graphically in a stylized manner. To generate figures 3.1-3.2, we set $\omega = 0.85$, i.e., a relatively high but realistic home bias. The discount rate $\beta$ is 0.9, while $\sigma$, the trade-price elasticity, is set to two. The steady-state price markup over marginal costs, needed for the welfare calculations, is 20%. We simulate a temporary shock of -5% to Foreign technology $z_t^*$ for all figures. The central bank adjusts the nominal interest rate in a way that the real interest rate equals $r_t = -z_t^*/2$, such that a transfer can close both overall labor wedges simultaneously in the case of flexible prices. The x-axes of all figures measure

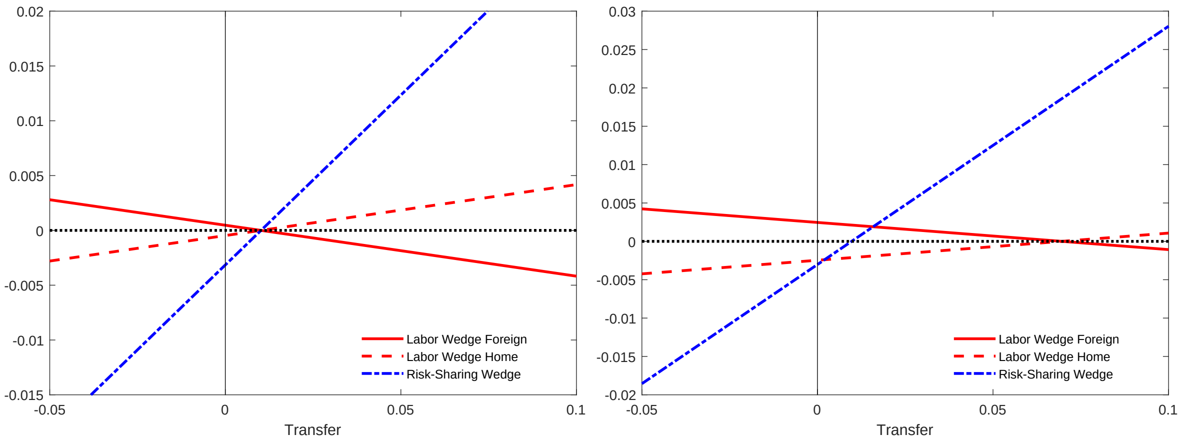


**Figure 3.1:** Wedges for flexible prices and moderate price rigidities

*Notes:* Flexible prices ($\xi = 1$, left) and moderate price rigidities ($\xi = 0.9$, right).

$t_t$, the lump-sum transfer from Home to Foreign over steady-state GDP of one country in the period of the shock. Transfers in all following periods are zero throughout; also technology in Foreign returns to its steady-state level. All figures depict period $t$, the period of the shock.

The left-hand panel of Figure 3.1 shows the case of flexible prices. Given that $\sigma \neq 1$, together with the assumption of incomplete markets, the risk-sharing condition is violated in case of no transfers. The fall in $z_t^*$ causes firms in the Foreign economy to increase prices. If $\sigma$ was equal to unity, quantities would adjust such that the risk-sharing condition would be fulfilled without a transfer (Cole and Obstfeld, 1991). Since $\sigma > 1$, however, quantities react more strongly to this price change, such that Home obtains a relatively large share of world expenditure. Seen from a risk-sharing perspective, its marginal utility of consumption is hence too low; the risk-sharing wedge is negative. Shifting resources from Home to Foreign increases Home's marginal utility of consumption. At the point of a closed risk-sharing wedge, utility costs of production are in line with the associated gains in utility; both labor wedges are closed. That is, implementing the same transfer that would result from the trade of a full set of state-contingent securities closes all wedges simultaneously, replicating the complete-markets solution.

This, however, is no longer possible with rigid prices. The right-hand panel of Figure 3.1 depicts the outcome under relatively modest price rigidities ($\xi = 0.9$). As visible, a trade-off between closing the labor wedges (efficient allocation of production) and the risk-sharing wedge (efficient distribution of consumption) obtains. The intuition is straightforward. Closing the risk-sharing wedge means that relative marginal utilities align with the relative prices of purchasing consumption in both countries. Given that these prices no longer move one-to-one with the disutility of producing consumption goods, production is allocated inefficiently even with a closed risk-sharing wedge. In particular, the Foreign price is 'too low' at this point, in

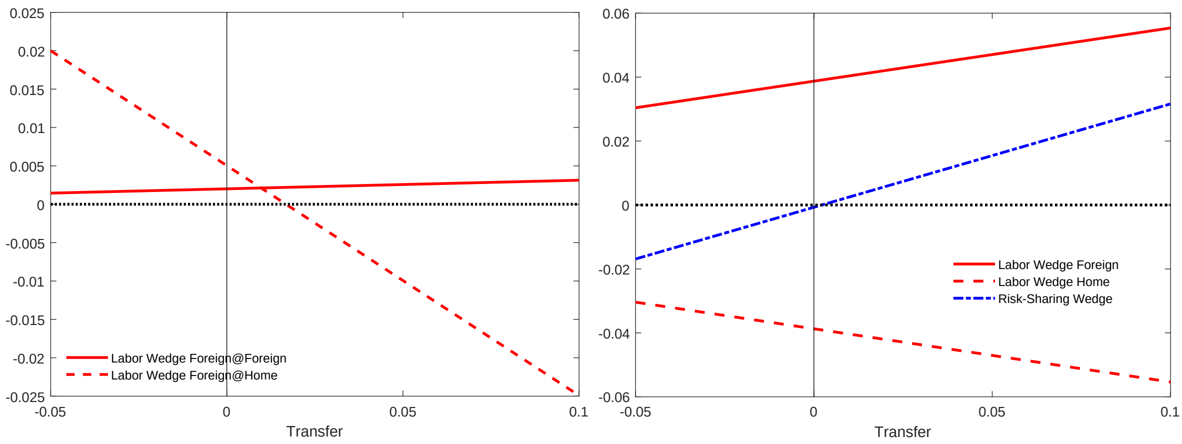


**Figure 3.2:** Wedges for moderate and strong price rigidities

*Notes:* Individual wedges of Foreign good for moderate price rigidities ($\xi = 0.9$, left) and labor and risk-sharing wedges for strong price rigidities ($\xi = 0.1$, right).

the sense that, due to price rigidities, it rises by less than the increase in marginal costs. Hence, a positive Foreign labor wedge obtains. Implementing a larger transfer closes the labor wedges, but violates the risk-sharing condition. The overall Foreign labor wedge is closed primarily because the transfer decreases Home's consumption level, raising the marginal utility derived from consuming the Foreign good. This reduces the Foreign@Home wedge, see the left-hand panel of Figure 3.2. Because of the home bias, Foreign spends the largest part of the transfer on the Foreign good. Thus, its marginal utility of consuming this good falls and production increases, exerting an upward pressure on the Foreign@Foreign wedge. However, the resulting increase in Foreign's price has a dampening impact on the surge in demand. Hence, the wedge rises slowly compared to the fall in the Foreign@Home wedge and the overall Foreign labor wedge diminishes until overall consumption utility from the Foreign good equals its costs of production.

Matters become even worse for higher price rigidities. First, without a transfer, depicted in the right-hand panel of Figure 3.2, labor wedges open up much wider, given the muted reaction of the relative price to the change in technology.[12] Second, the effect of the transfer reverses. A transfer towards Foreign still increases the marginal consumption utility of Home, which, as before, reduces the Foreign@Home wedge, see the left-hand panel of Figure 3.3. Yet, this improvement is overturned by a counteracting effect in the Foreign country. The transfer to Foreign is again spent primarily on the Foreign good. This time, however, the muted price reaction leads to a more pronounced surge in demand. Production rises strongly while Foreign's

[12] At the same time, the risk-sharing wedge is smaller. Consider the case of completely fixed prices as an example. Expenditure and hence income would be unaffected by the technology shock, such that consumption levels and the price ratio would remain at their steady-state values. Obviously, production would not be allocated efficiently in this case, visible in open labor wedges.

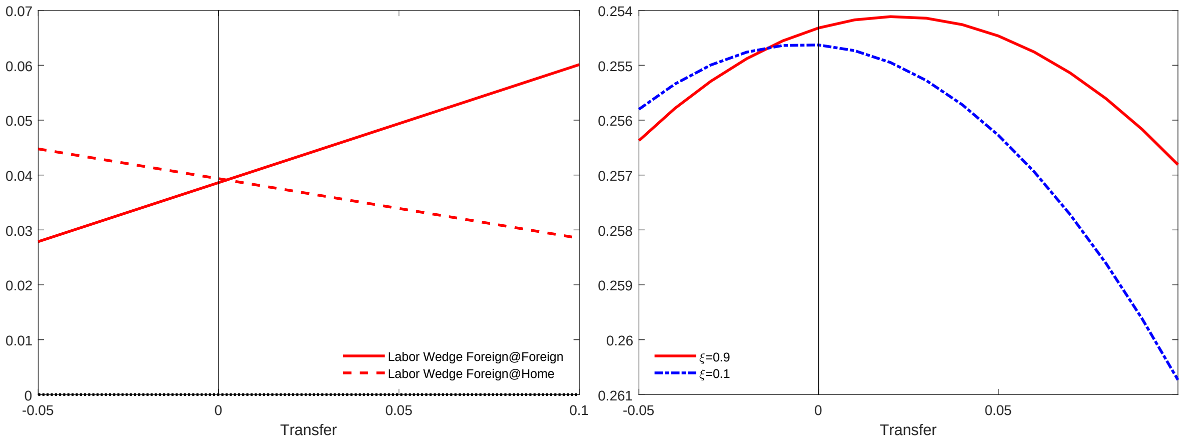


**Figure 3.3:** Wedges for strong price rigidities and welfare

*Notes:* Individual wedges of Foreign good with for strong price rigidities ($\xi = 0.1$, left), and equally-weighted welfare losses (right, inverted y-axis).

marginal utility of consumption drops, such that the further opening in the Foreign@Foreign wedge dominates the overall Foreign labor wedge. Thus, labor wedges start to close if the transfer is conducted *away* from the country with the negative technology shock. The risk-sharing wedge, however, opens up even further in this case, aggravating the described trade-off.

As a result, while welfare (measured here by the equally-weighted discounted sum of Home and Foreign current and future utilities) increases with a transfer towards Foreign after a negative technology shock in that country under relatively flexible prices, the opposite is true under relatively rigid prices. This is depicted in the right-hand panel of Figure 3.3, which shows welfare losses as a percentage of steady-state consumption.[13] Both countries are harmed by a lower Foreign technology, Foreign more than Home. A transfer to the Foreign country always harms Home and benefits Foreign, but joint welfare effects depend on parameter values as described.

To summarize, our analytical model shows that raising allocative efficiency by usage of an international transfer scheme may actually require transfers that are opposite of what a EUBS would imply, if unemployment is relatively higher in the recession country. If home bias and sticky prices, both realistic features, are prevalent, a transfer to the country with a temporarily inferior production technology may actually decrease efficiency and welfare, although bringing consumption levels closer to each other.

[13] Calculations for the figure are based on inserting first-order approximations into the non-linear welfare functions. Expected transfers are assumed to be zero from period $t + 1$ onwards, as the economies are expected to reach the new steady state then and we rule out steady-state transfers. Welfare effects are naturally small, as we are measuring the effects of a one-time shock and transfer by a permanent reduction in consumption. We invert the y-axis, such that a maximum denotes minimal welfare losses.

### 3.2.3 Demand shocks

To contrast the results for supply shocks with those for demand shocks, we next analyze the effects of financial-friction and government-spending shocks. Because the former introduce a consumption wedge in the Euler equation, they can be seen as ‘pure’ demand shocks. We show in Section 3.2.3 that a combination of monetary policy and transfer policy can perfectly offset the effects of such a shock. Although government-spending shocks are in principle demand shocks as well, they additionally open up labor wedges because government spending is assumed to be wasteful. We demonstrate in Section 3.2.3 that this feature introduces the same trade-off as for supply shocks, but with opposite signs. Finally, we look at the effects of a union-wide monetary-policy shock.

#### Financial-friction shock

A contractionary financial-friction shock ($\hat{\Delta}_t^* > 0$) in Foreign reduces Foreign consumption and output for given fundamentals and interest rates. International economic policy can fend off its effects by setting union-wide monetary policy to adjust average activity in both countries and by using the transfer to offset the asymmetric effects.

**Proposition 5 (Financial-friction shock)** *The risk-sharing wedge and both overall labor wedges can be closed simultaneously by implementing a transfer that flows towards country experiencing a contractionary financial-friction shock ($\Delta^* > 0$), supported by an appropriate monetary-policy response. This result holds independently of the degree of price rigidities.*

*Proof for $\sigma = 1$:* For $g_t^* = z_t^* = 0$, the wedges result as

$$\begin{aligned}
&\text{Overall Home:} && -\left[1 + \frac{\xi - 2\omega + 1}{(1+\xi)(1+r_s)}\right]\hat{\Delta}_t^* + \frac{\xi - 2\omega + 1}{(1+\xi)(1-\omega)}\frac{r_s}{1+r_s}t_t - 2r_t \\
&\text{Overall Foreign:} && -\left[1 - \frac{\xi - 2\omega + 1}{(1+\xi)(1+r_s)}\right]\hat{\Delta}_t^* - \frac{\xi - 2\omega + 1}{(1+\xi)(1-\omega)}\frac{r_s}{1+r_s}t_t - 2r_t \\
&\text{Risk Sharing:} && -\frac{1}{1+r_s}\hat{\Delta}_t^* + \frac{1}{1-\omega}\frac{r_s}{1+r_s}t_t.
\end{aligned}$$

All wedges can be closed by setting

$$\begin{aligned}
\check{r}_t =& -\frac{1}{2}\hat{\Delta}_t^* \\
\check{t}_t =& \frac{1-\omega}{r_s}\hat{\Delta}_t^*,
\end{aligned}$$

where the derivative of $t_t$ with respect to $\hat{\Delta}_t^*$ is positive. ■

**Government-spending shock**

A positive government-spending shock increases demand and wastes the produced goods. It has therefore different welfare implications compared to a 'pure' demand shock discussed above. Specifically, the Foreign labor wedge opens up following a positive government-spending shock in Foreign, even if prices are fully flexible. Since the produced goods are wasted, Foreign workers work 'too much', given the corresponding low marginal utility of consumption in Home and Foreign. This resembles the situation after a negative technology shock. For flexible prices, the transfer that closes the wedge flows towards Foreign. The strong price responses let Home's marginal utility of consuming the Foreign good increase without raising production too much. That is, the transfer flows towards the *boom* country. For relatively high price rigidities, however, the wedge-closing (and the optimal) transfer reverses out of the same logic as for supply shocks. Rigid prices limit the substitution effect, such that a transfer away from Foreign strongly reduces Foreign production, and hence the disutility of working. A transfer towards Foreign would raise production in Foreign considerably, although workers already work 'too much.' In both cases, the risk-sharing wedge is opened by the usage of a transfer. The following proposition summarizes the results.

**Proposition 6 (Government-spending shock)** *In case of a government-spending shock, overall labor wedges and the risk-sharing wedge cannot be closed simultaneously by setting the real interest rate and implementing a cross-country transfer, independently of price rigidities. The transfer that is needed to close both labor wedges flows to the country experiencing a positive government-spending shock (boom country), or away from this country in the case of high price rigidities (low $\xi$). The relevant threshold for the price rigidity is lower for high values of the home bias $\omega$.*

*Proof for $\sigma = 1$:* In case of $z_t^* = \hat{\Delta}_t^* = 0$, the wedges are

$$\text{Overall Home:} \quad \frac{\xi}{1+\xi} g_t^* + \frac{\xi - 2\omega + 1}{(1+\xi)(1-\omega)} \frac{r_s}{1+r_s} t_t - 2r_t \tag{3.5}$$

$$\text{Overall Foreign:} \quad \frac{\xi+2}{1+\xi} g_t^* - \frac{\xi - 2\omega + 1}{(1+\xi)(1-\omega)} \frac{r_s}{1+r_s} t_t - 2r_t \tag{3.6}$$

$$\text{Risk Sharing:} \quad \frac{1}{1-\omega} \frac{r_s}{1+r_s} t_t, \tag{3.7}$$

such that the risk-sharing wedge is zero without a transfer and the overall Foreign labor wedge is positive in case of $g_t^* > 0$, independently of the value of $\xi$. Now solve (3.5)-(3.6) for the transfer and real interest rate that close both labor wedges. This results in

$$\check{r}_t = \frac{g_t^*}{2}$$
$$\check{t}_t = \frac{1-\omega}{\xi - 2\omega + 1} \frac{1+r_s}{r_s} g_t^*.$$

For $\xi \neq 2\omega - 1$, the risk-sharing wedge is then

$$\text{Risk Sharing:} \qquad \frac{1}{\xi - 2\omega + 1} g_t^*.$$

The transfer $\check{t}_t$ that is, in addition to the given value of the real interest rate, required to close the labor wedges for $g_t^* > 0$ is positive (negative) if $\xi > (<) 2\omega - 1$. For $2\omega - 1 = \xi$, the transfer has no impact on the labor wedges, such that at least one remains open. ■

### Monetary-policy shock

Given the symmetry of the model, monetary-policy shocks have an identical effect on Home and Foreign.

**Proposition 7 (Monetary-policy shock)** *Following monetary-policy shocks (autonomous changes in $r_t$), labor wedges in Home and Foreign open and have the same sign, while the risk-sharing wedge remains closed. A transfer can close only one of the two labor wedges, but opens the risk-sharing wedge and the remaining labor wedge even further.*

*Proof for $\sigma = 1$:* In case of $z_t^* = \hat{\Delta}_t^* = g_t^* = 0$, the wedges are

$$\text{Overall Home:} \qquad \frac{\xi - 2\omega + 1}{(1+\xi)(1-\omega)} \frac{r_s}{1+r_s} t_t - 2r_t \tag{3.8}$$

$$\text{Overall Foreign:} \qquad -\frac{\xi - 2\omega + 1}{(1+\xi)(1-\omega)} \frac{r_s}{1+r_s} t_t - 2r_t \tag{3.9}$$

$$\text{Risk Sharing:} \qquad \frac{1}{1-\omega} \frac{r_s}{1+r_s} t_t. \tag{3.10}$$

■

### 3.2.4 Transfer schemes

Combining the analytical results of the previous sections with the shock reactions of other cross-country differences gives rise to the following proposition.

**Proposition 8 (Simple international transfer schemes)** *An international transfer that flows to the country with the relatively lower shock response of either output, the output gap, consumption, or hours worked opens at least one labor wedge following at least one shock for a certain degree of price rigidities, even in combination with a suitable monetary policy response. Specifically, a transfer scheme tied to the relative output response opens at least one labor wedge following some shock(s), irrespective of price rigidities. A scheme tied to the relative output-gap response reduces all labor wedges following all shocks, but only in the case of high price rigidities. A scheme tied to the relative consumption response reduces all labor wedges following all shocks, but only in the case of low price rigidities. A scheme tied to the relative response of hours worked reduces all labor wedges following all shocks, but only in the case of high price rigidities and a low trade-price elasticity.*

*Proof for $\sigma = 1$:* Propositions 3a, 5, 6, 7 show that for low (high) price rigidities, a transfer that reduces both labor wedges, in combination with a suitable monetary-policy response, flows to Foreign if $z_t^* < (>) 0$, $g_t^* > (<) 0$ or $\hat{\Delta}_t^* > 0$. Low (high) price rigidities are present if $\xi > (<) 2\omega - 1$. The direction of such a transfer in response to $z_t^* < 0$, $g_t^* > 0$, and $\hat{\Delta}_t^* > 0$ for low (high) price rigidities can hence be summarized by $\{+,+,+\}$ ($\{-,-,+\}$). The responses of relative variables are given in Lemma 1 and below (for $t_t = 0$, i.e., pre-transfer).

$$
\begin{aligned}
\bar{y}_t - \bar{y}_t^* &= \frac{1-\xi}{1+\xi} z_t^* - \frac{1-\xi}{2(1+\xi)} g_t^* + \frac{(1-\xi)\omega}{(1+r_s)(1+\xi)} \hat{\Delta}_t^* \\
c_t - c_t^* &= -2\xi \frac{2\omega - 1}{1+\xi} z_t^* + \xi \frac{2\omega - 1}{1+\xi} g_t^* + \frac{1 + \xi[1 - 2\omega(2\omega - 1)]}{(1+r_s)(1+\xi)} \hat{\Delta}_t^* \\
h_t - h_t^* &= \frac{1-\xi}{1+\xi} z_t^* - \frac{1}{1+\xi} g_t^* - \frac{\xi - 2\omega + 1}{(1+r_s)(1+\xi)} \hat{\Delta}_t^*,
\end{aligned}
$$

where $\bar{y}_t$ is the output gap, i.e., the difference between output under flexible ($\xi = 1$) and rigid prices ($\xi < 1$). The derivative of $c_t - c_t^*$ w.r.t. $\hat{\Delta}^*$ is positive, while the derivative of $h_t - h_t^*$ w.r.t. $\hat{\Delta}^*$ is positive (negative) if $\xi < (>) 2\omega - 1$. That is, the direction of the transfer induced by the reaction of $y_t - y_t^*$ to $z_t^* < 0$, $g_t^* > 0$, and $\hat{\Delta}_t^* > 0$ for low (high) price rigidities can be summarized by $\{+,-,-\}$ ($\{+,-,+\}$), the reaction of $\bar{y}_t - \bar{y}_t^*$ by $\{-,-,+\}$, the reaction of $c_t - c_t^*$ by $\{+,+,+\}$, and the reaction of $h_t - h_t^*$ by $\{-,-,-\}$ ($\{-,-,+\}$), where a '+' means non-negative and a '−' stands for non-positive. Comparing these reactions with the transfer direction needed for closing both labor wedges completes the proof. ■

We conclude that, additional to the discussed trade-off between efficient risk sharing and production efficiency, there are important obstacles to a practical implementation of a transfer scheme that aims at allocative efficiency. Such an implementation could be based on a specific cross-country differential. As shown in Proposition 8, however, there is no such simple transfer scheme that reaches the goal of allocative efficiency for all degrees of price rigidities.

Against this background, we explore the European situation by calibrating a quantitative business cycle model to the euro area in the next section. As we will see, unemployment differentials in the large model are inversely correlated to consumption differentials.[14] If price rigidities were low enough, a transfer scheme that enhances allocative efficiency could therefore be implemented. Yet, price rigidities will turn out to be severe, such that a scheme based on relative unemployment, like a EUBS, fails to enhance allocative efficiency after all shocks. That is, efficiency can be enhanced the most if the scheme is activated only after specific shocks.

## 3.3 Quantitative model

In this section, we provide an exposition of our quantitative business cycle model. We mainly draw on the medium-size two-country model laid out in Enders et al. (2013), which is itself related to models in Mortensen and Pissarides (1994), Stockman and Tesar (1995), and Chari et al. (2002). This model features several potential channels for risk sharing (international bonds, time-varying terms of trade with differentiated traded and non-traded goods) and search-and-matching labor market frictions. We add financial-friction shocks and a flexible specification for unemployment insurance schemes, ranging from national insurance schemes to a fully international EUBS. The 'Home' region (called 'Core') in our model is a euro area Core aggregate, whereas the 'Foreign' region (called 'Periphery') represents a euro area Periphery aggregate. The relative size of Core, as measured by its GDP divided by Periphery GDP, is denoted by $n$. Since both country aggregates share the same model structure, the exposition focuses on Core. We refer to Periphery with an asterisk where required.

There are a representative household, a final good firm, intermediate goods firms, and a government in each region. The final good firm combines domestically produced tradeable and non-tradeable as well as imported intermediate goods into a final good used for consumption, investment, and government spending. The model is closed with feedback rules for government spending and monetary policy, where monetary policy is set at the union-wide level.

[14] In contrast, output and hours worked increase following, e.g., government-spending shocks. Yet, unemployment rises as well over time because of the positive labor-supply effect induced by lower consumption.

### 3.3.1 Representative household

The representative household chooses consumption of final goods, $C_t$, and supplies hours worked, $H_t$. Preferences are represented by the following lifetime utility function

$$\mathcal{U}_t = E_0 \sum_{t=0}^{\infty} \beta_t \left( \frac{C_t^{1-\gamma} - 1}{1-\gamma} - \vartheta \frac{H_t^{1+\mu}(1-U_t)}{1+\mu} \right)$$
$$\beta_0 = 1, \;\; \beta_{t+1} = \beta(C_t)\beta_t, \;\; \beta(C_t) = \frac{1}{1+\psi C_t},$$

where $\gamma > 0$ denotes the coefficient of relative risk aversion, $\mu > 0$ refers to the inverse Frisch elasticity, and $\vartheta > 0$ determines the disutility of hours worked. The discount factor $\beta_t$ is endogenous and decreases in response to a rise in average consumption.[15] The parameter $\psi > 0$ pins down the value of the steady-state discount factor. The measure of unemployed workers is denoted by $U_t$.

The employed measure of workers earns the hourly wage $W_t$, which is taxed at rate $\tau_t = \tau_{EU,t} + \tau_{L,t}$, where $\tau_{EU,t}$ is a union-wide tax and $\tau_{L,t}$ is region specific. The unemployed measure receives unemployment benefits $b_t$. The benefits are distributed by an unemployment insurance scheme, which we describe in more detail below. Labor and capital are immobile across countries. The capital stock in the traded goods sector $K_{A,t}$ and the capital stock in the non-traded goods sector $K_{N,t}$ are owned by the household and are used in the production of intermediate goods. Financial markets are incomplete such that households can only trade international risk-free one-period bonds, $\Theta_t$. The budget constraint of the domestic household is given by

$$(1-\tau_t)W_t H_t(1-U_t) + R_{A,t}K_{A,t} + R_{N,t}K_{N,t} + \Upsilon_t + \Theta_t + b_t U_t = P_{F,t}(C_t + T_t + X_t) + \frac{\Theta_{t+1}}{R_t},$$

where $R_t$ refers to the gross nominal interest rate, $T_t$ denotes lump-sum taxes and $\Upsilon_t$ measures profits generated by intermediate and labor market firms. $R_{A,t}$ and $R_{N,t}$ are the rental rates of $K_{A,t}$ and $K_{N,t}$, respectively. Total investment is defined as $X_t = X_{A,t} + X_{N,t}$ and, following Christiano et al. (2005), adjusting the growth rate of investment is costly. Capital in each intermediate goods sector evolves according to

$$K_{k,t+1} \;\; = \;\; (1-\delta)K_{k,t} + \digamma(X_{k,t}, X_{k,t-1}), \text{ with } \digamma = \left[1 - \frac{\kappa}{2}\left(\frac{X_{k,t}}{X_{k,t-1}} - 1\right)^2\right] X_{k,t},$$

where the index $k \in \{A, N\}$ refers to the traded or non-traded goods sector and $\kappa \geq 0$ determines the amount of investment-adjustment costs.

[15] The effect is not internalized by the household. Schmitt-Grohé and Uribe (2003) show that this assumption ensures stationarity around a deterministic steady state.

Utility maximization gives rise to a standard intertemporal Euler equation for international bonds. Following Smets and Wouters (2007) and Christiano et al. (2015), we introduce a disturbance which drives a non-zero spread between the nominal interest rate set by the central bank and the return on assets owned by the household. The Euler equation is therefore given by

$$\mathcal{U}_{C,t} = \beta_t E_t \mathcal{U}_{C,t+1} \frac{R_t \Delta_t}{\Pi_{t+1}},$$

where $\mathcal{U}_{C,t}$ and $\Pi_t$ refer to marginal utility of consumption and inflation $P_t/P_{t-1}$, respectively, and $\Delta_t$ denotes the spread. This is a reduced-form way of capturing financial frictions in the economy. The spread follows an autoregressive process of the form

$$\ln \Delta_t = \rho_\Delta \ln \Delta_{t-1} + \varepsilon_{\Delta,t}, \tag{3.11}$$

where $\varepsilon_{\Delta,t}$ denotes a financial-friction shock.

### 3.3.2 Final good firm

The final good $F_t$ is composed of traded and non-traded intermediate goods produced by a continuum of monopolistically competitive intermediate goods firms in both countries. Intermediate goods firms and the corresponding varieties and prices are indexed by $j \in [0,1]$. The representative final good firm operates under perfect competition and aggregates domestically produced intermediate goods $A_t(j)$, imported intermediate goods $B_t(j)$, and domestically produced non-traded goods $N_t(j)$. We assume that the final good is not traded across countries. The resource constraint is therefore given by

$$\begin{aligned} F_t &= C_t + X_t + G_t + \chi V_t \\ &= \left\{ \begin{array}{c} \upsilon^{\varrho+1} \left[ \omega^{\varsigma+1} \left( \int_0^1 A_t(j)^{-\varepsilon} dj \right)^{\frac{\varsigma}{\varepsilon}} + (1-\omega)^{\varsigma+1} \left( \int_0^1 B_t(j)^{-\varepsilon} dj \right)^{\frac{\varsigma}{\varepsilon}} \right]^{\frac{\varrho}{\varsigma}} \\ +(1-\upsilon)^{\varrho+1} \left( \int_0^1 N_t(j)^{-\varepsilon} dj \right)^{\frac{\varrho}{\varepsilon}} \end{array} \right\}^{-\frac{1}{\varrho}}, \end{aligned}$$

where $G_t$ denotes government spending and $\chi V_t$ captures the resource loss due to vacancy posting in the frictional labor market discussed below. The parameter $\epsilon \equiv (1+\varepsilon)^{-1}$ measures the elasticity of substitution between intermediate goods of the same type, $\sigma \equiv (1+\varsigma)^{-1}$ denotes the trade-price elasticity of substitution, and $\eta = (1+\varrho)^{-1}$ refers to the elasticity of substitution between traded and non-traded goods. The home bias, i.e., the weight of domestically produced goods in the traded goods bundle, is measured by $\omega$, whereas the weight of traded goods in the final good bundle is given by $\upsilon$.

### 3.3.3 Intermediate goods firms

Intermediate goods are produced by monopolistically competitive firms in each sector $k \in \{A, N\}$ according to the production function

$$Y_{k,t}(j) = Z_{k,t} K_{k,t}(j)^{\theta} L_{k,t}(j)^{1-\theta}, \tag{3.12}$$

where $Z_{k,t}$ refers to technology and $K_{k,t}(j)$ and $L_{k,t}(j)$ are capital and labor inputs used by firm $j$ in sector $k$. The capital and labor shares in production are given by $\theta$ and $1-\theta$, respectively. Technology evolves according to the following sector-specific process

$$\ln Z_{k,t} = \rho_k \ln Z_{k,t-1} + \varepsilon_{k,t}, \tag{3.13}$$

where $\varepsilon_{k,t}$ denotes a technology shock in sector $k$. The input factors capital and labor are not firm-specific and can be adjusted every period. Intermediate goods firms pay $P_{L,t}$ to the labor market firms to hire one hour of labor, see below.
Price setting follows a discrete-time version of Calvo (1983) pricing. Each intermediate goods firm can adjust its price with a given probability $1-\xi_k$, where $\xi_k$ denotes the sector-specific Calvo parameter. The chance to re-set prices might come at different points in time for domestically-sold and exported goods, where the frequency of price changes depends on the destination market of the product, not on the origin. Thus, the law of one price does not necessarily hold.

### 3.3.4 Labor market

The model features a non-Walrasian search-and-matching labor market à la Mortensen and Pissarides (1994). Specifically, labor market firms meet total demand for labor by intermediate goods firms, $L_t = L_{A,t} + L_{N,t}$, where each firm represents a match between a single worker and single firm. Labor market firms operate under perfect competition and produce a homogeneous labor good according to a production function linear in hours worked. The equilibrium is symmetric, i.e., all matches provide the same amount of labor. The final labor market good is given by the aggregate of individual matches, $L_t = (1-U_t)H_t$. A standard Cobb-Douglas matching function maps the number of vacancies $V_t$ and unemployed $U_t$ into the number of matches $M_t$

$$M_t = sV_t^{\Psi} U_t^{1-\Psi},$$

where $s$ denotes a scaling constant and $\Psi$ measures the matching elasticity. The probability of filling a vacancy from the firms' perspective, $\pi_{f,t}$, and the probability of finding a job from the workers' perspective, $\pi_{ue,t}$, are given by

$$\begin{aligned} \frac{M_t}{V_t} &\equiv \pi_{f,t} = s\left(\frac{V_t}{U_t}\right)^{\Psi-1}, \\ \frac{M_t}{U_t} &\equiv \pi_{ue,t} = s\left(\frac{V_t}{U_t}\right)^{\Psi}. \end{aligned}$$

The profits of a labor market firm $J_t$ and the worker's surplus of the match $\widetilde{V}_t$ are given by

$$\begin{aligned} J_t &= \frac{P_{L,t}H_t - W_tH_t}{P_{F,t}} + E_t(1-f)\rho_{t,t+1}J_{t+1}, \\ \widetilde{V}_t &= \frac{W_tH_t - b_t}{P_{F,t}} - \frac{\vartheta}{\mathcal{U}_{C,t}}\frac{H_t^{1+\mu}}{1+\mu} + E_t\rho_{t,t+1}(1-f-\pi_{ue,t})\widetilde{V}_{t+1}, \end{aligned}$$

where $f$ denotes the exogenous separation rate of the match and the pricing kernel is $\rho_{t,t+1} = \beta_t E_t \mathcal{U}_{C,t+1}/\mathcal{U}_{C,t}$. The firms' profits and the corresponding vacancy postings depend on the wedge between the price for labor paid by the firms $P_{L,t}$ and the wage $W_t$. The surplus of the worker is determined by the wedge between the wage and the outside option, which is given by the unemployment benefits $b_t = \widetilde{b}WH_t$ and the saved amount of leisure. The unemployment benefits are a fraction of steady-state wage per hour $W$, where $\widetilde{b} \in [0,1]$ denotes the replacement rate.

Following Hall and Milgrom (2008) and Jung and Kuester (2011), we assume that the threat point of the worker in the bargaining process is given by the cost of delaying bargaining for one period rather than the value of being unemployed, used in standard Nash-bargaining.[16] The labor-market friction implies that the wage is a convex combination of productivity and the outside option

$$W_t = \Omega P_{L,t} + (1-\Omega)\left[\frac{P_{L,t}}{1+\mu} + \widetilde{b}W\right],$$

where $\Omega$ denotes the bargaining power of the worker.

We assume free entry such that firms make on average zero profits when posting a new vacancy;

$$\chi = \pi_{f,t}E_t\rho_{t,t+1}J_{t+1},$$

where $\chi$ are real vacancy posting costs expressed in terms of the consumption good, representing a resource loss for the economy. The unemployment rate $U_t$ evolves according to the law of

[16] This assumption yields the efficient static bargaining solution for hours worked $\vartheta H_t^{\mu}/\mathcal{U}_{C,t} = P_{L,t}/P_{F,t}$, which is equal to the choice in the neoclassical limiting case.

motion given by

$$U_{t+1} = U_t(1 - f - \pi_{ue,t}) + f. \tag{3.14}$$

### 3.3.5 Unemployment insurance and policy rules

In the baseline specification, which captures the status quo of the EMU, both regions feature separate unemployment insurance systems. In each region, an agency collects labor taxes and disburses unemployment benefits. The taxes are raised at the regional level only, i.e., $\tau_{EU,t} = 0$. Assuming a balanced budget in every period, the agency's constraint is given by

$$\text{Ben}_t \equiv b_t U_t = \tau_{L,t} W_t H_t (1 - U_t) \equiv \tau_{L,t} \text{TaxBase}_t, \tag{3.15}$$

where $\text{Ben}_t$ are disbursed benefits. In the counterfactual scenario, a EUBS is introduced. A union-wide labor tax $\tau_{EU,t}$ raises resources in both regions that are pooled at the European level and there are no additional region-specific taxes, i.e., $\tau_{L,t} = \tau^*_{L,t} = 0$. Benefits are then distributed to the unemployed workers in both regions. The constraint of the international agency (with a balanced budget) is as follows

$$\text{Ben}_t + \frac{\text{Ben}^*_t}{n} = \tau_{EU,t} \text{TaxBase}_t + \tau^*_{EU,t} \frac{\text{TaxBase}^*_t}{n}. \tag{3.16}$$

We fix the (multiplicative) spread $c$ between labor tax rates across regions at a value that ensures zero cross-regional transfers in steady state, i.e., $\tau^*_{EU,t} = c\, \tau_{EU,t}$.

Furthermore, we consider a set of intermediate cases in which only a part of the contributions is pooled at the European level. Specifically, we assume that the union-wide labor tax finances the fraction $\lambda$ of total benefits paid out in both countries. The remaining benefits are financed by region-specific labor taxes $\tau_{L,t}$ and $\tau^*_{L,t}$. The parameter $\lambda \in [0, 1]$ hence measures the degree of internationalization of the unemployment insurance system. The polar cases yield the baseline EMU scenario ($\lambda = 0$) and the fully international EUBS ($\lambda = 1$), see (3.15) and (3.16). In between, we obtain

$$\lambda \left( \text{Ben}_t + \frac{\text{Ben}^*_t}{n} \right) = \tau_{EU,t} \text{TaxBase}_t + \tau^*_{EU,t} \frac{\text{TaxBase}^*_t}{n}$$

$$(1 - \lambda) \text{Ben}_t = \tau_{L,t} \text{TaxBase}_t,$$

with a corresponding expression for Foreign. We again rule out steady-state transfers by adjusting the parameter $c$ in $\tau^*_{EU,t} = c\, \tau_{EU,t}$.

Fiscal policy in each region is characterized by a standard feedback rule for government spending

$$\ln G_t = (1-\rho_G)\ln G + \rho_G \ln G_{t-1} + \phi_Y \ln Y_{t-1} + \varepsilon_{G,t}, \tag{3.17}$$

where $\varepsilon_{G,t}$ denotes a government-spending shock and $G$ refers to government spending in steady state. We assume that government spending reacts to lagged output (determined by the coefficient $\phi_Y$) due to lags in decision and implementation processes, as discussed by Blanchard and Perotti (2002). The government raises lump-sum taxes to balance its budget in every period, i.e., $G_t = T_t$.

Since Core and Periphery countries form a monetary union, interest rates are set at the union level. The central bank reacts to inflation and economic activity according to

$$\ln R_t = \rho_R \ln R_{t-1} + (1-\rho_R)E_t\left[\varpi + \varphi_\Pi \ln\left(\sqrt{\Pi_{t,t-4}\Pi^*_{t,t-4}}\right) + \varphi_Y \ln\left(\sqrt{\widetilde{Y}_t\widetilde{Y}^*_t}\right)\right] + \varepsilon_{R,t}, \tag{3.18}$$

where $\varepsilon_{R,t}$ denotes a monetary-policy shock, $\Pi_{t,t-4}$ refers to year-over-year inflation of final goods and $\widetilde{Y}_t$ measures the output gap, which is defined as the deviation of current output $Y_t$ from its long-run trend, i.e., the steady-state value. The coefficients $\varphi_\Pi$ and $\varphi_Y$ determine the response of the interest rate to inflation and the output gap. Both feedback rules for monetary policy and government spending are estimated independently of the model, see Section 3.4.1 for details.

### 3.3.6 Equilibrium and aggregation

In equilibrium, markets clear at the level of intermediate goods in each sector. Households maximize utility and firms maximize profits subject to their constraints, government policies, and intital conditions. Following Galí and Monacelli (2005), we define an index for aggregate output in each sector $Y_{A,t} \equiv \left(\int_0^1 Y_{A,t}(j)^{-\varepsilon}dj\right)^{\frac{1}{\varepsilon}}$ and $Y_{N,t} \equiv \left(\int_0^1 Y_{N,t}(j)^{-\varepsilon}dj\right)^{\frac{1}{\varepsilon}}$. Aggregate factor inputs used in the intermediate goods sectors, labor $L_{k,t}$ and capital $K_{k,t}$, are given by

$$L_{k,t} = \int_0^1 L_{k,t}(j)dj \quad \text{and} \quad K_{k,t} = \int_0^1 K_{k,t}(j)dj. \tag{3.19}$$

Aggregate production in each sector is

$$\zeta_{k,t} Y_{k,t} = Z_{k,t} K^{\theta}_{k,t} L^{1-\theta}_{k,t}, \tag{3.20}$$

where $\zeta_{k,t} \equiv \int_0^1 \left(\frac{P_{k,t}(j)}{P_{k,t}}\right)^{-\epsilon} dj$ measures price dispersion at the level of intermediate goods.

We define exports and imports as $A^*_t \equiv \left(\int_0^1 A^*_t(j)^{-\varepsilon}dj\right)^{\frac{1}{\varepsilon}}$ and $B_t \equiv \left(\int_0^1 B_t(j)^{-\varepsilon}dj\right)^{\frac{1}{\varepsilon}}$, respectively.

Real GDP is given by

$$Y_t \equiv C_t + X_t + G_t + \chi V_t + \frac{P^*_{A,t}}{nP_{F,t}} A^*_t - \frac{P_{B,t}}{P_{F,t}} B_t. \tag{3.21}$$

The real exchange rate and the trade balance are defined as

$$RX_t \equiv \frac{P^*_{F,t}}{P_{F,t}} \quad \text{and} \quad NX_t \equiv \frac{P^*_{A,t} A^*_t - nP_{B,t} B_t}{nP_{F,t} Y_t}. \tag{3.22}$$

### 3.3.7 Efficiency and risk sharing

Finally, we derive measures for efficiency in the quantitative model. Following the discussion in Section 3.2.1, we define the sector-specific labor wedges for Core and the risk-sharing wedge as follows

| | |
|---|---|
| Core@Core (non-tradeable): | $\frac{-\mathcal{U}_{H,t}}{MP_{N,t}} - \mathcal{U}_{C,t} C_{N,t}$ |
| Core@Core (tradeable): | $\frac{-\mathcal{U}_{H,t}}{MP_{A,t}} - \mathcal{U}_{C,t} C_{A,t}$ |
| Core@Periphery (tradeable): | $\frac{-\mathcal{U}_{H,t}}{MP_{A,t}} - \mathcal{U}^*_{C,t} C^*_{A,t}$ |
| Overall Core (tradeable): | $\frac{-\mathcal{U}_{H,t}}{MP_{A,t}} - \left[\frac{A_t}{Y_{A,t}} \mathcal{U}^{\sigma}_{C,t} C^{\sigma}_{A,t} + \frac{A^*_t}{nY_{A,t}} \mathcal{U}^{*\sigma}_{C,t} C^{*\sigma}_{A,t}\right]^{\frac{1}{\sigma}}$ |
| Risk sharing: | $\frac{\mathcal{U}_{C,t}}{\mathcal{U}^*_{C,t}} - \iota \frac{P_t}{P^*_t},$ |

where $-\mathcal{U}_{H,t}$ denotes marginal disutility of labor,$C_{k,t}$ the partial derivative of the final good (3.3.2) with respect to good $k$, and $MP_{k,t}$ the marginal product of labor in sector $k$, determined by the production function (3.12). The parameter $\iota$ is related to initial wealth differences and, due to the asymmetric calibration, takes a non-unitary value. Specifically, it ensures that the risk-sharing condition is zero in steady state. We define corresponding labor wedges for Periphery.

## 3.4 Simulation

We solve the model based on a first-order approximation of the equilibrium conditions around the deterministic steady state to analyze different scenarios. In the following subsections, we discuss the calibration of the model parameters and report the empirical performance of the model.

### 3.4.1 Calibration

The two-country model is carefully calibrated to account for key characteristics of a euro area *Core* aggregate (Austria, Belgium, Germany, Finland, France, Netherlands) and a *Periphery* aggregate (Greece, Ireland, Italy, Portugal, Spain).[17] This strategy allows us to compare the effects of a common unemployment insurance on two heterogeneous sets of countries that have been characterized by fundamental asymmetries over the last years. One period in the model corresponds to one quarter. We use data from 1999, the starting date of the EMU, through 2017 for the calibration and estimation of shock processes. In the following, we discuss two sets of parameters: First, structural parameters which define household preferences, the production side of the model, and the labor market. Second, parameters determining the evolution of exogenous variables and the policy rules.

**Preferences, production, and the labor market:** Table 3.1 shows the first set of parameter values. We distinguish parameters which are symmetric and asymmetric across countries. The table also reports the sources or calibration targets used to determine the parameters.[18]
We set the coefficient of relative risk aversion $\gamma = 1$, which is consistent with balanced growth. Following Domeij and Flodén (2006), the Frisch wage elasticity of labor supply is 0.5, which implies $\mu = 2$. We target steady-state hours worked at 0.3 in both countries and set the disutility-of-work parameter $\vartheta$ accordingly. The depreciation rate $\delta$ is consistent with the empirical steady-state investment-to-output ratio of 0.21.[19] The capital share $\theta$ reflects the empirical labor share in production, the investment adjustment costs are in line with Enders et al. (2013). The price elasticity of intermediate goods of the same type is set to match a markup of 20% (Rotemberg and Woodford, 1993), and the price elasticities in the traded and non-traded goods sectors are taken from Chari et al. (2002) and Stockman and Tesar (1995), respectively. The relative regional size $n$ is set according to the ratio of Core PPP-adjusted GDP relative to that of Periphery. Following Jung and Kuhn (2014), the separation rate is $f = 0.045$. The bargaining parameter $\Omega$ and the matching elasticity $\Psi$ are set to 0.5, which is in line with Mortensen and Pissarides (1994) and Petrongolo and Pissarides (2001), respectively. This implies that the Hosios condition holds in our model, such that the resulting dynamics are not driven by congestion effects.
In order to account for important heterogeneities across regions, we allow for a comprehensive set of asymmetric parameters. These are mainly related to the functioning of the labor market

[17] See Appendix 3.B for details on the aggregation.
[18] Calibration targets are typically determined by several parameters in a general equilibrium model. We hence list the parameter which is most closely linked to the respective target.
[19] We use averages over Core and Periphery countries for symmetric parameters that are calibrated to the data, weighted by PPP-adjusted GDP (i.e., the same weights as for the aggregation of time series below).

**Table 3.1:** Structural parameters

| **Symmetric parameters** | | | **Value** | **Calibration target/source** | | **Value** |
|---|---|---|---|---|---|---|
| Risk aversion | $\gamma$ | | 1.00 | Balanced growth | | |
| Inverse Frisch elasticity | $\mu$ | | 2.00 | Domeij and Flodén (2006) | | |
| Utility weight of work | $\vartheta$ | | 36.3 | Hours worked steady state | | 0.30 |
| Depreciation rate | $\delta$ | | .017 | $I/Y$ | | 0.21 |
| Capital share | $\theta$ | | 0.37 | Labor share | | 0.63 |
| Investment adjustment cost | $\kappa$ | | 1.50 | Enders et al. (2013) | | |
| Price elasticity | $\epsilon$ | | 6.00 | Rotemberg and Woodford (1993) | | |
| Trade-price elasticity | $\sigma$ | | 1.50 | Chari et al. (2002) | | |
| Non-traded price elasticity | $\eta$ | | 0.44 | Stockman and Tesar (1995) | | |
| Relative regional size | $n$ | | 1.69 | GDP Core/Periphery | | |
| Separation rate | $f$ | | .045 | Jung and Kuhn (2014) | | |
| Bargaining parameter | $\Omega$ | | 0.50 | Mortensen and Pissarides (1994) | | |
| Matching elasticity | $\Psi$ | | 0.50 | Petrongolo and Pissarides (2001) | | |
| **Asymmetric parameters** | | **Core** | **Periph.** | **Calibration target/source** | **Core** | **Periph.** |
| Replacement rate | $\widetilde{b}$ | 0.65 | 0.66 | Unemployment/Output volatility | Table 3.3 | |
| Vacancy posting | $\chi$ | 0.09 | 0.02 | Unemployment steady state | 0.076 | 0.115 |
| Matching constant | $s$ | 0.55 | 0.35 | Normalization $V/U$ | 1.000 | 1.000 |
| Government share | $G/Y$ | 0.24 | 0.19 | Government spending share | 0.24 | 0.19 |
| Weight traded goods | $\upsilon$ | 0.33 | 0.34 | Production manuf./services | 0.485 | 0.508 |
| Weight domestic goods | $\omega$ | 0.89 | 0.76 | Import & export share Core | 0.037 | 0.046 |
| Elast. of discount factor | $\psi$ | .013 | .012 | $K/Y$ | 12.1 | 12.1 |
| Price rigidity tradeables | $\xi_T$ | 0.76 | 0.81 | Price duration indust. goods | 4.146 | 5.387 |
| Price rigidity non-tradeables | $\xi_N$ | 0.84 | 0.86 | Price duration services | 6.270 | 6.890 |

*Notes*: Variables without time subscript refer to steady-state values. Parameters remain unchanged across simulations. See Appendix 3.B for description of the data used for the target values.

and to the severity of the nominal frictions, as we are interested in the effects of an international unemployment insurance on risk sharing and efficiency. We target an average of relative unemployment and output volatilities, reported in Table 3.3 below, to pin down the replacement rate of unemployment benefits $\widetilde{b}$. Vacancy posting costs $\chi$ are determined by targeting the average unemployment rate, which amounts to 7.6% for Core and 11.5% for Periphery.[20] The number of posted vacancies is normalized to determine the matching constant $s$.

Government spending for Core and Periphery is, on average, 24% and 19% of GDP, respectively. We hence set the steady-state shares of government spending accordingly. The weight of traded goods in the final good $\upsilon$ is set to match the average ratio of output in the manufacturing sector relative to output in services. For a given weight of traded goods $\upsilon$, import and export shares in steady state are determined by $\omega$. We set $\omega$ such that Core steady-state imports from Periphery amount to 3.7% of GDP, while Core exports to Periphery are 4.6% of GDP.

We target a steady-state capital-to-output ratio of 12.1, corresponding to the empirical average, to determine the elasticity of the endogenous discount factor $\psi$. The Calvo parameters $\xi_T$ and $\xi_N$ are chosen to be in line with average price durations for the considered countries, as reported

[20] We use the average over the considered countries in both groups for the asymmetric parameters that are calibrated to the data, weighted by PPP-adjusted GDP.

**Table 3.2:** Estimated processes for exogenous variables

| **Technology** | | **Core** | **Periphery** |
|---|---|---|---|
| Persistence | | | |
| Tradeables | $\rho_T$ | 0.88 | 0.91 |
| Non-tradeables | $\rho_N$ | 0.86 | 0.91 |
| Variance of innovations $(10^{-4})$ | | | |
| Tradeables | | 2.31 | 1.38 |
| Non-tradeables | | 0.18 | 0.13 |
| **Financial frictions** | | | |
| Persistence | $\rho_\Delta$ | 0.88 | 0.93 |
| Variance of innovations $(10^{-8})$ | | 4.47 | 8.50 |
| **Government spending** | | | |
| Smoothing | $\rho_G$ | 0.92 | 0.90 |
| Output | $\phi_Y$ | 0.03 | 0.11 |
| Variance of innovations $(10^{-4})$ | | 0.15 | 0.24 |
| **Monetary policy** | | | |
| Smoothing | $\rho_R$ | 0.97 | |
| Inflation | $\varphi_\Pi$ | 1.31 | |
| Output gap | $\varphi_Y$ | 0.38 | |
| Variance of innovations $(10^{-6})$ | | 1.28 | |

*Notes*: See Appendix 3.B for description of the data.

in Dhyne et al. (2006).[21] Price rigidity is higher in Periphery, while prices of non-traded goods are in general more rigid than prices of traded goods.

**Technology:** Technology in intermediate goods production, approximated by Solow residuals, follows the autoregressive process specific to each region and sector specified in equation (3.13). Results of the estimation are reported in the top panel of Table 3.2. We find important differences across countries and sectors. Technology in Periphery is more persistent than in Core, while Core technology is more volatile. Moreover, technology in the tradeable goods sector is slightly more persistent (in Core) and more volatile than in the non-tradeable goods sector.

**Financial frictions:** The reduced-form interest rate spread $\Delta_t$ in the Euler equation for bonds follows the process given by equation (3.11). We estimate region-specific processes on data for the quarterly spread between loan and deposit rates in each country aggregate. The estimates are reported in the second panel of Table 3.2. The spread is found to be more persistent and volatile in Periphery. The size of the innovations, as measured by the variances, is generally quite small.

[21] We follow Baharad and Eden (2004) for the aggregation of price durations across countries.

**Policy rules:** Fiscal and monetary policy is governed by the feedback rules specified in equations (3.17) and (3.18). We estimate region-specific fiscal policy rules for Core and Periphery.[22] The results are summarized in the third panel of Table 3.2. The persistence of government spending is found to be slightly higher in Core. In both country aggregates, fiscal policy is generally not reacting strongly to changes in output, where Periphery government spending is more procyclical.

Second, since Core and Periphery are assumed to form a monetary union, we estimate a common monetary policy rule for both regions. As in the model equation (3.18), the short-term interest rate (shadow rate from 2004Q4 onwards) depends on year-on-year CPI inflation and the output gap (both union-wide, where the output gap is based on linearly detrended data). Following Clarida et al. (1998), we use an instrumental variable approach with year-on-year CPI inflation, the output gap, the short-term interest rate, and commodity prices as instruments in the first stage. The estimates are reported in the bottom panel of Table 3.2. We find strong interest-rate smoothing and a considerable response of the interest rate to the economic cycle.

### 3.4.2 Model performance

Table 3.3 shows the ability of the model to replicate the data. Specifically, we compare the predictions for standard deviations and correlations generated by the baseline model—which captures the EMU with national unemployment benefit schemes—with characteristics of the data. The first three panels of the table show that the model is successful in predicting volatilities of key variables. In particular, the model does not suffer from a lack of volatility of unemployment (Shimer, 2005) because we introduce some degree of effective wage rigidity, see Hagedorn and Manovskii (2008) and Hall and Milgrom (2008) for details. Other key facts are also replicated, such as the ordering of unemployment, investment, output, consumption, and inflation in terms of relative volatilities, where consumption volatility in Core is overpredicted.

The third panel of Table 3.3 displays the empirical and theoretical standard deviations of the real exchange rate and net exports, divided by the volatility of output in Core. The model is quite successful in capturing the volatilities of these variables. The bottom panel summarizes the cross-regional correlations in the data and the corresponding model predictions. All correlations are positive in the data and in theory. For output, investment, and government spending the model underpredicts the magnitudes, while the correlations of the remaining variables, including unemployment, are close to their empirical counterparts.

[22] OLS estimation with linear trend.

**Table 3.3:** Model performance

| Core | Data | Model EMU |
|---|---|---|
| Std($Y$) · 100 | 1.29 | 0.93 |
| Std($C$)/Std($Y$) | 0.38 | 0.90 |
| Std($X$)/Std($Y$) | 2.12 | 2.68 |
| Std($G$)/Std($Y$) | 0.47 | 0.55 |
| Std($U$)/Std($Y$) | 4.67 | 5.30 |
| Std($\pi$)/Std($Y$) | 0.25 | 0.36 |
| **Periphery** | | |
| Std($Y^*$) · 100 | 1.31 | 0.96 |
| Std($C^*$)/Std($Y^*$) | 0.95 | 0.81 |
| Std($X^*$)/Std($Y^*$) | 2.42 | 2.89 |
| Std($G^*$)/Std($Y^*$) | 0.72 | 0.77 |
| Std($U^*$)/Std($Y^*$) | 5.60 | 6.13 |
| Std($\pi^*$)/Std($Y^*$) | 0.41 | 0.23 |
| **Trade** | | |
| Std($RX$)/Std($Y$) | 0.32 | 0.44 |
| Std($NX$)/Std($Y$) | 0.11 | 0.06 |
| **Cross-regional** | | |
| Corr($Y, Y^*$) | 0.81 | 0.46 |
| Corr($C, C^*$) | 0.64 | 0.63 |
| Corr($X, X^*$) | 0.70 | 0.33 |
| Corr($G, G^*$) | 0.60 | 0.03 |
| Corr($U, U^*$) | 0.50 | 0.42 |
| Corr($\pi, \pi^*$) | 0.73 | 0.83 |

*Notes*: See Appendix 3.B for description of the data and the aggregation method. Statistics are based on HP-filtered empirical and theoretical time series.

Based on the comparison of the 20 empirical and theoretical moments listed in Table 3.3, we deem the model performance good enough to conduct counterfactual experiments regarding the introduction of a European unemployment benefit scheme in the next section.

## 3.5 Effects of a European unemployment benefit scheme

In this section, we evaluate the effects of the introduction of a EUBS. In particular, we identify the implications for volatilities and cross-regional correlations, for the transmission of shocks, as well as for production efficiency and risk sharing.

### 3.5.1 Volatilities and correlations

In the following, we document the effects of the introduction of a EUBS on unconditional volatilities of key variables and cross-regional correlations. For this purpose, we implement two different EUBS regimes. The EMU scenario ($\lambda = 0$) serves as the baseline case. The corresponding volatilities and correlations are displayed in the first column of Table 3.4.

**Table 3.4:** Theoretical volatilities and correlations

| Core | EMU | EUBS | Complete Markets |
|---|---|---|---|
| Std($Y$) | 0.93 | 0.90 | 0.87 |
| Std($C$) | 0.84 | 0.80 | 0.76 |
| Std($U$) | 4.94 | 4.80 | 4.48 |
| Std($L$) | 1.32 | 1.31 | 1.28 |
| Std($\pi$) | 0.34 | 0.34 | 0.33 |
| Std($\tau$) | 0.33 | 0.30 | 0.30 |
| Std(Labor wedge) | 4.73 | 4.74 | 4.70 |
| **Periphery** | | | |
| Std($Y^*$) | 0.96 | 0.92 | 0.95 |
| Std($C^*$) | 0.77 | 0.74 | 0.78 |
| Std($U^*$) | 5.88 | 6.05 | 5.84 |
| Std($L^*$) | 1.45 | 1.47 | 1.51 |
| Std($\pi^*$) | 0.22 | 0.23 | 0.24 |
| Std($\tau^*$) | 0.60 | 0.48 | 0.60 |
| Std(Labor wedge$^*$) | 4.24 | 4.31 | 4.44 |
| **Trade** | | | |
| Std($RX$) | 0.41 | 0.46 | 0.38 |
| Std($NX$) | 0.05 | 0.06 | 0.04 |
| Std(Risk sharing wedge) | 0.75 | 0.59 | 0.00 |
| **Cross-regional** | | | |
| Corr($Y$,$Y^*$) | 0.46 | 0.57 | 0.61 |
| Corr($C$,$C^*$) | 0.63 | 0.79 | 0.87 |
| Corr($U$,$U^*$) | 0.42 | 0.44 | 0.63 |
| Corr($L$,$L^*$) | 0.61 | 0.60 | 0.64 |
| Corr($\pi$,$\pi^*$) | 0.83 | 0.75 | 0.81 |

*Notes*: Statistics are based on HP-filtered theoretical moments. Standard deviations are multiplied with 100.

The first counterfactual scenario is a EUBS regime in the second column, as described in Section 3.3 for $\lambda = 1$. We find that the EUBS lowers the volatility of output and consumption in Core and Periphery, relative to the EMU case. The volatility of the risk-sharing wedge falls considerably, primarily driven by a large increase in the cross-regional correlation of consumption (additional to higher correlations of output and unemployment). Yet, the volatilities of the labor wedges increase in both regions. This is in line with the intuition from our analytical results in Section 3.2. For most shocks, a EUBS is unable to achieve consumption risk sharing and production efficiency at the same time (see propositions 2, 6, and 7). There is, however, another positive side to the EUBS: the volatilities of the labor taxes are reduced because, in a downturn, national unemployment insurance schemes do not have to raise all required funds domestically.

Finally, in the third column of Table 3.4, we compare the EUBS scenario to a setting with complete markets, but otherwise the same frictions as in the incomplete-markets case.[23] The volatility of the risk-sharing wedge is zero by construction in this case. This is achieved by implementing implicit transfers in reaction to the specific shocks such that Core volatilities generally decrease, relative to the EMU or EUBS scenarios. At the same time, however, Periphery's volatilities increase with this mechanism. That is, especially the higher technology-shock volatility of Core is 'exported' to Periphery, raising cross-regional correlations substantially.

### 3.5.2 Shock transmission

We now investigate changes in shock transmission that are induced by an introduction of a EUBS. Figures 3.4-3.7 plot responses of important variables to shocks in Periphery that have a negative impact on Periphery consumption. As for the supply side, we consider a negative technology shock in the non-tradeable sector (figures 3.4-3.5). On the demand side, we analyze the effects of a contractionary financial-friction shock (Figure 3.7) and an expansionary government-spending shock (Figure 3.8). Lastly, we investigate the transmission of a contractionary common monetary-policy shock (Figure 3.9). In all plots, the blue bold line shows the response for the EMU case with national unemployment insurance schemes and a monetary union ($\lambda = 0$). The red bold line plots the counterfactual scenario of a European unemployment benefit scheme within a monetary union (full pooling, $\lambda = 1$). The lines in between, slowly changing colors from blue to red, represent increasing values of $\lambda$, from 0 to 1. Finally, the dotted black line represents the complete-markets case, with the same nominal rigidities as in the incomplete-markets case. The shock sizes are set to one standard deviation of the calibrated shock processes. In all figures, responses are multiplied by 100 to obtain deviations from steady state in percent. Exceptions are those of the labor tax rate, the unemployment rate, and the wedges, which are measured in deviations from steady state. For better readability, they are also multiplied by 100. The transfer is expressed in percent of Core steady-state GDP.

**Technology shocks in the non-tradeable sector:** The impulse-response functions display spillovers that switch signs following the introduction of a EUBS. Specifically, Figure 3.4 shows that output and consumption in the Core increase after a negative technology shock in Periphery under the EMU scenario, while unemployment falls. This results from a shift towards Core traded and non-traded goods, as the Foreign traded good, and hence the Core tradeable bundle in general, becomes more expensive. Because of sticky prices, hours worked in the Periphery non-tradeable sector increase following the negative technology shock. As a result, labor costs

[23] Labor taxes are set in the same way as in the EMU scenario with national unemployment insurance schemes.

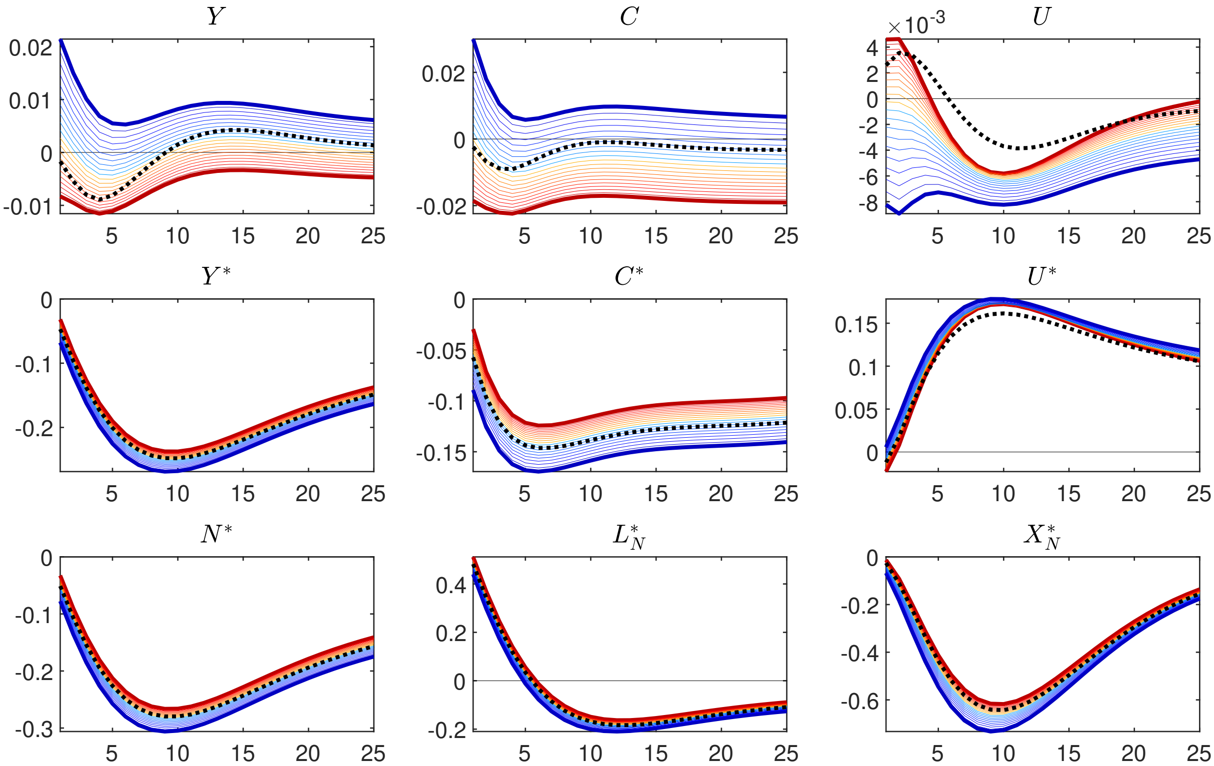


**Figure 3.4:** Responses to contractionary technology shock in Periphery non-traded goods sector under EMU (blue), EUBS (red), and complete markets (black dotted) scenarios

*Notes:* Shock size is one standard deviation of calibrated shock process. Figures show deviations from steady state in percent, except for labor tax rate, unemployment rate, and wedges, which are measured in deviations from steady state, multiplied by 100. Transfers are in percent of Core steady-state GDP.

surge, rendering the tradeable sector less competitive. Periphery unemployment nevertheless rises due to the higher labor supply (except for the first periods in case of a EUBS, as initial labor demand rises strongly in the non-tradeable sector, see below).

In the case of a full EUBS with a corresponding transfer towards Periphery, however, the transmission turns positive, see also Section 3.2.2. Output, consumption, and even unemployment now co-move to some extent across regions. Compared to the EMU case, unemployment in Periphery is somewhat lower. The increased risk sharing is also visible in the muted responses of these variables in Periphery (note the distinct scales, which let the differences in the Periphery reaction appear smaller in comparison). The change in the shock transmission after the regime shift is in line with the increase in cross-regional correlations documented in Table 3.4.[24]

With the sign of the spillover flipped, the risk-sharing wedge now 'overshoots': without a EUBS, consumption (and/or prices) in Periphery is too low, seen from a risk-sharing perspec-

[24] This is similar to the results of the introduction of a common currency. As discussed in detail in Enders et al. (2013), abolishing the nominal exchange rate also makes foreign technology shocks more and domestic technology shocks less important for domestic business cycles. Since both the monetary union and the introduction of a EUBS shift, in this particular dimension, the dynamics in the same direction, the EUBS is very far from being a perfect substitute for flexible exchange rates: flexible exchange rates reduce the adverse effects of foreign shocks, while a EUBS increases them.

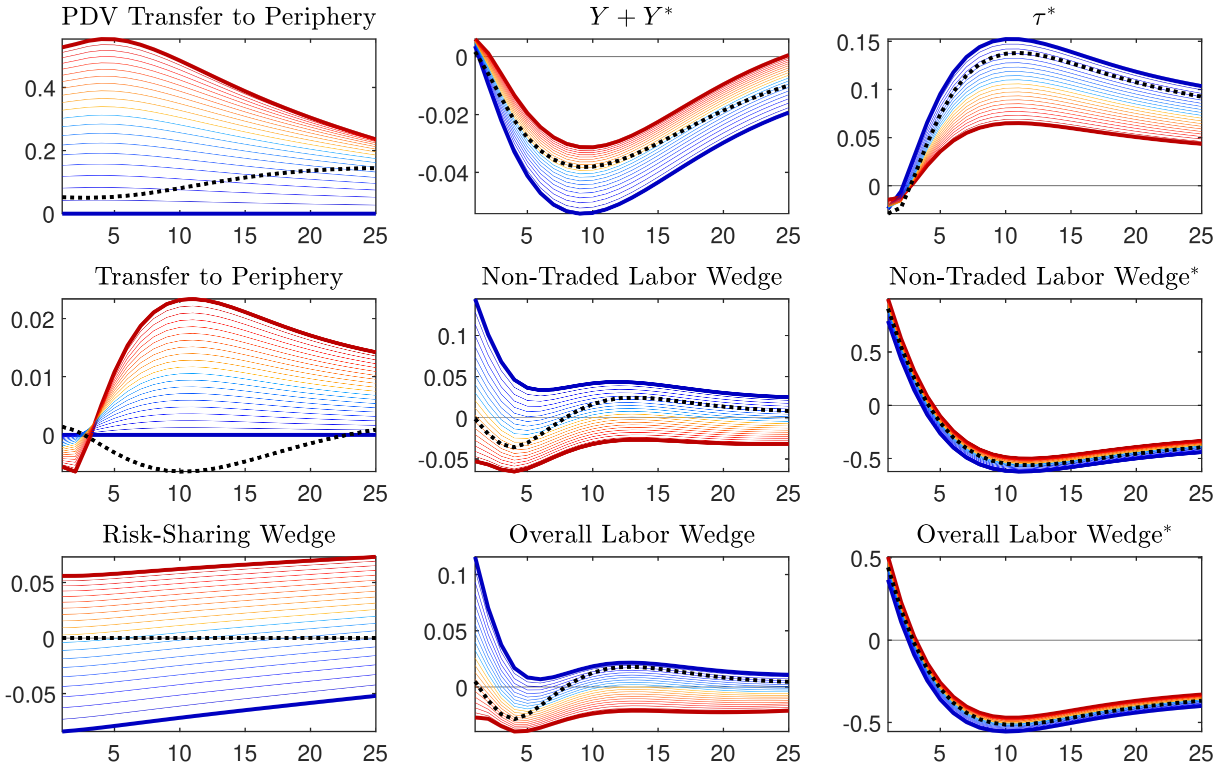


**Figure 3.5:** Responses to negative technology shock in Periphery non-traded goods sector under EMU (blue), EUBS (red), and complete markets (black dotted) scenarios

*Notes:* See Figure 3.4.

tive (Figure 3.5). Implementing a transfer towards Periphery fosters Periphery consumption; the risk-sharing wedge turns positive. This is detrimental for production efficiency, since Periphery prices would now be even more elevated under flexible prices, reinforcing the conclusion that Periphery consumption is inefficiently high. The sum of Core and Periphery output ($Y + Y^*$) is pushed upwards by Periphery consumption if a full EUBS is present. In other words, the pie is a bit larger, but it gets baked inefficiently. This is visible especially in the reactions of variables in the Periphery non-tradeable sector (Figure 3.4). Since this sector experiences a negative technology shock, sectoral output $N_t^*$ falls. With the EUBS, the transfer embodied in the cross-border insurance payments is spent to a large degree on non-tradeables in Periphery, lifting output $N_t^*$, labor input $L_{N,t}^*$, and investment $X_{N,t}^*$, relative to the case without a EUBS. That is, more of the inefficiently produced good is demanded. The labor wedges in the tradeable (not shown) and non-tradeable sectors of Periphery are hence larger on impact with a EUBS (Figure 3.5).[25]

[25] The non-tradeable labor wedge in the Core is positive after the contractionary technology shock in Periphery without a EUBS because of the reduced marginal utility of consumption. With a EUBS, consumption (also of non-tradeables) and the labor wedge fall. This effect, however, is fairly small in comparison to the movement of the labor wedges in Periphery (again, note the differences in scales). We also observe that the overall labor wedges are very similar to those in the non-tradeable sectors.

In the top panel of Figure 3.6 we illustrate the above findings by plotting the volatilities of overall labor wedges for Core (left) and Periphery (middle), as well as the volatility of the risk-sharing wedge (right) for different values of $\lambda$ (on the x-axis). We consider the cases in which all shocks are turned on, or only technology shocks (in the tradeable or non-tradeable sectors, always in both countries), only government-spending shocks, only monetary-policy shocks, only financial-friction shocks, or all but technology shocks. For each scenario, we normalize volatilities in the no-EUBS case ($\lambda = 0$) to zero by subtracting the corresponding value for $\lambda = 0$ and trace the changes relative to this starting point for rising values of $\lambda$. As visible, higher levels of centralization of the unemployment insurance lead to higher volatilities of the labor wedges (yellow lines for shocks in the non-tradeable sector, red lines for the tradeable sector), while the volatility of the risk-sharing wedge falls. An exception is visible for shocks in the non-tradeable sector: the risk-sharing wedge first becomes more stable, but its volatility increases again if $\lambda$ has surpassed an intermediate value. The corresponding plot in Figure 3.5, and its discussion above, give an intuition for this effect.

The described mechanisms render the welfare effect of a EUBS in case of technology shocks negative, as shown in the lower panel of Figure 3.6. There, we plot welfare gains in percentage of steady-state consumption (of the respective region, on the y-axis) for different values of $\lambda$ (on the x-axis).[26] We show the welfare gains for the Core (left-hand panel), Periphery (middle panel), and the sum of both, weighted by the relative regional size $n$ (right-hand panel). For each scenario, we again normalize welfare costs in the no-EUBS case ($\lambda = 0$) to zero and trace the gains relative to this starting point for rising values of $\lambda$. That is, we subtract the corresponding value for $\lambda = 0$ from all welfare numbers for the same shock. The yellow lines show that joint (and individual) welfare is lower for $\lambda = 1$ than without a EUBS in the case of non-tradeable technology shocks only. Since the transfer, flowing to the recession region, creates negative welfare results, the economies are in the region of high price rigidities and home bias discussed in propositions 3a and 3b.

Note that the welfare effect of shocks in the tradeable sector for increasing $\lambda$ is different in the two regions and, for the Core, stands in contrast to the effect on the volatility of the overall labor wedge. A EUBS leads to (small) welfare gains in the Core in this case, while it is detrimental for Periphery welfare. The reason lies in the asymmetric calibration. Core's tradeables display the lowest price rigidities and the highest variance of technology of all considered sectors. Taken together, technology fluctuations in this sector lead to large swings of Core consumption (also compared to labor input). In this case, and only in this of all considered cases, the pos-

[26] We insert the theoretical variances and covariances that result from the first-order approximated model in the second-order approximated welfare function.

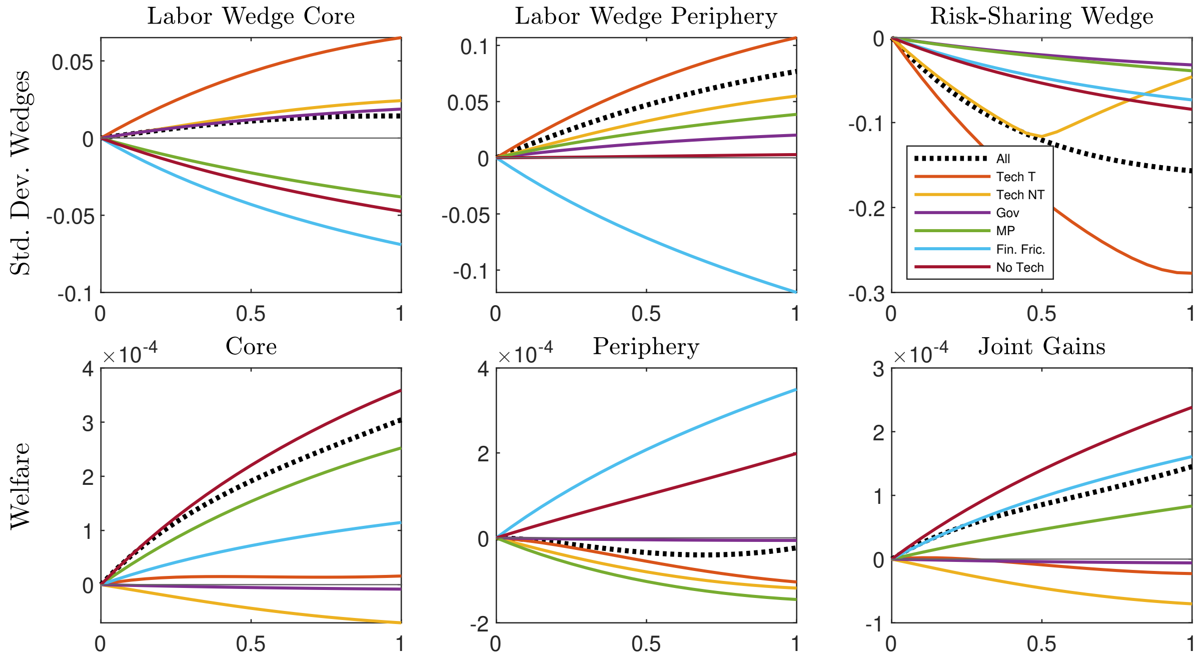


**Figure 3.6:** Top: Standard deviations of overall labor and risk-sharing wedges (times 100) for $\lambda \in [0, 1]$. Bottom: Welfare gains in percent of steady-state consumption for $\lambda \in [0, 1]$

*Notes:* 'All', 'Tech', 'Gov', 'MP', 'Fin. Fric.' refer to scenarios, in which all or only technology, government-spending, monetary-policy, financial-friction, or all but technology shocks are turned on. 'No Tech' denotes a scenario in which all but technology shocks are turned on. Numbers are normalized to zero for $\lambda = 0$.

itive insurance effect of a EUBS overturns the negative consequences of opening labor wedges: stabilizing consumption (at the expense of Periphery) raises welfare by slightly more than the reduction via the larger labor wedge. This stabilization is also visible in the strongly declining risk-sharing wedge and will contribute to the conclusion that a EUBS would be beneficial for Core. However, joint welfare in the case of shocks in the tradeable sector would be reduced by the introduction of a EUBS.

Furthermore, there is a positive aspect on the financing side of the EUBS that is not present in the analytical model of Section 3.2. Absent such a risk-sharing mechanism, labor taxes in the region experiencing a negative technology shock have to increase substantially to finance the unemployment benefits, representing a strong drag on economic activity. In fact, this effect lets the overall labor wedge in the affected region turn negative (i.e., below its steady-state value) after some periods: first, sticky prices lead to an inefficiently high labor input, while rising labor taxes subsequently reduce labor input below its efficient level. With a EUBS, parts of the required funds are obtained from the remaining region, such that labor taxes need to rise by much less. This effect, however, is not strong enough to generate positive welfare effects for Periphery in case of non-tradeable or tradeable technology shocks.

Finally, we note that the complete-markets allocation represents an intermediate case between EMU and a full EUBS. It closes the risk-sharing wedge by construction but opens the overall

Periphery labor wedge further in the initial periods, compared to the EMU case. This result is in accordance with the trade-off between closing labor wedges and the risk-sharing wedge postulated in propositions 2 and 3a. The risk-sharing wedge is closed by a positive present discounted value (PDV) of the transfer that corresponds to that of intermediate values of $\lambda$ (Figure 3.5).[27] This increases consumption and hence inefficient production in the Periphery non-tradeable sector. In the times of a negative labor wedge in Periphery (see above) the trade-off is dominated by the effects of a reduction of Periphery labor taxes, which tends to reduce the labor wedge.

**Financial-friction shocks:** We now turn to demand shocks. Figure 3.7 shows the responses to a contractionary financial-friction shock in Periphery. As discussed in Section 3.3, this shock essentially reduces consumption demand for given fundamentals. Periphery consumption and output fall, while unemployment rises. Lower demand in Periphery lets the union-wide inflation rate fall (not shown), triggering an expansionary monetary-policy response. This pushes Core output and consumption upwards. Since consumption in Periphery is too low, seen from an efficiency perspective given current productivity, its overall labor wedge turns negative. Similarly, the risk-sharing wedge is negatively affected by the dampened consumption in Periphery. The Core labor wedge, on the other hand, is positive due to higher domestic demand.

In line with Proposition 5, a EUBS transfer towards Periphery, resulting from the unemployment differential, is able to reduce all wedges, including the Core labor wedge. This includes the risk-sharing wedge, also visible in its volatility (blue line in the upper panel of Figure 3.6). Thus, the welfare costs of fluctuations triggered by the financial-friction shock are reduced by a EUBS for both regions (lower panel of Figure 3.6). However, the transfer is not sufficient to close the labor wedge of the region experiencing the shock completely. In a sense, this result is embodied in the transfer mechanism. If the transfer is effective in reducing unemployment differentials, which is mostly the case, it is automatically reduced. These differentials can therefore not be reduced to zero, as no transfer would then take place.

Comparing the EUBS outcome with that of complete markets reveals that the responses of Core consumption and output flip signs in the latter case. This reaction is needed to close the risk-sharing wedge. The allocation is implemented by an implicit transfer that is close to zero. The crucial difference to the EMU scenario is that under complete markets Periphery households cannot not use the riskless bond to save as much, following the contractionary financial-friction shock. Analogously, Core households do not dissave. The reduction in Core consumption is in

[27] The present discounted value is positive despite the negative values of the transfer, i.e., transfers away from Periphery, in the medium-run, since they are overturned by subsequently positive transfers. By implementing this time path of the transfer, the complete-markets solution achieves relatively higher consumption levels in Periphery in the longer run, such that the risk-sharing wedge remains closed throughout.

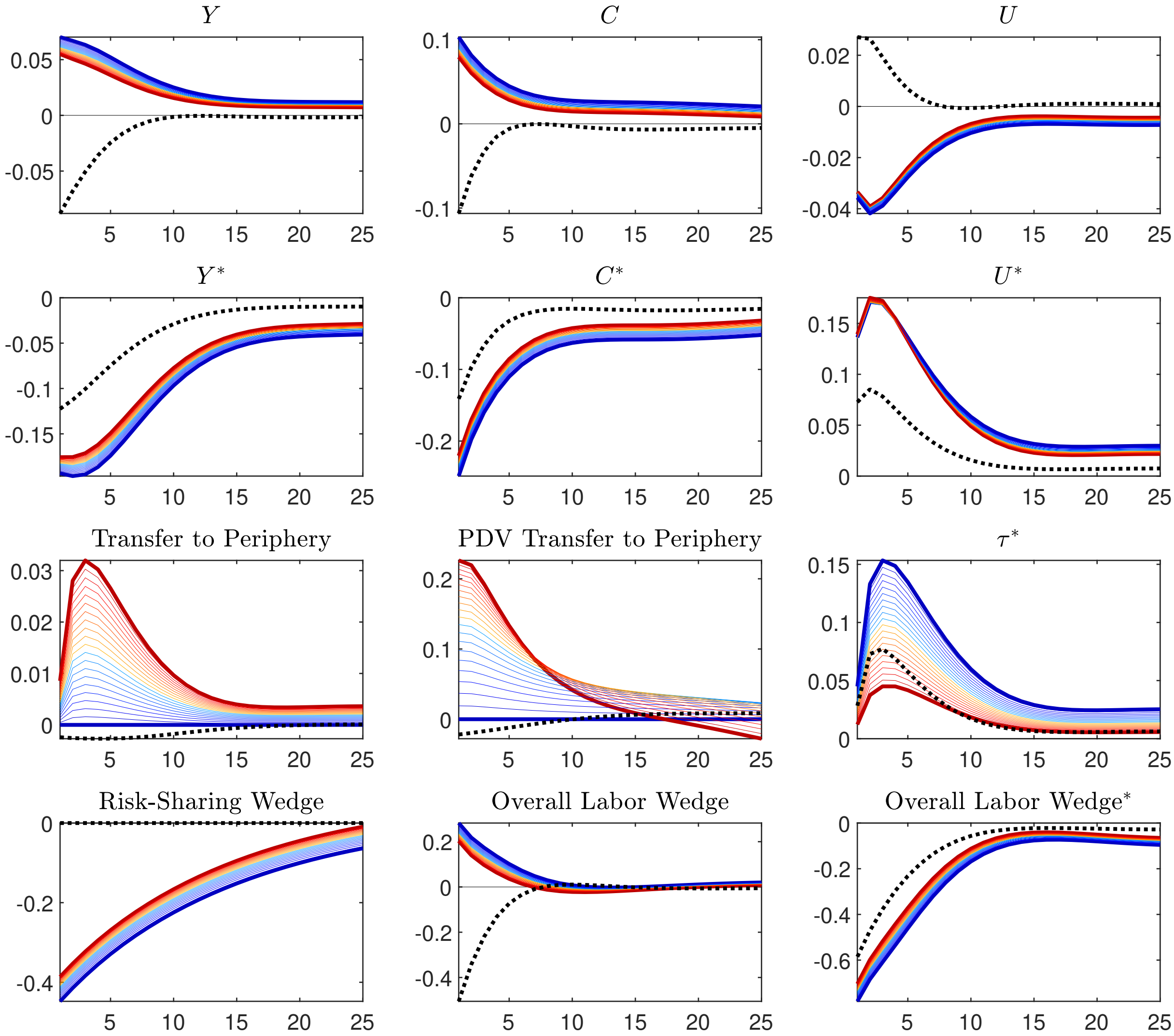


**Figure 3.7:** Responses to contractionary financial-friction shock in Periphery under EMU (blue), EUBS (red), and complete markets (black dotted) scenarios

*Notes:* See Figure 3.4.

line with efficient risk sharing but renders Core's labor wedge negative ('too little' is consumed from an efficiency point of view). In a sense, the financial-friction shock is 'exported' to Core in the case of complete markets.

**Government-spending shocks:** A positive shock to government spending in Periphery leads to a negative wealth effect, falling consumption, and rising output due to higher overall demand in this region, see Figure 3.8. Hence, net exports from Core to Periphery increase (not shown). At the same time, however, Core consumption (and investment) falls because of the subsequently reduced import demand of Periphery in the medium run. Core GDP is therefore negatively affected. GDP in Periphery falls below the steady-state level after a couple of periods, when the negative wealth effect starts to dominate higher government demand.

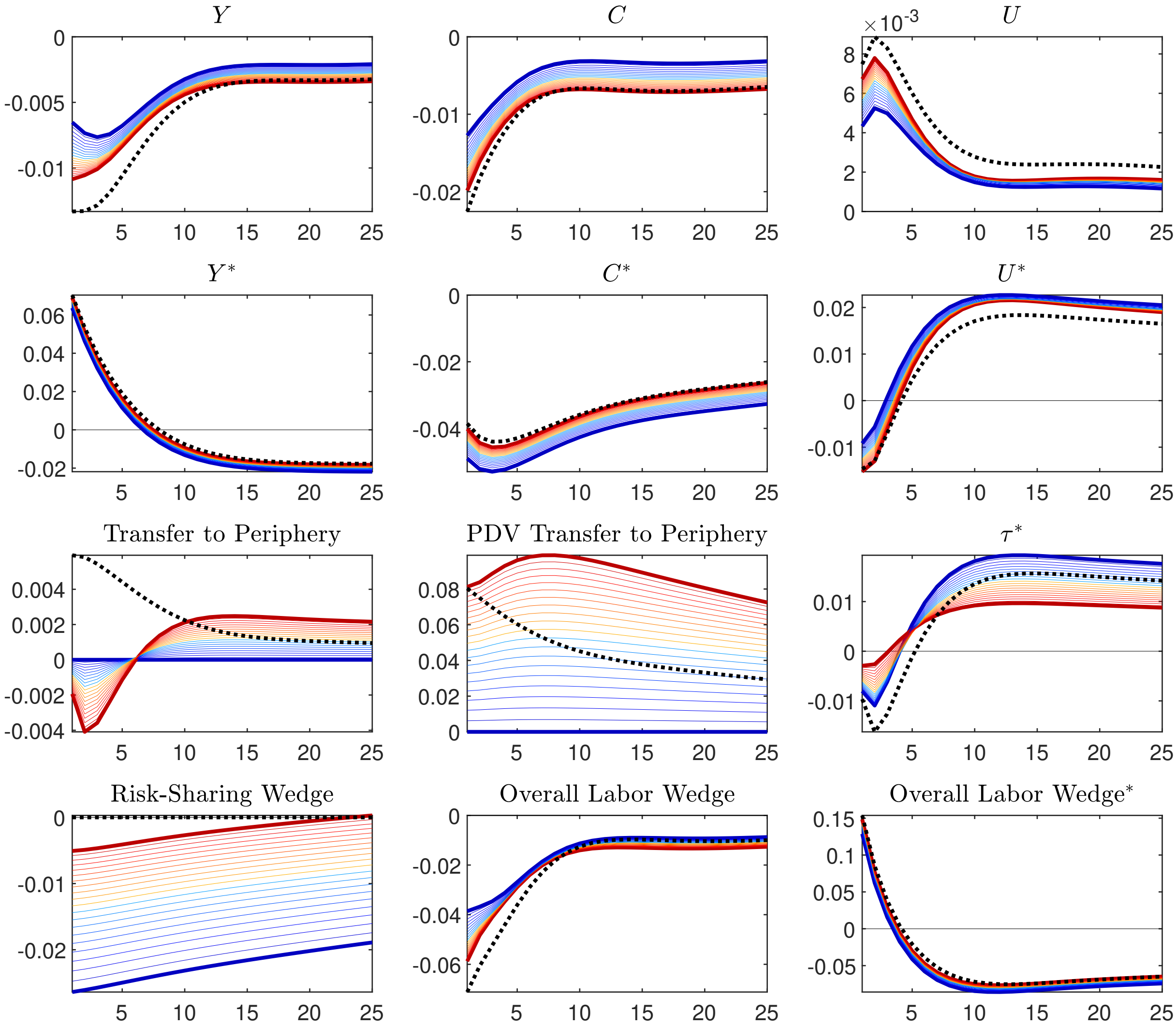


**Figure 3.8:** Responses to expansionary government-spending shock in Periphery under EMU (blue), EUBS (red), and complete markets (black dotted) scenarios

*Notes:* See Figure 3.4.

Thus, unemployment rises above the steady-state level in Periphery after around five periods and displays a stronger positive reaction than in Core, despite the initial opposite output differential. Implementing a EUBS increases these spillovers further. Because of the mentioned sign-flip in the cross-regional difference in unemployment, the transfer also changes direction over time. Specifically, it flows towards Periphery after around one and a half years. That is, the present discounted value of the transfer is actually positive for Periphery, despite the initial outflow. This dampens the negative Periphery consumption response and reduces Core consumption. It also reduces unemployment in Periphery. The reduction in export demand, combined with sticky prices, leads to a negative labor wedge in Core, which is aggravated by a EUBS transfer. The transfer-induced increased demand in Periphery falls mainly on Periphery tradeable or non-tradeable goods, pushing the positive labor wedge even further upwards. As in the case of technology shocks, it falls below its steady-state value after some periods because of the increase in the labor tax rate, needed to finance the rising unemployment benefits.

However, the effects of introducing a EUBS on the volatilities of the labor wedges and particularly on welfare are negligible (see the purple lines in Figure 3.6) because of a relatively low standard deviation of government-spending shocks and the mentioned sign-flip, resulting in a low present discounted value of the transfer. The region-specific and joint welfare effects of the transfer are therefore small, but negative. This is in line with Proposition 6: the welfare effect is negative since the transfer (in terms of its net present value) flows towards the region experiencing a positive government-spending shock and the economies display relatively high price rigidities (see above). Corresponding to the predictions of the proposition, risk sharing is therefore improved by a EUBS, visible in the reduction in the risk-sharing wedge, while efficiency is reduced. Thus, a full EUBS in the large model has detrimental welfare effects for technology *and* government-spending shocks.

Looking at the complete-markets allocation demonstrates the trade-off between risk sharing and efficiency following government-spending shocks postulated in Proposition 6 once more: the risk-sharing wedge is closed completely, while the labor wedges are initially opened up further.

**Monetary-policy shocks:** A union-wide contractionary monetary-policy shock represents an almost perfectly symmetric shock, see Figure 3.9. Here, a one-standard-deviation shock corresponds to an increase in the policy rate of 0.46 percentage points (annualized). The qualitative responses are identical across regions and mirror the predictions of Proposition 7 (except for the risk-sharing wedge, which is non-zero due to the asymmetric calibration). In particular, the contractionary shock decreases output and consumption in both regions. It also raises unemployment in the whole currency union. Both labor wedges are negative following the contractionary shock, as nominal rigidities prevent prices from falling further and hence 'too few' hours are worked, relative to the utility gain from consumption.

Due to different economic structures in Core and Periphery, some quantitatively asymmetric effects are observable. Specifically, steady-state profits of labor market firms are higher in Core. Hence, less jobs are destroyed in a downturn and unemployment rises by less, such that the transfer embodied in the EUBS initially flows towards Periphery. Since unemployment in both regions increases, however, the transfer under a EUBS is relatively small, compared to the effect of the shock on, e.g., output. As a result, the effects of the shock are almost unchanged by the introduction of a EUBS. Generally, the union-wide reduction in economic activity is detrimental for Core, which is a net exporter in steady state, such that the consumption drop is somewhat higher than in Periphery. The lower prices in Core then generate a positive risk-

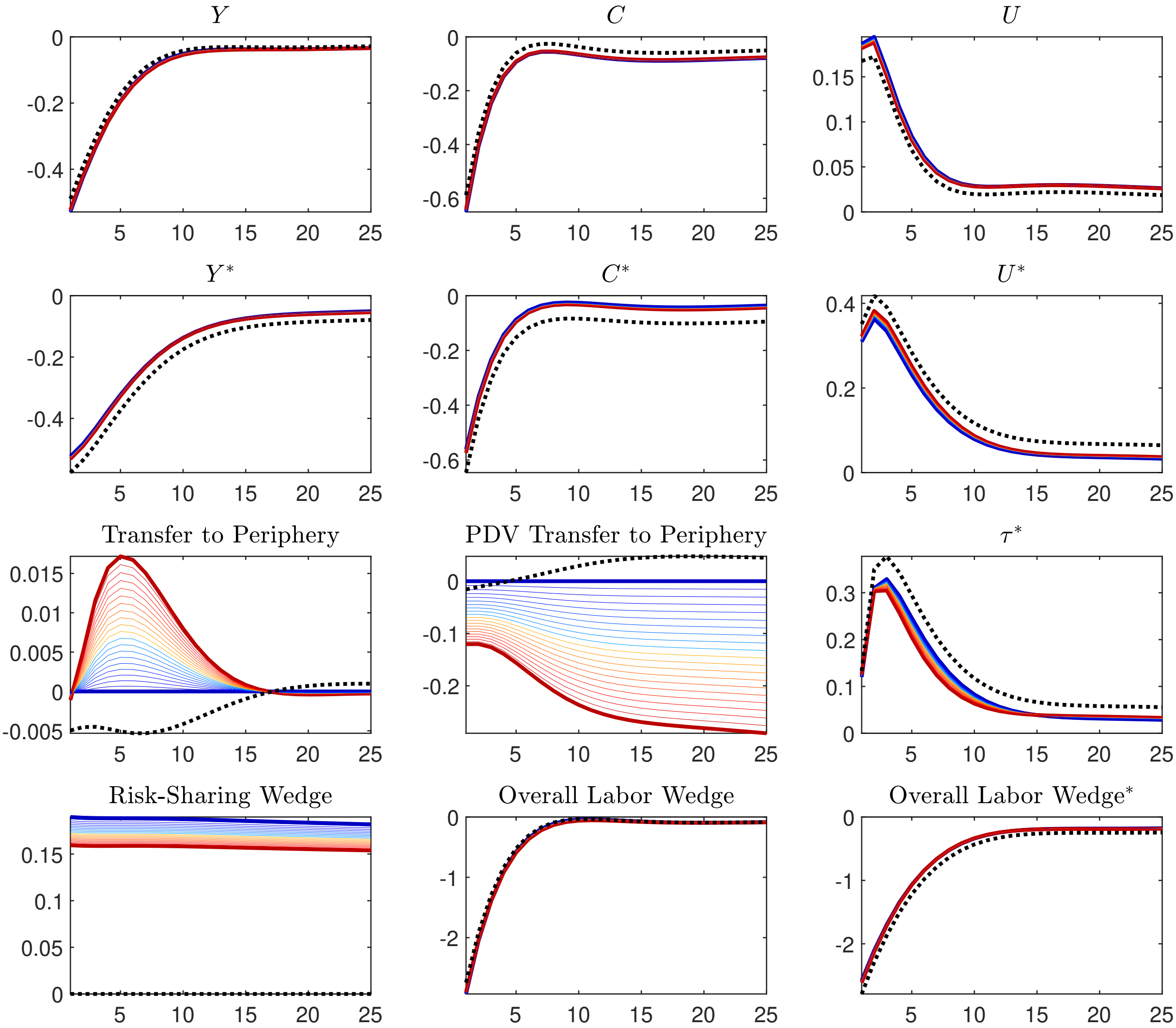


**Figure 3.9:** Responses to contractionary monetary-policy shock under EMU (blue), EUBS (red), and complete markets (black dotted) scenarios

*Notes:* See Figure 3.4.

sharing wedge. Core borrows from abroad to smooth the impact on consumption. The resulting interest payments reduce demand in the future, which raises Core unemployment slightly above that of Periphery. This differential triggers a series of (small) transfers towards Core. Overall, the present discounted value of the transfer is therefore negative, i.e., Core benefits from a EUBS. This mechanism represents a form of insurance for Core following monetary-policy shocks.

The small EUBS effect on the responses compared to their size makes it difficult to spot the differences. However, since the monetary-policy shock has a relatively high standard deviation, these differences nevertheless impact on welfare. Specifically, the described insurance value of the EUBS for Core brings about welfare gains of a EUBS for Core (and joint welfare) in the case of monetary-policy shocks (see the green lines in the lower panel of Figure 3.6). For Periphery, however, the welfare effect is negative.

The complete-market solution is again in line with Proposition 7. Given that the risk-sharing wedge opens up due to the asymmetric calibration, an implicit transfer that reduces it also reduces one labor wedge, while increasing the other (also visible, for the incomplete-markets case, in the upper panel of Figure 3.6).

## 3.6 Policy implications

The introduction of an international unemployment insurance scheme increases the co-movement of consumption, output, and unemployment across European regions, enhancing consumption risk sharing. However, at the same time it can lead to a misallocation of demand and factor inputs, particularly in response to technology shocks. Specifically, sticky prices give rise to a trade-off between consumption insurance and production efficiency, which becomes worse in the presence of consumption home bias, see Section 3.2. As shown analytically in that section and for the large model in Section 3.5, a transfer that flows towards the country hit by a negative technology shock, which is what a EUBS would implement, deteriorates production efficiency. In a sense, it leads to a 'zombification' of the now inefficient sector, as spending falls overproportionally on domestic goods. Structural reforms of this sector are therefore in order.

Yet, there are also beneficial aspects of a EUBS. First, even in the case of technology shocks, a transfer to the recession region reduces the increase in tax rates that is required to finance the unemployment benefits, which counteracts the efficiency loss. Second, following financial-friction shocks a EUBS is beneficial as it directly offsets the negative demand impulse. Although this is not the case for government-spending shocks, which trigger a transfer in the 'wrong' direction from a efficiency point of view, the impact of a EUBS on the welfare effects of government-spending shocks is negligible. Third, for the calibration of the (asymmetric) large model, a EUBS has positive overall welfare effects in case of monetary-policy shocks, since it acts as an implicit insurance mechanism for the larger Core.

Summing up the positive and negative effects for the European calibration leads to the conclusion that the union of both regions would benefit from the implementation of a EUBS when all considered shocks are active (see black dotted line in Figure 3.6). Periphery, however, would experience a (very small) decline in welfare. Alternatively, if feasible, a EUBS that is not triggered following technology and government-spending shocks would perform much better in terms of welfare gains, see also Proposition 8. If, in the large model, a full EUBS is active following all shocks less technology shocks, joint welfare gains would already be higher (see

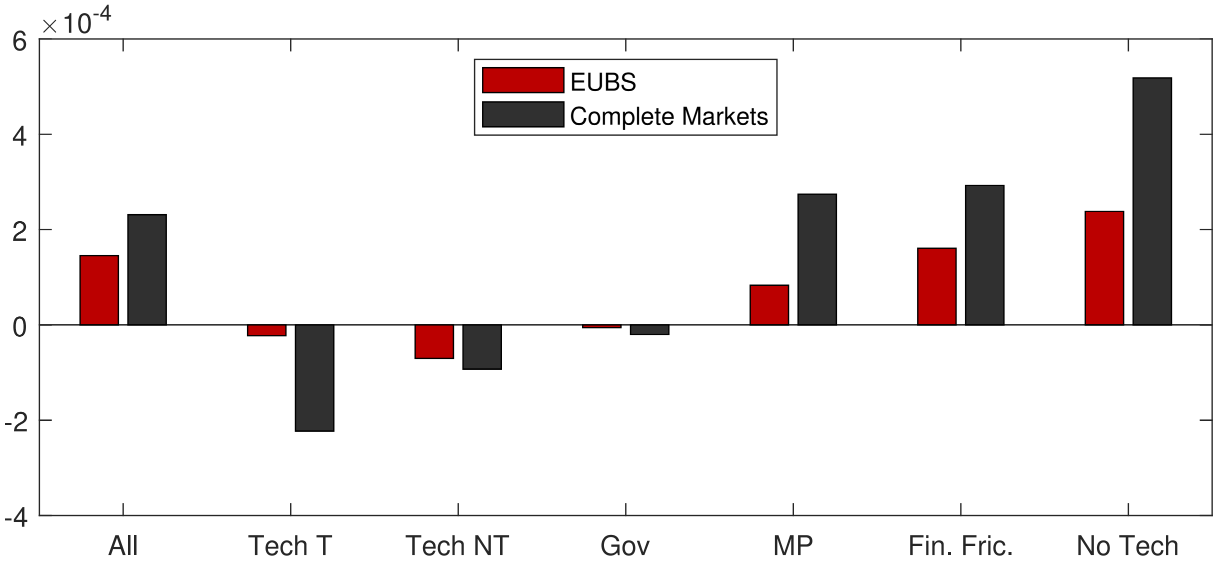


**Figure 3.10:** Welfare gains (in percent of steady-state consumption) for different shocks, relative to $\lambda = 0$

*Notes:* 'EUBS' refers to $\lambda = 1$. For different scenarios, see Figure 3.6.

dark-red line in Figure 3.6). That is, a EUBS is most useful after 'pure' demand shocks, where 'pure' excludes government-spending shocks as those shocks change the availability of resources for a given input of production factors. Although discussed in policy circles, the option of triggering a EUBS only after certain shocks might be technically difficult to implement.

The shock dependence is also visible in the comparison between a EUBS transfer scheme and the complete-markets allocation, depicted in Figure 3.10. Here, we plot the welfare effects of a full EUBS ($\lambda = 1$) and of the complete-markets allocation for the same scenarios as in Figure 3.6, relative to the EMU ($\lambda = 0$) baseline. If all shocks are active, the complete-markets solution gives the highest welfare. This is due to two facts. First, the implicit transfer of the complete-markets allocation is not tied to one particular variable, as it is the case for the EUBS transfers. It is therefore able to achieve a complete stabilization of the risk-sharing wedge following all shocks. This is beneficial for welfare because, second, there is no general trade-off between efficiency and risk sharing after financial-friction and monetary-policy shocks. Thus, the complete-markets allocation raises welfare more than the EUBS, which is not able to close the risk-sharing wedge completely after these shocks.

Yet, as discussed previously, closing the risk-sharing wedge is harmful in terms of efficiency after technology and government-spending shocks (see propositions 2 and 6). Here, the objective of the complete-markets allocation to close this wedge renders its welfare effect negative. The EUBS arrangement does better, in particular following technology shocks. We again conclude that a system that could react differently to the different shocks would raise welfare unambiguously.

## 3.7 Conclusion

A well-known result from the Theory of Optimum Currency Areas states that one option to compensate for the missing adjustment via flexible exchange rates are state-contingent transfers. More recently, politicians in different countries of the euro area have taken up this argument and have pled for the introduction of a European unemployment benefit scheme. In this chapter, we evaluate the macroeconomic effects of such a scheme in the specific context of the euro area and assess the impact on allocative efficiency.

We find that a EUBS has indeed the potential to stabilize consumption and reduce unemployment in the negatively-affected region after a shock. Yet, whether a EUBS is welfare enhancing (or decreasing) depends crucially on the reason for existing unemployment differentials. A EUBS can raise welfare in case of certain demand shocks, as the transfer embodied in the unemployment benefit payments counteracts demand shifts across countries. In the case of technology shocks, however, a EUBS increases factor misallocation across countries and sectors. Given that a large part of the transfer that is embodied in the international benefit payments is spent on inefficiently produced goods, a 'zombification' of the adversely affected sectors might result. This calls for accompanying structural reforms in addition to the transfer.

Without such reforms, a EUBS that is only active after certain shocks would maximize joint welfare. Specifically, technology and government-spending shocks drag down the welfare effects of a EUBS. Identifying such shocks in real time, however, poses a major obstacle to such a 'selective' EUBS. Nevertheless, we find (small) positive effects of EUBS on joint welfare even without this conditionality.

# Appendix

## 3.A Analytical solution of simple model

This appendix presents the simple model of Section 3.2 and its solution. We first state the linearized equations for the sum of Foreign and Home variables, denoted by the superscript $w$: $x_t^w = x_t + x_t^*$, where lower-case letters denote percentage deviations from steady state. The variable $a_t^w$ is defined as $a_t^w = a_t + b_t^*$, while $b_t^w = a_t^* + b_t$. The sum of country-specific prices is $p_t^w = p_{a,t} + p_{b,t}^* = p_t + p_t^*$, where $p_{a,t}$ is the price of good $A$. We directly set $z_t = g_t = \hat{\Delta}_t = 0$, that is, we focus on Foreign shocks. We also make use of the fact that variables are expected to remain in a steady state from the period following the shock onwards, as we assume temporary shocks only and all prices can be adjusted until then. For simplicity, government spending is assumed to be zero in steady state.

The sums of Foreign and Home variables, resulting from the first-order conditions and constraints, are as follows.

$$y_t^w = h_t^w + z_t^* \qquad \text{Production functions}$$

$$w_t^w = p_t^w + h_t^w + c_t^w \qquad \text{Labor supply}$$

$$p_t^w = \xi w_t^w - \xi z_t^* \qquad \text{Price setting}$$

$$0 = c_t^w + 2r_t + \hat{\Delta}_t^* \qquad \text{Euler equations}$$

$$y_t^w = c_t^w + g_t^* \qquad \text{Global demand}$$

$$a_t^w = c_t^w + g_t^*/\omega \qquad \text{Demand domestic goods}$$

$$b_t^w = c_t^w \qquad \text{Demand imported goods}$$

Next, we state the same variables in cross-country differences, denoted by the superscript $d$, i.e., $x_t^d = x_t - x_t^*$. The variable $a_t^d$ is defined as $a_t - b_t^*$, while $b_t^d = a_t^* - b_t$ and $p_{a,t}^d = p_{a,t} - p_{b,t}^*$.

$$y_t^d = h_t^d - z_t^* \qquad \text{Production functions}$$

$$w_t^d = p_t^d + h_t^d + c_t^d \qquad \text{Labor supply}$$

$$p_{a,t}^d = \xi w_t^d + \xi z_t^* \qquad \text{Price setting}$$

$$p_t^d = (2\omega - 1)p_{a,t}^d \qquad \text{Price index}$$

$$y_t^w = (2\omega - 1)c_t^w - g_t^* - \sigma p_{a,t}^d + \sigma(2\omega - 1)p_t^d \qquad \text{Global demand}$$

$$a_t^d = c_t^d - g_t^*/\omega - \sigma p_{a,t}^d + \sigma p_t^d \qquad \text{Demand domestic goods}$$

$$b_t^d = -c_t^d - \sigma p_{a,t}^d - \sigma p_t^d \qquad \text{Demand imported goods}$$

All above equations hold in all periods, i.e., the period of the shock $t$ and the subsequent expected steady state in $t+1$. The following two equations are valid for the period of the shock only, assuming that the economies start at the old steady state with zero bond holdings and allowing for the implementation of a cross-country transfer in period $t$ only.

$$c_t^d - g_t^* = p_{a,t}^d + y_t^d - p_t^d - 2b_t - 2t_t \qquad \text{Budget constraints in period } t$$
$$D_t = c_t^d + p_t^d - \hat{\Delta}_t^* \qquad \text{Euler equations in period } t$$

The variable $D_t$ represents the cross-country difference in expected nominal consumption. We solve for this difference in period $t+1$. The period $t+1$ represents the new steady state, as expected in period $t$. The parameter $r_s > 1$ is the real interest rate in the old and new steady state.

$$c_{t+1}^d = p_{a,t+1}^d + y_{t+1}^d + 2b_{t+1}r_s - p_{t+1}^d \qquad \text{Budget constraints periods} > t$$
$$D_t = c_{t+1}^d + p_{t+1}^d \qquad \text{Differences nominal consumption periods} > t$$

We solve the system of linear equations for the cross-country sums and differences. Country-specific variables can then be calculated from this solution. For propositions 1-4, we set $g_t^* = \hat{\Delta}_t^* = 0$. The linearized wedges are derived as follows.

$$rs_t = -c_t^d - p_t^d \qquad \text{Risk-sharing wedge}$$
$$lw_t^w = 2(y_t^w - z_t^*) \qquad \text{Sum overall labor wedges}$$
$$lw_t^d = \frac{1+\sigma}{\sigma} y_t^d - \frac{1-\sigma}{\sigma}(2\omega - 1)c_t^d + 2z_t^* \qquad \text{Difference overall labor wedges}$$
$$lw_t = \frac{lw_t^w + lw_t^d}{2} \qquad \text{Overall labor wedge Home}$$
$$lw_t^* = \frac{lw_t^w - lw_t^d}{2} \qquad \text{Overall labor wedge Foreign}$$

The overall labor wedge at Home results as

$$lw_t = \frac{2\xi(\Xi'-1)[\Xi' r_s + (\Xi+1)(r_s+1)]}{\Gamma} z_t^* + \frac{(\Xi'-1)[2\Xi'\xi(\omega-1)+\xi-2\omega+1]}{\Gamma(\omega-1)} r_s t_t - 2r_t,$$

with

$$\Xi = 2\omega(\sigma-1) \geq 0$$

$$\Xi' = \Xi(\omega - 1) \leq 0$$
$$\Gamma = (1 + r_s)(1 - \Xi')[\xi(2\Xi + 1) + 1] + \Xi\omega(1 - \xi) > 0,$$

while the overall Foreign labor wedge reads as

$$lw_t^* = 2\frac{(\Xi'\xi - 1)[\Xi + 1 - r_s(\Xi' - 1)] + r_s(\Xi' - 1)\Xi\xi}{\Gamma} z_t^* - \frac{(\Xi' - 1)[2\Xi'\xi(\omega - 1) + \xi - 2\omega + 1]}{\Gamma(\omega - 1)} r_s t_t - 2r_t.$$

The risk-sharing wedge is

$$rs_t = -\frac{(\Xi' - 1)[\xi(2\Xi'\xi - 1) - 1]}{(\omega - 1)\Gamma} r_s t_t - \frac{2\Xi\xi(\Xi' - 1)}{\Gamma} r_s z_t^*.$$

For $\sigma = 1$, the wedges reduce to the expressions in Section 3.2. Having solved for the wedges, the proofs of the lemma and propositions are straightforward.

**Proof of Lemma 1.** The output difference for the general case is

$$\begin{aligned} y_t - y_t^* = & \frac{(\Xi + 1)[\xi(2\Xi' - 1) + 2\omega - 1]}{\Gamma} \hat{\Delta}_t^* - \frac{r_s(1 - \Xi')(\xi\Xi + 1) + \Xi + 1}{\Gamma} g_t^* \\ & - 2\xi\frac{\Xi(r_s + 2)(1 - \omega - \Xi') + (r_s + 1)(\Xi + 1)}{\Gamma} z_t^*. \end{aligned}$$

The derivatives with respect to $g_t^*$ and $z_t^*$ are both negative, while the sign of the derivative with respect to $\hat{\Delta}_t^*$ depends on parameter values. ■

**Proof of Proposition 1.** The wedges for the case of $\xi = 1$ and $g_t^* = \hat{\Delta}_t^* = 0$ are

$$\begin{aligned} lw_t &= -\left[1 + \frac{\Xi'}{\Xi + 1}\frac{r_s}{r_s + 1}\right] z_t^* - \frac{\Xi' - 1}{\Xi + 1}\frac{r_s}{r_s + 1} t_t - 2r_t \\ lw_t^* &= -\left[1 - \frac{\Xi'}{\Xi + 1}\frac{r_s}{r_s + 1}\right] z_t^* + \frac{\Xi' - 1}{\Xi + 1}\frac{r_s}{r_s + 1} t_t - 2r_t \\ rs_t &= \frac{\Xi}{\Xi + 1}\frac{r_s}{r_s + 1} z_t^* + \frac{\Xi' - 1}{\Xi' + \omega - 1}\frac{r_s}{r_s + 1} t_t. \end{aligned}$$

Setting $t_t$ and $r_t$ such that $lw_t{=}lw_t^*{=}0$ yields

$$\check{r}_t{=}-\frac{z_t^*}{2}$$
$$\check{t}_t{=}\frac{\Xi'}{1{-}\Xi'}z_t^*$$
$$rs_t{=}0.$$

■

**Proof of Proposition 2.** Setting $t_t$ and $r_t$ such that $lw_t{=}lw_t^*{=}0$ in the general case with $g_t^*{=}\hat{\Delta}_t^*{=}0$ yields

$$\check{r}_t{=}-\frac{z_t^*}{2}$$

$$\check{t}_t{=}\frac{(\omega{-}1)[(\xi{-}1)(\Xi{+}1){-}r_s(\Xi'{-}1)(2\Xi'\xi{+}\xi{-}1)]}{r_s(\Xi'{-}1)(2\Xi'\xi(\omega{-}1){+}\xi{-}2\omega{+}1)}z_t^*$$
$$rs_t{=}\frac{\xi{-}1}{2\Xi'(\omega{-}1)\xi{+}\xi{-}2\omega{+}1}z_t^*.$$

■

**Proof of Proposition 3a.** See the proof for Proposition 2 for the value of the transfer $\check{t}_t$ that closes both labor wedges with $g_t^*{=}\hat{\Delta}_t^*{=}0$. It is positive (flows to Foreign) whenever

$$\frac{1}{2[\Xi'(\omega{-}1)\xi{-}\omega]{+}1{+}\xi}z_t^*{<}0.$$

Hence, for negative Foreign technology shocks ($z_t^*{<}0$) it is positive if

$$\xi{>}\frac{2\omega{-}1}{1{-}2\Xi'(1{-}\omega)}.$$

This is fulfilled for $\xi{=}1$, i.e., flexible prices. For $\xi{=}0$, on the other hand, it is not: the transfer reverses its direction. Furthermore, if $\omega{\to}0.5$, the transfer flows to Foreign, while for $\omega{\to}1$, it flows to Home, as long as $0{<}\xi{<}1$. ■

**Proof of Proposition 3b.** To derive the optimal transfer, we employ a second-order approximation of the equally-weighted sum of country-specific welfare functions. This approximation is then maximized over $t_t$ subject to the solution of the system of equations at the beginning of this section, i.e., the expressions for $c_t$, $c_t^*$, $c_{t+1}$, $c_{t+1}^*$, $h_t$, $h_t^*$, $h_{t+1}$, and $h_{t+1}^*$ in dependence of $t_t$ and $z_t^*$, where $g_t^*{=}\hat{\Delta}_t^*{=}0$. Expected transfers are assumed to be zero from period $t{+}1$ onwards, as the economies are expected to reach the new steady state then and we rule out steady-state transfers. For fully flexible prices ($\xi{=}1$), the optimal transfer $\hat{t}_t$ results as

$$\hat{t}_t{=}\frac{\mathcal{M}[1{-}(2\omega{+}\Xi)^2]}{\mathcal{M}(1{+}2\omega{+}\Xi)^2{+}(1{+}\Xi)^2}z_t^*.$$

This expression is positive if $z_t^*{<}0$, i.e., the transfer flows towards Foreign, the country that has experienced a negative technology shock. In contrast, the optimal transfer in case of fully rigid prices ($\xi{=}0$) is

$$\check{t}_t{=}\frac{(1{-}\omega)(2\omega{-}1)(1{-}\Xi')[\Xi{+}1{+}r_s(1{-}\Xi')]}{\mathcal{M}[r_s(1{-}\Xi')^2{+}(\omega{-}1)^2(\Xi{+}2\omega{+}1)^2]{+}r_s(1{-}2\omega)^2(1{-}\Xi')^2{+}(\omega{-}1)^2(\Xi{+}1)^2}z_t^*.$$

This expression is negative for $z_t^*{<}0$, i.e., the transfer flows away from Foreign, the country that has experienced a negative technology shock. ■

**Proof of Proposition 4.** The Foreign@Foreign wedge for $g_t^*{=}\hat{\Delta}_t^*{=}0$ is

$$FaF{=}\frac{(1{-}\xi)(1{-}\Xi')}{\Gamma}\frac{\omega}{1{-}\omega}r_st_t{+}2\frac{(\Xi{+}1)(\Xi'\xi{-}1){+}r_s(\Xi'{-}1)(\Xi\xi{+}1)}{\Gamma}z_t^*{-}2r_t.$$

The denominators of the derivatives of this expression with respect to $z_t^*$ and $t_t$, i.e., $\Gamma$ and $(1{-}\omega)\Gamma$, are positive. Hence, the derivative of the Foreign@Foreign wedge with respect to $z_t^*$ is negative, while the derivative with respect to the transfer is positive for $\xi{<}1$ (and zero for $\xi{=}1$). ■

**Proof of Proposition 5.** For $g_t^*{=}z_t^*{=}0$, the wedges result as

$$\begin{aligned}lw_t{=}&{-}\frac{2(\Xi{+}1)[\Xi'\xi(\omega{-}2){+}\xi{-}\omega{+}1]{-}r_s(\Xi'{-}1)[\xi(2\Xi{+}1){+}1]}{\Gamma}\hat{\Delta}_t^*\\&{+}\frac{(\Xi'{-}1)[2\Xi'\xi(\omega{-}1){+}\xi{-}2\omega{+}1]}{(\omega{-}1)\Gamma}r_st_t{-}2r_t\\lw_t^*{=}&\frac{2\omega(\Xi{+}1)(\xi\Xi'{-}1){+}r_s(\Xi'{-}1)[\xi(2\Xi{+}1){+}1]}{\Gamma}\hat{\Delta}_t^*\end{aligned}$$

$$-\frac{(\Xi'-1)[2\Xi'\xi(\omega-1)+\xi-2\omega+1]}{(\omega-1)\Gamma}r_st_t-2r_t$$
$$rs_t=\frac{(\Xi+1)[\xi(2\Xi'-1)-1]}{\Gamma}\hat{\Delta}^*_t+\frac{(\Xi'-1)[\xi(2\Xi'-1)-1]}{(1-\omega)\Gamma}r_st_t.$$

Setting

$$\check{r}_t=-\frac{\hat{\Delta}^*_t}{2}$$
$$\check{t}_t=\frac{(1-\omega)(\Xi+1)}{r_s(1-\Xi')}\hat{\Delta}^*_t$$

closes all wedges. The derivative of $\check{t}_t$ with respect to $\hat{\Delta}^*_t$ is positive. ■

**Proof of Proposition 6.** For $\hat{\Delta}^*_t=z^*_t=0$, the wedges result as

$$lw_t=-\frac{(\Xi+1)\{2\xi[\Xi'(2\sigma-1)-1]-(3\xi+1)(\sigma-1)\}+r_s(\Xi'-1)\{2\xi[\Xi(2\sigma-1)+\Xi'\sigma+1]+(3\xi+1)(\sigma-1)\}}{2\sigma\Gamma}g^*_t$$
$$+\frac{(\Xi'-1)[2\Xi'\xi(\omega-1)-2\omega+\xi+1]}{\Gamma(\omega-1)}r_st_t-2r_t$$
$$lw^*_t=\frac{(\Xi+1)[-2\Xi'\xi(2\sigma+1)+(3+\xi)\sigma+1+\xi]-r_s(\Xi'-1)\{2\xi[\Xi(2\sigma+1)-\Xi'\sigma]+(3+\xi)\sigma+1+\xi\}}{2\sigma\Gamma}g^*_t$$
$$-\frac{(\Xi'-1)[2\Xi'\xi(\omega-1)-2\omega+\xi+1]}{\Gamma(\omega-1)}r_st_t-2r_t$$
$$rs_t=-\frac{\Xi\xi(1-\Xi')}{\Gamma}r_sg^*_t+\frac{(\Xi'-1)(2\Xi'\xi-\xi-1)}{(1-\omega)\Gamma}r_st_t.$$

Setting again $t_t$ and $r_t$ such that $lw_t=lw^*_t=0$ yields

$$\check{r}_t=\frac{g^*_t}{2}$$
$$\check{t}_t=\frac{r_s(\Xi'-1)[2\xi(\Xi'\sigma-\Xi)+\xi(\sigma-1)-\sigma-1]-(\Xi+1)[\xi(\sigma-1)+2\xi\Xi'-\sigma-1]}{2r_s\sigma(\Xi'-1)[2\xi\Xi'(\omega-1)+\xi-2\omega+1]}(\omega-1)g^*_t$$
$$rs_t=\frac{\sigma+1-2\xi\Xi'-\xi(\sigma-1)}{2\sigma[2\Xi'\xi(\omega-1)+\xi-2\omega+1]}g^*_t,$$

where $\sigma+1-2\xi\Xi'-\xi(\sigma-1)\neq0$. The transfer is positive for $g^*_t>0$ if

$$\xi>\frac{2\omega-1}{1-2\Xi'(1-\omega-1)}.$$

■

**Proof of Proposition 7.** For $\hat{\Delta}_t^*=z_t^*=g_t^*=0$, the wedges result as

$$
\begin{aligned}
lw_t &= \frac{(\Xi'-1)[2\Xi'\xi(\omega-1)+\xi-2\omega+1]}{(\omega-1)\Gamma} r_s t_t - 2r_t \\
lw_t^* &= -\frac{(\Xi'-1)[2\Xi'\xi(\omega-1)+\xi-2\omega+1]}{(\omega-1)\Gamma} r_s t_t - 2r_t \\
rs_t &= -\frac{(\Xi'-1)[\xi(2\Xi'-1)-1]}{(\omega-1)\Gamma} r_s t_t.
\end{aligned}
$$

■

**Proof of Proposition 8.** Propositions 3a, 5, 6, 7 show that for low (high) price rigidities, a transfer that reduces both labor wedges, in combination with a suitable monetary-policy response, flows to Foreign if $z^*<(>)0$, $g_t^*>(<)0$ or $\hat{\Delta}_t^*>0$. Low (high) price rigidities are present if $\xi>(2\omega-1)/[1-2\Xi'(1-\omega)]$. The direction of such a transfer in response to $z_t^*<0$, $g_t^*>0$, and $\hat{\Delta}_t^*>0$ for low (high) price rigidities can hence be summarized by $\{+,+,+\}$ $(\{-,-,+\})$. The responses of relative variables are given in Lemma 1 and below (for $t_t=0$, i.e., pre-transfer).

$$
\begin{aligned}
\bar{y}_t-\bar{y}_t^* =& -\frac{(\xi-1)[r_s(\Xi'-1)-\Xi-1][r_s(\Xi'-1)+2\Xi'-1]}{(\Xi+1)[\xi(2\Xi'-1)-1]+r_s(\Xi'-1)[\xi(2\Xi+1)+1]} \frac{1}{(r_s+1)(\Xi'-1)} z_t^* \\
&+\left[\frac{1}{\xi(2\Xi'-1)-1}\left(1-\frac{\Xi\xi r_s(\Xi'-1)[\xi(2\Xi'-1)+2\omega-1]}{(\Xi+1)[\xi(2\Xi'-1)-1]+r_s(\Xi'-1)[\xi(2\Xi+1)+1]}\right)-\frac{1}{2(\Xi'-1)}\left(1-\frac{r_s\Xi'}{r_s+1}\right)\right] g_t^* \\
&+\frac{(\xi-1)\omega(\Xi+1)[r_s(\Xi'-1)+2\Xi'-1]}{(\Xi+1)(\Xi'-1)[\xi(2\Xi'-1)-1]+r_s(1-\Xi')^2[\xi(2\Xi+1)+1]} \frac{1}{1+r_s} \hat{\Delta}_t^* \\
c_t-c_t^* =& -2\xi\frac{r_s\{\omega[2-\Xi(\Xi-2(\sigma-\omega)-1)]-1\}+(2\omega-1)(\Xi+1)}{\Gamma} z_t^* \\
&-\xi\frac{r_s(\Xi+2\omega-1)(\Xi'-1)-(2\omega-1)(\Xi+1)}{\Gamma} g_t^* - \frac{(\Xi+1)\{\xi[2\Xi'+2\omega(2\omega-1)-1]-1\}}{\Gamma}\hat{\Delta}_t^*
\end{aligned}
$$

$$
\begin{aligned}
h_t-h_t^* =& \frac{(\Xi+1)[\xi(2\Xi'-1)+1]+(\xi-1)r_s(\Xi'-1)}{\Gamma} z_t^* - \frac{r_s(1-\Xi')(\xi\Xi+1)+\Xi+1}{\Gamma} g_t^* \\
&+\frac{(\Xi+1)[\xi(2\Xi'-1)+2\omega-1]}{\Gamma}\hat{\Delta}_t^*.
\end{aligned}
$$

The derivative of the hours-worked differential $n_t-n_t^*$ w.r.t. $\hat{\Delta}_t^*$ is positive (negative) if $\xi<(>)(2\omega-1)/(1-2\Xi')$. The derivative of the hours-worked differential $n_t-n_t^*$ w.r.t. $z_t^*$ is positive (negative) if

$$
\xi<(>)\frac{1+r_s(1-\Xi')+\Xi}{1+r_s(1-\Xi')+\Xi-2\Xi'(\Xi+1)}, \tag{3.23}
$$

where the derivative of the right-hand side of this inequality w.r.t. $\sigma$ is negative. The sign of the derivative of the output-gap differential w.r.t. $g_t^*$ can be best derived by taking the derivative of the output differential reaction to $g_t^*$ w.r.t. $\xi$:

$$\frac{\partial \frac{\partial y_t - y_t^*}{\partial g_t^*}}{\partial \xi} = \frac{r_s(1-\Xi')\Xi}{\Gamma} - \frac{[r_s(1-\Xi')(\xi\Xi+1)+\Xi+1][(1+r_s)(1-\Xi')(2\Xi+1)-\Xi\omega]}{\Gamma^2} < 0.$$

That is, the direction of the transfer induced by the reaction of $y_t - y_t^*$ to $z_t^* < 0$, $g_t^* > 0$, and $\hat{\Delta}_t^* > 0$ for low (high) price rigidities can be summarized by $\{+,-,-\}$ ($\{+,-,+\}$), the reaction of $\bar{y}_t - \bar{y}_t^*$ by $\{-,-,+\}$, and the reaction of $c_t - c_t^*$ by $\{+,+,+\}$. The reaction of $h_t - h_t^*$ can be summarized by $\{+,-,-\}$ if $\xi > [1+r_s(1-\Xi')+\Xi]/[1+r_s(1-\Xi')+\Xi-2\Xi'(\Xi+1)]$ (high trade-price elasticity and low price rigidities, by $\{-,-,-\}$ if

$$\frac{1+r_s(1-\Xi')+\Xi}{1+r_s(1-\Xi')+\Xi-2\Xi'(\Xi+1)} > \xi > \frac{2\omega-1}{1-2\Xi'}$$

(low trade-price elasticity and low price rigidities) and $\{-,-,+\}$ if $\xi < (2\omega-1)/(1-2\Xi')$ (low trade-price elasticity and high price rigidities). Comparing these reaction with the transfer direction needed for closing both labor wedges completes the proof. ■

## 3.B Data

**Data series and sources:**

Our main data source for all considered countries is the OECD Economic Outlook, but we also take data from the OECD Main Economic Indicators, the OECD Quarterly National Accounts, the IMF Direction of Trade Statistics, the OECD STAN Database, the AMECO Database of the European Commission, national central banks, the European Central Bank, and updates of the data in Wu and Xia (2016). Table 3.B-1 lists the exact names of the data series and the corresponding sources.

**Country aggregates and parameter values:**

We construct the parameter and target values for the aggregates *Core* (Austria, Belgium, Germany, Finland, France, Netherlands) and *Periphery* (Greece, Ireland, Italy, Portugal, Spain) using average PPP-adjusted GDP weights. In order to avoid national basis effects, we construct aggregate series by first calculating quarterly growth rates and then aggregating the weighted series. The aggregated growth rates are then cumulated from the normalized base year in order to transform the series into levels. Net exports are calculated based on data on bilateral trade between countries in Core and Periphery, while the real exchange rate equals the ratio of the

**Table 3.B-1:** Data

| **OECD Economic Outlook 103, 1999Q1–2017Q4 (quarterly frequency)** |
|---|
| GDP, volume, market prices |
| Private final consumption expenditure, volume |
| Gross fixed capital formation, volume |
| Government final consumption expenditure, volume |
| Government gross fixed capital formation, volume |
| Unemployment rate |
| GDP, volume, at 2010 PPP USD |
| Exchange rate, national currency per USD |
| Euro-area consumer price index, harmonised |
| Euro-area core inflation index, harmonised |
| **OECD Main Economic Indicators 2018/7, 1999Q1–2017Q4 (quarterly frequency)** |
| Consumer price index, all items |
| Employment services |
| Employment industry |
| **OECD Quarterly National Accounts 2018/1, 1999Q1–2017Q4 (quarterly frequency)** |
| Industry |
| Services |
| **IMF Direction of Trade Statistics 12/2017, 1999Q1–2017Q4 (quarterly frequency)** |
| Imports, Million USD |
| Exports, Million USD |
| **OECD STAN (ISIC Rev. 4 , SNA08), 1999–2017 (annual frequency)** |
| Manufacturing output (D10T33) |
| Total Services output (D45T99) |
| **AMECO Edition May 2018, 1999–2017 (annual frequency)** |
| Wage share (ALCD2) |
| Capital-output ratio (AKNDV) |
| **National Central Banks, 2000–2017 (quarterly frequency)** |
| Loan rate |
| Deposit rate |
| **European Central Bank, 1999Q1–2017Q4 (quarterly frequency)** |
| EONIA |
| **Wu and Xia (2016), 2004Q4–2017Q4 (quarterly frequency)** |
| Shadow rate euro area |

aggregated region-specific price indices. Commodity prices are based on the difference between the HCPI and Core CPI. Due to (quarterly) data availability, Solow residuals are estimated based on data for production and employment in industry and services.

**Filtering:**

We generally apply the HP-filter with a smoothing parameter of 1600 to the time series data, before computing statistics of interest. Data used in the estimation of the Taylor rule is not filtered.

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