Time Varying Fiscal-Monetary Interactions within a Monetary Union

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Chapter 1

Introduction

The effectiveness of government spending on output or consumption, as measured by fiscal multipliers, has been a subject of much debate. Traditional Keynesian theory suggests that government spending has significant effects on consumption and output. In contrast, neoclassical theory argues for a relatively small impact on output since it crowds out private consumption. Hence, multipliers differ across models, the flexibility of prices, or the elasticity of substitution (Woodford (2011), Illing and Watzka (2014)).

In a dynamic framework, introducing frictions such as price or wage rigidities can reduce the crowding out of consumption caused by increased public demand. As Gali and Monacelli (2005) or Spilimbergo et al. (2009) have shown, its size and effectiveness depend on various parameters. For example, Auerbach and Gorodnichenko (2012), Canzoneri et al. (2016) and Baum and Koester (2011) show that multipliers are larger during recessions. According to Cwik et al. (2011) and Christiano et al. (2011) monetary policy must be at the zero lower bound, and the country should close its borders to trade for larger multipliers. While Huidrom et al. (2020) and Mueller (2014) argue that a high debt-to-GDP ratio weakens the effect of fiscal spending. One factor responsible for high fiscal impact is how these purchases are introduced. It is not surprising that several papers have emphasized the importance of financing dependence, particularly when Ricardian equivalence is violated (Hagedorn et al. (2019), Canova and Pappa (2007), Fatas and Mihov (2001), Corsetti et al. (2010)). Overall, the influence of fiscal spending shocks has different implications across countries and, thus, requires individual identification (Baum et al. (2012)).

As the European Monetary Union (EMU) was hit by multiple aggregate shocks such as the financial crisis, the sovereign debt crisis, and the Covid pandemic, stabilization mechanisms were much required. To facilitate a swift recovery, instead of national fiscal stimulus packages, they were implemented on a collective scale, such as the "European Economic Recovery Plan" in 2008 to mitigate the impact of the Great Recession or the "Next Generation EU" to assist member states in recovering from the consequences of the pandemic. Nevertheless, despite the implementation of these measures, the economies of countries within the union experienced divergent trajectories. According to Figure 1.1, France and Germany already showed positive output growth in 2011. However, for some countries such as Greece, Spain, and Portugal, the consequences of the financial crisis were devastating and resolved into a follow-up recession. Hence, while their decline in output growth was just as severe, their recovery path took longer than for countries with lower debt-to-GDP ratios. It was only in 2014 that their growth rates returned to positive territory. Tuca (2014) and Bankowski

et al. (2021) reported that the stimulus packages supported mainly countries without serious structural problems. Hence, recovery paths were vastly heterogeneous among members.

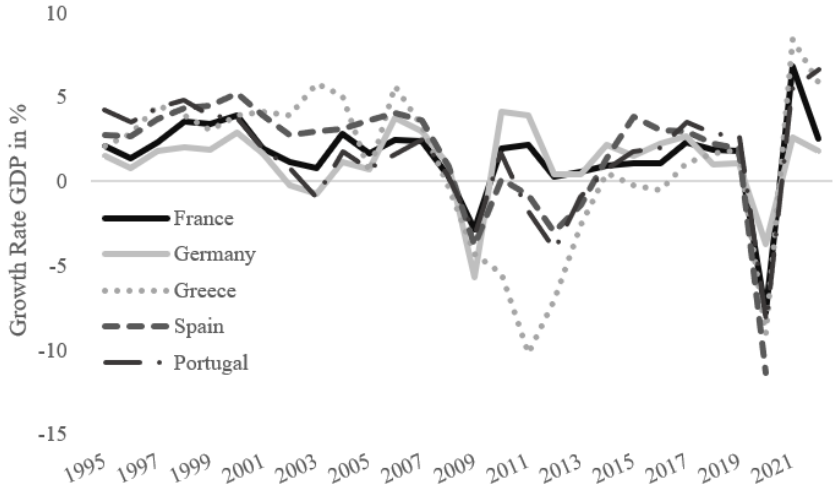


Figure 1.1: Annual Growth Rate of GDP for selected members of the Euro Area

One might argue that fiscal spending cuts across highly indebted countries were responsible for their slow recovery. However, while no excessive domestic stabilization measures were in place due to restrictions, there is no sign of individual spending cuts. In fact, the government spending to GDP ratio of members of the euro area across these countries maintained homogeneous and constant over time (Figure 1.2). Therefore, I argue that to identify sources of diverse recovery within a monetary union, it is essential to consider stabilization measures that go beyond national and union-wide solutions.

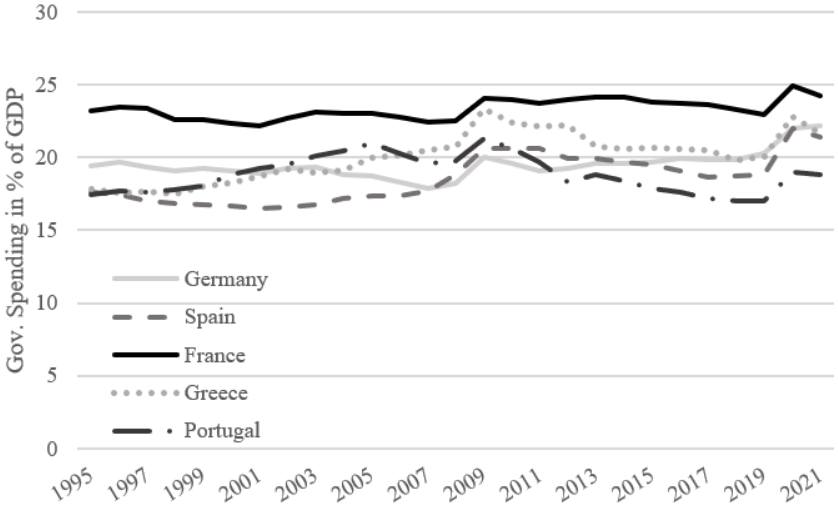


Figure 1.2: Relationship between debt and government spending after the financial crisis

As previous literature has mostly covered the efficacy of fiscal stabilization in the context of a closed economy, it ignored influence from across borders. Though, within a monetary union, where multiple countries share a common currency and face intertwined economic destinies, understanding the transmission of spending shocks is crucial for effective policy

formulation and coordination. Consequently, fiscal shocks in one country can propagate and affect the economic performance of other members. Depending on their trade relations, increased spending in one country can lead to higher demand for goods from other countries. Greater demand might also result in higher prices in the exporting country, improving its trading conditions. As Mongelli and Bandt (2000) have shown, the cross-correlation between euro area members has increased over time, while fiscal dispersion has declined, thus, spillovers propose a growing opportunity for stabilization. Hence, aside from determining the impact of national spending programs, spillovers and second-round effects across borders play a non-negligible role in affecting the economy, hence should be identified (Barbier-Gauchard et al. (2015)). Especially for countries without large fiscal space, this creates opportunities for free-riding, as they do not have to increase their expenses.

Hence, rather than being driven solely by direct spending shocks, the substantial network of trade relationships between countries plays a crucial role in determining the efficacy of fiscal stimulus. Spillover and second-round effects are key factors that can shape the heterogeneous patterns of stabilization and recovery among countries, particularly within a currency union. Under the assumption that spillovers transmit via the trade channel, a large share of imports to government expenditures indicates their importance relative to national multipliers. Figure 1.3 compares this measure between high and low-debt countries in the euro area. So although Blanchard et al. (2017) and Beetsma et al. (2006) argue for substantial benefits from spillovers for the periphery, the share for countries that recovered slowly was declining, especially after the financial crisis.

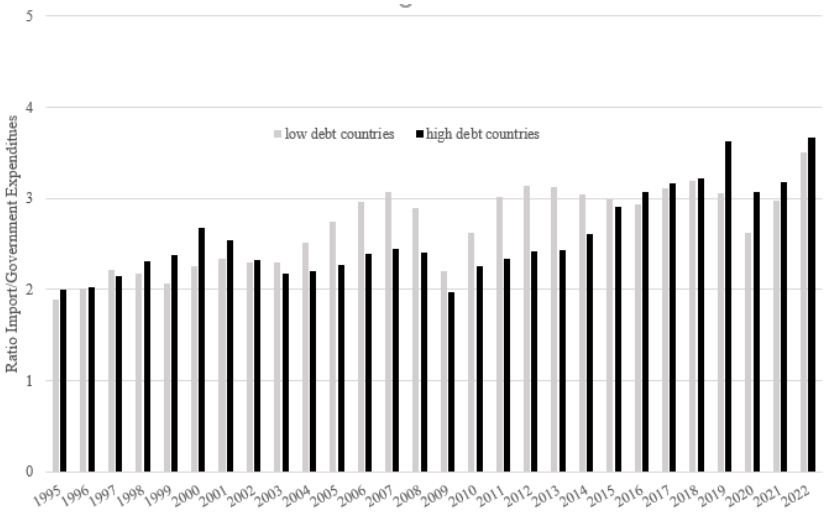


Figure 1.3: Ratio of import to government expenditures for high and low debt countries

Given the significant influence of cross-border dependencies on economic stabilization and recovery patterns, it becomes crucial to identify the instances when such dependencies are substantial and beneficial and when to rely on direct fiscal stimulus. This way, policymakers can understand how to optimally behave and coordinate among currency union members to guarantee a fast recovery for all concerning their available sources. Furthermore, exploring these spillovers yield new insight into free-riding opportunities among countries with low fiscal space to create a more homogeneous union.

As Multipliers and spillovers are not uniform and can be influenced by many factors, one

has to consider the degree of economic integration, the interlinkages of markets, the heterogeneity of economic structures, and the policy responses adopted by individual countries. Because even within a currency union, where members share a single monetary authority and share rather homogeneous business cycles, its members differ significantly in various exogenous and endogenous aspects, affecting the transmission channels of spending measures.

First, countries differ in size; thus, their economic importance directly impacts monetary policy reaction. The European Central Bank's target is to keep the medium-term inflation rate across the union at slightly below 2%, and its decision-making process depends upon a weighted average of "[...] the countries' relative household consumption expenditure shares in the euro area" (ECB (2023)). Hence, if small countries experience higher inflation rates due to increased government demand for domestic products, the monetary authority reacts only marginally with their nominal interest rate. Consequently, it reduces the real rate for such countries, creating inter-temporal substitution of consumption towards current periods. Conversely, spending shocks in large countries such as Germany or even on aggregate union level might cause strong monetary reactions experienced by all Faini et al. (2006).

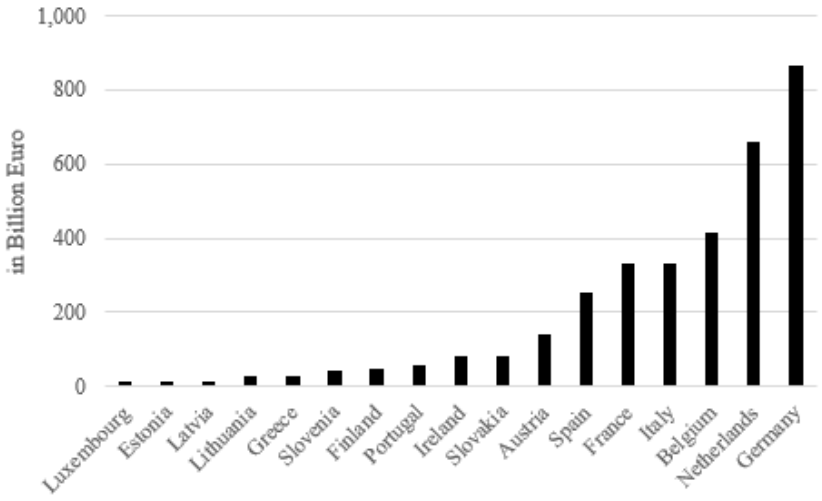


Figure 1.4: Exports of goods to other member states in 2022, data source: Eurostat

Second, the trade intensity differs significantly across members. While small countries account for only a small share in intra-EMU trade, goods from the union make up a large part of their household's consumption basket (Figure 1.4). Thus, they experience great dependence on foreign price levels and the terms of trade. Therefore, increasing domestic goods prices through government demand hurts these countries by worsening their purchasing power and reducing competitiveness. Due to the member's size, it cannot mitigate the effect of the terms of trade loss through price level spillovers on the union level or other countries as large members can. Furthermore, the degree of imports decides the benefit through possible spillover effects between countries. When assuming that government stimulus carries over to other members via trade, countries with a larger import share experience greater impact (Dabla-Norris (2017)).

Lastly and most importantly, fiscal multipliers are known to be different across certain fiscal and monetary regimes (Kirsanova et al. (2007), Mittnik and Semmler (2012),Gechert and Rannenberg (2018)). Davig and Leeper (2011) argue that the highest multipliers in

the US occur whenever monetary policy is not inflation targeting to keep interest rates low, despite the upward shift in inflation. This monetary behavior should accompany a fiscal behavior that shows a low reaction of taxes toward spending and debt and, thus, acts rather expansionary. The policy mix should guarantee to keep the interest rates and the negative wealth effect on households low such that consumption and output multipliers are high (Corsetti et al. (2019)). However, for an open economy model, these effects differ. For one, the effect of monetary policy mitigates through its centralization. Secondly, the effect on a member also depends on the behavior of the rest of the union. Especially for spillover effects, the regime of the country of origin or the union can influence its transmission channels significantly. And thirdly, monetary and fiscal policy cannot coordinate perfectly as multiple fiscal policies work independently.

Thus, given some of the previous results, this dissertation evaluates the efficacy of fiscal spending within a monetary union, depending on various factors, such as size, trade intensiveness, fiscal space, and especially regime prevalence. Furthermore, the analysis sheds light on the size of national multipliers, aggregate effects, and spillovers and identifies the regimes that generate the largest outcomes. The thesis consists of empirical and theoretical approaches to quantitatively and qualitatively evaluate the regime-dependent impact of fiscal spending shocks.

Chapter 2 starts this analysis by covering an empirical approach to estimate regime-dependent spillover multipliers across the members of the EMU. While Auerbach and Gorodnichenko (2013) have shown spillover multipliers to vary across the business cycle and Davig and Leeper (2011) analyzed the impact of different fiscal and monetary policy regimes on national multipliers in the US, I combine both approaches and apply them to the members of the EMU. Thus, government spending shocks are constructed using forecast prediction errors, weighted by their share of import to government expenditures as they are assumed to spill across borders through the trade channel. To introduce regime dependence, I assume that the originating and the receiving country vary in their behavior across regimes. For that, I estimate a two-state Markov Switching Regression of the underlying policy rules for all countries. Just as Davig and Leeper (2011), I differentiate between *active* and *passive* fiscal and monetary policy regimes. An *active* central bank is characterized by strong inflation targeting, whereas a *passive* regime raises the nominal interest rate not enough to allow real increases. For fiscal policy, the regime definition is more general than in Leeper (1991) as some countries from the sample don't allow a clear separation between *passive* and *active* states, where only the passive regime is said to satisfy the budget constraint through an adjustment of its surplus. Hence, in some cases I allow for a general differentiation based on it's intensity of debt reducing efforts but keep the notation of *active* and *passive*.

I find large and positive spillover multipliers and show that these regimes influence the transmission channels and, thus, the size of the multipliers significantly. The largest multiplier for the general member occurs when the targeted country behaves actively and the country of origin and the surrounding union are passive. Monetary policy has little influence on the average member. This combination indicates a high preference for improving terms of trade since foreign taxes and prices are relatively large. For highly indebted countries, the results differ. While it is still beneficial to behave actively for the receiving country, the interest rate channel gains importance such that an active union and passive monetary

policy secure the lowest costs for debt. Hence, countries with high debt have an option for free riding when interest rates are low across the union. Thus, they could have gained additional stabilization during their sovereign debt crisis through imported government spending shocks.

Chapter 3 extends this analysis by focusing on the theoretical determinacy of fiscal and monetary regimes in a monetary union. Based on the work by Leeper (1991), the coordination between monetary and fiscal policy is an important factor in yielding stable and unique solutions in theoretical models. In the past, literature has often claimed that monetary policy is inflation targeting to determine the price level and is combined with a fiscal policy that adjusts the surplus accordingly to fulfill its budgetary constraint. However, especially since the introduction of the *Fiscal Theory of the Price Level* by Cochrane (2001), the determination of the price level does not only have to be pinned down by the monetary authority. When extending this theory to a two-country open economy New Keynesian Model, the main difference is the existence of two fiscal policy authorities besides a single monetary policy. Thus, instead of two stable and unique equilibria, I find three, where one still has monetary dominance, and the others are both fiscally dominated, one by the member and one by the union. Thus, if one authority behaves actively and the others react accordingly, the model is uniquely solved. Furthermore, through the introduction of the joint union fiscal behavior, monetary policy can be made redundant, or on the opposite, this can be interpreted as the ECB can fully compensate for the issue of missing fiscal supervision. The determinacy analysis of the model is extended by two applications: First, I use the estimated regime probabilities from Chapter 2 to identify the phases of stable and unique equilibria and explosive periods for selective members of the EMU. The results indicate an extraordinarily explosive path for only three countries, Ireland, Greece, and Portugal, during 2007-2010, all of which showed an extreme upward shift of debt during these times. Second, following the empirical results from Chapter 2, I simulate the difference between output and spillover multipliers from the three stable equilibria and find the largest under a passive monetary and passive union-wide fiscal policy combined with an active domestic regime. However, this equilibrium would indicate that single countries behave significantly differently from the other union members while simultaneously having a central bank that fails its main objective. As this is unrealistic, the succeeding analysis continues with a slightly different approach.

Hence, in Chapter 4, I add to the theoretical approach explaining the results from Chapter 2 by introducing a quantitative analysis. I use a two-country New Keynesian Model with time-varying fiscal policy rules. In contrast to the previous Chapter, I keep the analysis within one unique and stable equilibrium: Monetary dominance. As maintaining price stability is the official mandate of the ECB, while fiscal rules by the Stability and Growth Pact dictate to balance debt, this equilibrium should be dominant. Hence, I identify the ideal regime interaction across two fiscal policies given an inflation-targeting central bank instead of comparing various fiscal and monetary regimes. I estimate and calibrate the model to fit Spain and the rest of the union. Both fiscal policies differ in their behavior across two passive regimes, one that is consolidating with *high* and one that is maintaining a *low* intensity for debt reduction. Hence, only one regime shows a significant reaction of income taxes towards changes in debt and little deficit financing. I estimate these using a

two-state Markov process. These regimes are then jointly integrated into the model, with their transition probabilities fully known by the households. I then analyze their impact on a national, union-wide, and spillover government spending shock and compare these results to a similar country with greater size and trade intensity. Furthermore, I simulate the influence of the *European Economic Recovery Plan* on macroeconomic variables for each regime combination. The results indicate that small countries benefit from a centralized monetary authority through decreases in real interest rates. Moreover, trade intensity increases the returns from union-wide solutions. Regarding the fiscal regime policy effects, a combination of *low/high* leads to the highest output multiplier since it minimizes the negative wealth effect and the terms of trade loss. However, consumption benefits from national shocks, and a *low*-intensity union to keep overall inflation low. These opposing effects increase with a member's level of trade dependence and size. Overall, this Chapter proves that relative consolidation matters through its influence on the price level and, thus, competitiveness. Hence, just like Chapter 3, it supports the findings in Chapter 2 in normal times when countries differ quantitatively but not qualitatively.

This dissertation comprises five chapters. The upcoming Chapter 2 provides an empirical analysis of regime-dependent fiscal spillover multipliers. In Chapter 3, I identify the determinacy conditions for monetary-fiscal regime interactions to explain the findings in Part 2 qualitatively. This follows a quantitative study in Chapter 4 via a Markov Switching open New Keynesian Model to identify the regime mix for the highest multiplier. Chapter 5 concludes.

Chapter 2

Estimating Regime Dependent Fiscal Spillover Effects in a Monetary Union

2.1 Introduction

On December 8th, 2022, the European Defence Agency (EDA) announced that defense spending in its member states had reached a new record high of 52 billion Euros, with 82% of the spending allocated towards equipment procurement. Italy recorded the highest increase in spending, with an additional 4 billion Euros compared to the previous year, followed by Finland, Greece, and Slovenia. The ongoing war in Ukraine suggests that this trend of increased spending is likely to continue in the coming years, leading to a rise in unproductive government spending across many members of the European Monetary Union. Aside from the military spending offensive, the Next Generation EU program provides another example of a coordinated fiscal spending shock to balance out the aftermath of the pandemic.

As the focus has shifted from national to aggregate stabilization measures, more countries are involved in the determinacy of fiscal multipliers. Furthermore, strong cross-border linkages and a single monetary authority cause important dependencies across members. Hence, the efficacy of fiscal spending shocks requires new insight. First, as multiple countries are involved, acceleration and second-round effects should be identified. Second, regarding the structure of a currency union, shocks in one country directly affect economic variables in other members through spillovers. Previous literature has mostly dealt with multipliers in the context of a closed economy. However, for currency union members, the relative importance of spillovers to their own spending measures is significant. Figure 2.1 displays the share of imports to government purchases in countries of the EMU. Under the assumption that spillovers transfer via the trade channel, this indicates a significant influence on GDP relative to national expenditures. Imports in larger countries such as France, Germany, Italy, or Spain are less than twice the size of government consumption. For other countries, their import reaches more than three times the size of their domestic fiscal spending. Thus, spillover effects induced by trade are likely to be larger for small countries, such as the former Soviet countries, Ireland, and Luxembourg. Hence, taking into account spillover effects on other countries allows a better understanding of the efficacy of fiscal stimulus.

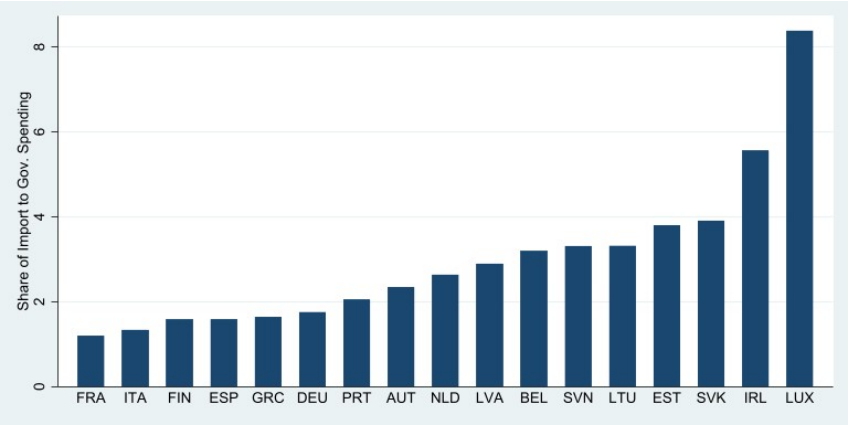


Figure 2.1: Average Share of Imports to Government Purchases 1995-2022

To understand the size of fiscal spillovers is important, as it directly influences the stabilization effects of national fiscal policies. Moreover, members with limited fiscal space depend greatly on foreign fiscal spending to stimulate their economy (Blanchard et al. (2017)). Large and positive spillover effects for highly indebted countries imply stabilizing the economy without rising national expenditures and calling for more coordinated stimulus programs. Hence, the interactions generate freeriding opportunities for some countries at the cost of large countries.

Extending the basic analysis of fiscal spillover multipliers, I investigate the existence of regime dependence. Previous literature has mostly dealt with business cycle dependence (see Auerbach and Gorodnichenko (2012), Canzoneri et al. (2016), Glocker et al. (2019)), indicating larger spillovers in recessions. However, only little is done in the context of fiscal and monetary behavior, despite its great effect on national multipliers, as shown by Davig and Leeper (2011) or Favero and Monacelli (2005). Following the definition by Leeper (1991), fiscal and monetary policy can be sometimes split up into *active* and *passive* behavior. In this definition, active monetary policy shows strong inflation-targeting, increasing interest rates by more than the rise in inflation, while passive behavior reduces the real interest rate. Fiscal policy differs in their reaction to taxes towards debt, where an active regime implies deficit financing and a low reaction to debt, and a passive regime is defined by a stronger reaction of taxes to debt to fulfill the requirements of their budget balance. According to Davig and Leeper (2007), a debt-financed tax cut will increase households' present value of consumption rather than future taxes. Consequently, output and inflation rise, causing debt revaluation as long as interest rates do not follow. Low interest rates, despite high inflation, are an indicator of passive monetary policy. Thus, the combination of active fiscal and passive monetary states generates the highest national multipliers. In a currency union, however, the centralization of the monetary authority allows even an inflation-targeting central bank to cause declining national real interest rates as long as the overall inflation is not too high. Furthermore, due to strong trade linkages, the behavior of other members might have a significant influence. Active behavior has a lower negative wealth effect and distortions, dampening the labor supply reduction due to lower net return through an increase in income taxes. Thus, active states are characterized by lower pressure on marginal costs and hence, inflation improving the terms of trade for a country and

vice versa for the passive regimes. Therefore, domestic and foreign fiscal regimes and the succeeding influence on macroeconomic variables are important for the analysis of national and also spillover multipliers.

Hence, this paper tries to identify the impact of fiscal spillovers on output within the European Monetary Union by using local projection methods following the setup by Auerbach and Gorodnichenko (2013). Specifically, government spending shocks that cross borders are constructed through unexpected innovations from forecast errors for government expenditures as in Ramey (2011) and the relative trade intensity towards another member since shocks are assumed to spill over through the trade channel. Regime dependence is created by weighting these spending shocks with the resulting regime probabilities from the estimated Markov switching policy rules.

I find that spillover multipliers are large and positive among the members of the EMU. They are more than twice as large when the targeted country (OT) behaves actively, and the country of origin (OC) is passive when the shock is issued. Furthermore, monetary policy plays a negligible role for members of the EMU, while fiscal regimes are essential. Highly indebted countries benefit even more from foreign spending shocks. Furthermore, in contrast to the general member, these countries show larger multipliers when the overall union is active and keeps the price level and, thus, interest rates low. Moreover, while the results indicate that monetary policy behavior is negligible for the average member, highly indebted members require a passive monetary policy to maintain low costs for debt.

The next Chapter will summarize the previous literature on fiscal spillover multipliers. In Chapter 2.3, I explain the data used to construct state probabilities and foreign government spending shocks. Chapter 2.4 will then explain the model's setup and outline the regression equations used for this analysis. The results for these equations are presented and discussed in Chapter 2.5, followed by some concluding remarks.

2.2 Previous Literature

Previous literature has dealt broadly with the regime dependence on government spending multipliers. For example, Bilbiie et al. (2008) and Perotti (2004) differentiate its level based on monetary behavior and find larger multipliers after the 80s as fiscal transmission mechanisms changed significantly with a transition of monetary policy towards inflation targeting. Ilzetzki et al. (2013) find larger multipliers in very open countries with flexible exchange rates, much in contrast to Corsetti et al. (2013). Furthermore, many papers have focused on the business cycle dependence of fiscal multipliers: Glocker et al. (2019), Auerbach and Gorodnichenko (2012), and Canzoneri et al. (2016) have found multipliers to be much larger than one during recessions. Similar conclusions are drawn by Baum and Koester (2011) for Germany, Baum et al. (2012) for the G7 and Nakamura and Steinsson (2014) Fazzari et al. (2015) for the US. Drivers of this phenomenon are the existence of financial frictions that hinder fast price adaptions, thus, reducing crowding out effects, unexploited production capacity, and psychological effects.

Another strand of literature argues for the importance of fiscal behavior and budgetary conditions that influence the efficacy of government spending. Mountford and Uhlig (2009) and Davig and Leeper (2011) have found larger multipliers whenever spending was deficit-

financed because the negative wealth effect on households is small. Others, however, argue that fiscal consolidation and low debt benefit the impact of fiscal stimulus (Bernoth et al. (2006), Huidrom et al. (2020), Ilzetzki et al. (2013) or Corsetti et al. (2013)). Since higher consolidation efforts will decrease the risk premium on government bonds, the effect on real interest rates declines, allowing larger consumption and output. Due to the restrictions of a single monetary policy, De Grauwe and Ji (2013) find this effect to be even larger for Euro Area members. Cugnasca and Rother (2015) shows that both facts (consolidation and deficit-financed spending) are not mutually exclusive but depend on how consolidation is done. A tax-financed consolidation causes multipliers to be lower than in the case of future spending cuts. In both cases deficit will be reduced; however, increasing current or future taxes, in contrast to cutting spending, directly affects households' budget constraints. This paper identifies, as well, the influence of fiscal behavior on government spending shocks; however, instead of their national impact, I analyze its effect on foreign spillovers. Fiscal stimulus does not just affect a country's macroeconomic variables but influences other economies simultaneously. Especially for tightly linked European countries, national stabilization mechanisms might spill over through various channels such as trade, monetary policy, and the labor market. Rising spending in one country can lead to an appreciation of the real exchange rate worsening terms of trade (Benetrix and Lane (2013)). These trade effects are significantly large for small countries that rely largely on their trade balance. However, this might improve the partner country's competitiveness because the spillover multiplier increases with a higher account surplus (Clancy et al. (2016)). The monetary channel, on the other side, might dampen this positive trade effect due to its aim of price stability. A government spending shock increases overall inflation enticing the central bank to raise interest rates for the whole union and so cause an inter-temporal shift in consumption (Faini et al. (2006)). Eventually, this excess spending needs to be reversed, which might then lead to a fall in long-term interest rates (Corsetti et al. (2010)). Additionally, tightly linked labor markets allow workers to wander across borders, reducing labor supply in the receiving country. Thus, whether or not spillover multipliers are positive and large depends on which effects dominate.

As in Poghosyan et al. (2017), Alloza et al. (2020) and Clancy et al. (2016), I find spillover effects to be mostly positive and large among the members of the Euro Area, especially for small countries. Simultaneously, the transmission through monetary policy seems negligible for single currency areas (Benassy-Quere and Cimadomo (2007)). Thus, since small trade-intensive countries benefit largely from trade effects and spillovers compared to national solutions, like Beetsma and Giuliodori (2011) and Hebous and Zimmermann (2013), I argue for the importance of coordinated fiscal policy.

While Faccini et al. (2016) analyze the spillovers from the US to trade partners and find little evidence for regime dependence, Corsetti et al. (2010) and Ivanova and Weber (2011) highlight the importance of debt-consolidation regimes for fiscal spillover effects, especially for small open economies. Both use DSGE models to quantify the effect, while I apply an empirical approach to estimate these consolidation-dependent spillover effects for members of the EMU. For that, I rely on the setup from Auerbach and Gorodnichenko (2013), but instead of business cycle dependence, I extend this analysis through an identification process for time-varying fiscal policy regimes which follow a two-state Markov process as in Davig

and Leeper (2011). In contrast to the theoretical model from Vetlov et al. (2017), I find significant differences between multipliers in different fiscal regimes.

2.3 Data

2.3.1 Fiscal State Dependence

Regime dependence of spillover multiplier is based on fiscal and monetary regimes within the countries and the union. Hence, I discuss the estimation procedure and the resulting state probabilities in this section. Both sectors are represented by policy rules following Davig and Leeper (2011). Thus, monetary policy follows a standard Taylor rule where nominal interest rates are reacting either more than one towards increases in inflation (*active*) or less, such that real rates decline (*passive*). While fiscal policy differs in its behavior of taxes towards debt, showing an *passive* regime when the coefficient is sufficiently high and *active* when it is not. However, in contrast to Leeper (1991), I sort countries' regimes into active and passive even when they do not differ in their response of adjusting the surplus to fulfill the budget balance. Some will simply vary in their intensity of taxes responding to debt. A further discussion will follow in Chapter 3.

I first estimate the equation for monetary policy, characterized by a standard Taylor Rule:

$$R_t = \alpha_0(S_t^\pi) + \alpha_\pi(S_t^\pi)\pi_t + \epsilon_t^\pi.$$

Nominal interest rate R_t is the effective federal funds rate for the Euro Area over three months, and π_t is the consumer price index covering the Euro Area. All data is taken from the OECD database. The policy rule is then estimated via a unique switching equation following a Hidden Markov Process as in Hamilton (1994). S_t^π defines the state variable, taking a value of 0 or one, depending on the state the central bank is in and following a Markov Switching process. Hence, the resulting regime probabilities are $Prob(S_t^\pi = k)$ for both values of k ($\in (0, 1)$). Based on the value of α_π, I then define the one regime as active with a resulting coefficient of 1.03 and the other as passive with a value of 0.72. The resulting regime probabilities for the passive monetary regime can be found in the bottom right graph, showing a passive behavior right before the Great Recession and during the phase of the zero lower bound from 2010-2019.

At the same time, governments and the union differ in their reaction to taxes towards deviations in debt. A passive fiscal regime is generally characterized by a greater debt reduction effort than the long-term real interest rate to satisfy the budget balance. In contrast, the active regime keeps tax responses to debt low (Leeper (1991)). It implies that passive governments adjust their surplus in a way to endogenously satisfy their budget constraint, while active behavior requires price level or interest rate adjustments to guarantee a stable equilibrium.

Fiscal policy is estimated for 14 members and the union itself following the policy rule,

$$\tau_t = \gamma_0(S_t^\tau) + \gamma_y(S_t^\tau)y_t + \gamma_d(S_t^\tau)d_{t-1} + \gamma_g(S_t^\tau)g_t + \epsilon_t^\tau.$$

The variable S_t here defines the state variable, defining the fiscal regime in period t. I refer to annual data from the OECD national accounts for the regime-varying equations. For τ_t, I

use total tax receipts net transfers, d_t is the gross public debt, and g_t represents government purchases and investments. The output gap $\hat{y}_t$ is defined by the difference between actual and potential gross domestic product at current prices deducted as annual time series from the AMECO database. All variables are divided by the gross domestic product and interpolated into quarterly data. Based on the resulting coefficient of γ_d, I separate each regime into the active or passive regime. The resulting regime probabilities of $Prob(S_t^\tau = k)$ will then serve as a weighting measure to construct fiscal spending shocks according to their prevailing regime. Figure 2.2 and 2.3 display the resulting regime probabilities for each member's passive regime and the aggregate European Union.

The resulting coefficients for each country across regimes can be found in 2.1. Additionally, one can derive the coefficients on government spending γ_g to understand how severe the regimes are. In order to divide the countries into the two regimes, I calibrate the country-specific β for which I identify a threshold value of γ_b for which a country is passive. However, even if one country is not considered passive or active by this definition, I still claim that one period is *more* active or passive in its intensity.

	AUT	BEL	EST[a]	FIN	FRA	GER	GRC	IRL
$\gamma_b(S=0)$	-0.06^{***}	0.098^{***}	0.21^{***}	0.043^{***}	0.077	0.025^{***}	0.093^{***}	0.038^{***}
$\gamma_b(S=1)$	-0.064^{***}	-0.087^{***}	0.2^{***}	-0.023^{***}	-0.085	0.011^{***}	0.071^{***}	0.007
$\gamma_g(S=0)$	-0.708^{***}	-0.185	0.362^{***}	0.317^{***}	1.376^{***}	0.187^{***}	0.283	0.133^{***}
$\gamma_g(S=1)$	-1.101^{***}	1.097^{***}	0.198^{***}	0.633^{***}	1.02^{***}	0.104^{***}	-0.252^{***}	0.634^{***}
$\bar{\gamma}_b$	0.0163	0.0175		0.0209	0.0207	0.0173	0.0442	0.024

	ITA	LUX	NLD	PRT	SVK	SVN	SPA	EA
$\gamma_b(S=0)$	0.064^{***}	0.059^{***}	-0.036^{***}	0.032^{***}	0.0286	0.011^{***}	0.074^{***}	0.022^{***}
$\gamma_b(S=1)$	0.042^{***}	-0.022	-0.171^{***}	0.012^{***}	0.001	-0.058^{***}	-0.028^{***}	0.013^{**}
$\gamma_g(S=0)$	0.107^{***}	0.72^{***}	0.065	0.008	0.236^{***}	-0.126	0.62^{***}	0.51^{***}
$\gamma_g(S=1)$	0.291^{***}	0.441^{***}	0.249^{***}	-0.415^{***}	0.176^{***}	-0.391^{***}	0.378^{**}	0.607^{***}
$\bar{\gamma}_b$	0.0263	0.0138	0.0143	0.0301	-0.0074	-0.0052	0.0209	0.0216

Table 2.1: Estimated coefficients and a threshold value for 16 members and the union.

[a]No data availability to construct $\bar{\gamma}_b$

Some countries, just like Greece, however, have a relatively low threshold $\bar{\gamma}_b$ since it is measured on the long-term average. Since their real interest rate on government bonds was much higher during 2010-2013, when they had to behave passively, I claim these countries are switching across both regimes based on a much higher threshold. The same is true for Italy.

I set the regime probabilities into a historical context and compared them to previous tax reforms in these countries.

Belgium, for example, experienced a large progressive tax reform from 2002 to 2005, reducing overall income taxation, while a major corporate tax reform was initiated in 2018 (Abreu (2004), Robbroeck (2018)), signaling the existence of active periods right afterward. While Germany, Finland, and the Netherlands lowered income taxes with the initiative in 2011, other members such as France, Spain, Portugal, and Luxembourg increased their overall tax rates to consolidate their existing debt (European Comission (2011)). The latter

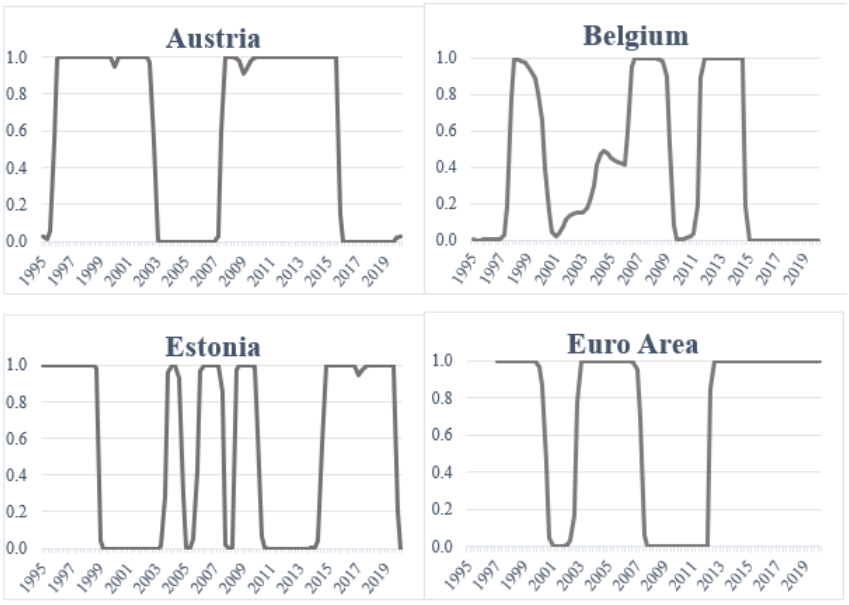


Figure 2.2: Regime Probabilities for Passive States Across Countries

country also initiated a deducting tax reform in 2001, where reductions ranged from deductions to higher progressiveness (Liegeois et al. (2010)). In 2008 Germany introduced interest expense deductibility and a corporate tax reduction to stimulate the economy after the financial crisis. These numerous historical reductions align with active fiscal regimes, while tightening reforms show the rise of passive regime probabilities. Portugal has been behaving actively since 2000; however, in 2013, large savings reforms were introduced that, for example, increased income taxation on the worker's side by 7% (International Monetary Fund (2016)).

2.3.2 Construction of Government Spending Shocks

To construct unexpected government spending shocks, I use deviations from OECD Economic Outlook projections that are unexpected and independent of fundamentals. For changes in government spending, I use the forecasts for government final expenditures in volume and constant prices from December 1997 until the end of 2022. The first few years are only available as semiannual data; thus, I will transform all variables within the analysis into semiannual data. I then calculate the growth rates for the current period and the expected growth rate for the period in $t+1$. Thus, the resulting differences between the expected growth in an economic projection of year t are compared to the current growth in the projection database of year $t+1$. Thus, an innovation at time t of horizon p is constructed for each country via,

$$\xi_{t,q} = g_t - E_{t-p}(g_t|I_{t-p}) \tag{2.1}$$

To control for any revisions in the forecasts of the following periods, different horizons ($p \in (1,2,3)$) are compared with each other. The final revision corrected innovations $E_{t,q}$ are then used to construct government spending shocks. These spending shocks are regressed on various macroeconomic variables to correct for the possibility of fundamental changes

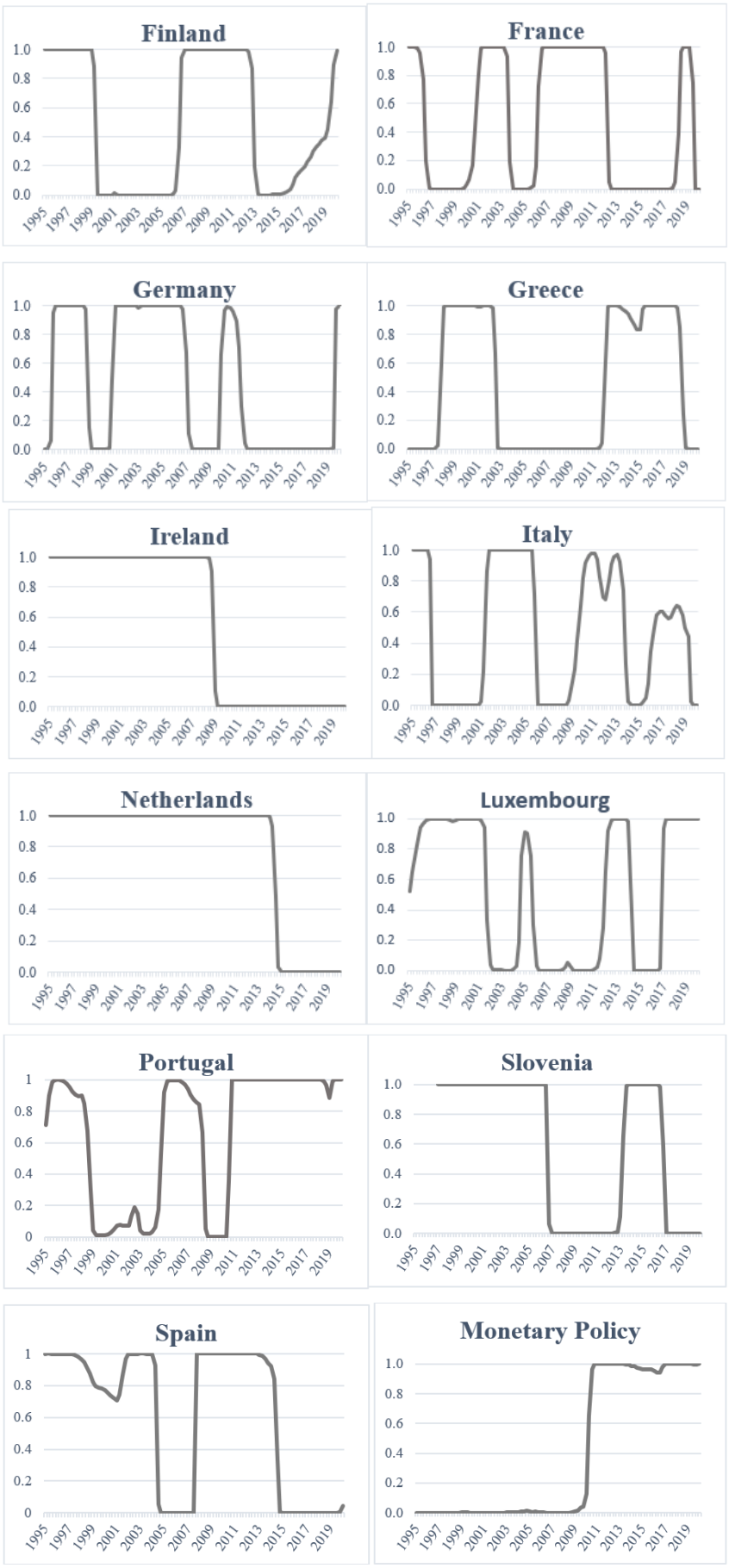


Figure 2.3: Regime Probabilities for Passive States Across Countries

responsible for these innovations.

$$\xi_{t,q} = \gamma_0 + \gamma_1 Y_{q,t} + \gamma_2 I_{q,t} + \gamma_3 M_{q,t} + \gamma_4 X_{q,t} + \nu_{q,t}$$

$$\xi_{t,q} = \gamma_0 + \sum_{s=0}^{T} \gamma_s X_{q,t-s} + \nu_{q,t} \tag{2.2}$$

where X contains various macroeconomic variables like GDP, consumption, import, export, and investment to correct for any fundamental changes in these projection errors. The residual $\nu_{q,t}$ contains all the unaccounted factors within these projection errors. For $\mathcal{G}$, these residuals are then set in relation to the country's actual fiscal spending level and its import ratio relative to it, such that it evolves according to,

$$\mathcal{G}_{i,t} = \sum_{q \neq i} (M_{i,q,B}/G_{q,B}) \times (\nu_{q,t} \times G_{q,t-1}) \tag{2.3}$$

where the residual is multiplied by the lagged government spending in Euro to express it in values. Since I assume government spending shocks to transmit through the trade channel, the indicator used to construct spillover effects is the relative trade share compared to government purchases $(M_{i,q,B}/G_{q,B})$. The trade shares are measured with data from imports and exports of goods and services as well as GDP; all series are in national currency and current prices and are seasonally adjusted. This way, one can correct for the heterogeneity coming through larger trade linkages across countries or influenced by one country's size. Moreover, the setup in equation 2.3 describes how fiscal shocks are assumed to be working across countries: Through the trade channel and especially through the import of goods from other members. Thus, a spillover shock in country i is constructed through the unexpected increase in government spending in country q where a share of it is imported into country i.

A further specification to introduce the regime dependence in the country of origin can be generated by modifying equation 2.3 by multiplying the resulting shock sequence with the regime probabilities. Thus, the unexpected shock $\mathcal{G}$ imported from country q can be separated in the following expressions,

$$\mathcal{G}^{act}_{i,t} = \sum_{q \neq i} (M_{i,q,B}/G_{q,B}) \times (S^{act}_t)(\nu_{q,t} \times G_{q,t-1}) \tag{2.4}$$

$$\mathcal{G}^{pas}_{i,t} = \sum_{q \neq i} (M_{i,q,B}/G_{q,B}) \times (1 - S^{act}_t)(\nu_{q,t} \times G_{q,t-1}) \tag{2.5}$$

These two resulting shock constructions can then be used to estimate multipliers under an external regime switching. This way, I can now also identify the impact of the fiscal regime of the country of origin on its spillover effect to another country.

Using these definitions of unexpected government spending shocks, I estimate their impact on GDP. Output Y_t is measured as the gross domestic product national currency in current prices and seasonally adjusted. G_t is taken from the government's final expenditure at current national prices and seasonally adjusted. All data is made stationary by applying the Hodrick-Prescott filter. Furthermore, the analysis allows for correlation across countries and time in the errors according to Driscoll and Kraay (1998).

The panel estimates are based on quarterly and semiannual data from 14 Euro Area

countries from the first quarter of 1997 to 2020. All data is derived from the OECD database and is available until 2022. However, the sample will be restricted up to the first quarter of 2020 to eliminate any effects influenced by the pandemic. All variables are transformed or linearly interpolated to semiannual data due to the availability of forecast data.

2.4 Methodology

2.4.1 Baseline Model

In order to estimate the impact of fiscal spillovers on multipliers within another country, I will rely on the approach set up in Auerbach and Gorodnichenko (2013) and Auerbach and Gorodnichenko (2012). Thus, I regress the change of output over a horizon of $h \in [1; H]$ on the government spending shocks coming from other countries over the set of members of the currency union via a Panel Estimation as the following,

$$\frac{Y_{i,t+h} - Y_{i,t-1}}{Y_{i,t-1}} = \alpha_h \frac{\mathcal{G}_{i,t}}{Y_{i,t-1}} + \sum_{s=1}^{m} \beta_{h,s} \frac{\Delta Y_{i,t-s}}{Y_{i,t-s-1}} + \sum_{s=1}^{m} \delta_{h,s} \frac{\Delta G_{i,t-s}}{Y_{i,t-s-1}} + \phi_{i,h} + \mu_{t,h} + \epsilon_{i,t,h}. \quad (2.6)$$

Where $Y_{i,t}$ and $G_{i,t}$ describe output and government spending in the country i at time t, $\phi_{i,h}$ and $\mu_{t,h}$ are country and time fixed effects and $\mathcal{G}$ denotes the fiscal spending shock that origins in a different country. All variables are expressed in differences and divided upon the lagged value of GDP such that the sequence of $\{\alpha_h\}_{h=0}^{H}$ can be directly interpreted as the fiscal impact multiplier of horizon h. Since equation 2.6 is the baseline regression, the resulting multipliers describe the impact of government stimulus in other countries on the average EMU member. Assuming these countries are much more comparable than OECD or G7 countries through their shared monetary policy, strong trade relations, and shared cultural identities, the average effect is quite informative.

2.4.2 Regime Dependent Models

The first model, considering the impact of the different fiscal regimes, will measure how the regime in country i changes the resulting spillover multiplier. For that, equation 2.6 is extended by the weighted shares of the regressors, depending on the regime probabilities:

$$\begin{aligned}\frac{Y_{i,t+h} - Y_{i,t-1}}{Y_{i,t-1}} = \alpha_h^{act}(S_t^{act})\frac{\mathcal{G}_{i,t}}{Y_{i,t-1}} + \alpha_h^{pas}(1 - S_t^{act})\frac{\mathcal{G}_{i,t}}{Y_{i,t-1}} + \sum_{s=1}^{m} \beta_{h,s}^{act}(S_t^{act})\frac{\Delta Y_{i,t-s}}{Y_{i,t-s-1}} + \\ + \sum_{s=1}^{m} \beta_{h,s}^{pas}(1 - S_t^{act})\frac{\Delta Y_{i,t-s}}{Y_{i,t-s-1}} + \sum_{s=1}^{m} \delta_{h,s}^{act}(S_t^{act})\frac{\Delta G_{i,t-s}}{Y_{i,t-s-1}} + \sum_{s=1}^{m} \delta_{h,s}^{pas}(1 - S_t^{act})\frac{\Delta G_{i,t-s}}{Y_{i,t-s-1}} + \\ + \phi_{i,h} + \mu_{t,h} + \epsilon_{i,t,h}. \quad (2.7)\end{aligned}$$

S_t^{act} defines the regime probability that a member, the union itself, or monetary policy is perceived to behave actively. This regression then generates multipliers in different states of the targeted country. For one, whether the domestic fiscal policy behavior matters; secondly, whether the union-wide fiscal policy has an impact; and third, how the monetary policy affects the results.

In the second setup, I estimate the impact of the fiscal regime in the country of origin. For

that, I include the different $\mathcal{G}$-shock specification from equations **??** and **??** in the baseline model. The modified baseline model then results in

$$\frac{Y_{i,t+h} - Y_{i,t-1}}{Y_{i,t-1}} = \alpha_{h,A}\frac{\mathcal{G}^{act}_{i,t}}{Y_{i,t-1}} + \alpha_{h,P}\frac{\mathcal{G}^{pas}_{i,t}}{Y_{i,t-1}} + \sum_{s=1}^{m}\beta_{h,s}\frac{\Delta Y_{i,t-s}}{Y_{i,t-s-1}} + \sum_{s=1}^{m}\delta_{h,s}\frac{\Delta G_{i,t-s}}{Y_{i,t-s-1}} + \\ + \phi_{i,h} + \mu_{t,h} + \epsilon_{i,t,h}. \quad (2.8)$$

The influence of the country of origin can be explained by the impact of its reaction toward its spending shock and the effect on its competitiveness. The larger responsiveness of taxes to debt increases the relative prices of these goods. This will worsen the terms of trade and hence, cause a loss in countries q's competitiveness. Imports will be lower, and so the overall government shock might be lower, but the effect on output for a given value of $\mathcal{G}$ in country i might be larger since the country gains relative competitiveness in trade.

Lastly, by combining the specification of regression 2.7 and 2.8, I receive the cross-country regime interdependence effect on the multipliers. I restrict the analysis to only focus on country-specific changes assuming the monetary and overall union to be constant. Thus, lastly, I run the following regression,

$$\frac{Y_{i,t+h} - Y_{i,t-1}}{Y_{i,t-1}} = \alpha^{act}_{h,A}(S^{act}_t)\frac{\mathcal{G}^{act}_{i,t}}{Y_{i,t-1}} + \alpha^{act}_{h,P}(S^{act}_t)\frac{\mathcal{G}^{pas}_{i,t}}{Y_{i,t-1}} + \alpha^{pas}_{h,A}(1 - S^{act}_t)\frac{\mathcal{G}^{act}_{i,t}}{Y_{i,t-1}} + \\ \alpha^{pas}_{h,P}(1 - S^{act}_t)\frac{\mathcal{G}^{pas}_{i,t}}{Y_{i,t-1}} + \sum_{s=1}^{m}\beta^{act}_{h,s}(S^{act}_t)\frac{\Delta Y_{i,t-s}}{Y_{i,t-s-1}} + \sum_{s=1}^{m}\beta^{pas}_{h,s}(1 - S^{act}_t)\frac{\Delta Y_{i,t-s}}{Y_{i,t-s-1}} + \\ \sum_{s=1}^{m}\delta^{act}_{h,s}(S^{act}_t)\frac{\Delta G_{i,t-s}}{Y_{i,t-s-1}} + \sum_{s=1}^{m}\delta^{pas}_{h,s}(1 - S^{act}_t)\frac{\Delta G_{i,t-s}}{Y_{i,t-s-1}} + \phi_{i,h} + \mu_{t,h} + \epsilon_{i,t,h}. \quad (2.9)$$

The fiscal regime in country i, together with country q's behavior, might generate even larger multipliers through interdependence. Thus this last regression identifies the best cooperation behavior between two union members.

2.5 Results

2.5.1 Government Spending Shocks

The summary statistic for the resulting government spending shocks can be found in Figure 2.4. Overall the mean is centered around zero for all countries. The standard deviation, however, differs quite significantly across the members of the Euro Area. Large countries seem to be more constant in their spending, while especially eastern countries have a standard deviation up to 34% in Slovakia. Thus, high trade shares seem to influence the volatility of spending shocks. Another interesting fact stands out when looking at the correlations between the shocks. While most countries seem to increase spending at times when their neighbors do so as well, France and Austria show opposing effects toward Germany. Thus, when Germany introduces fiscal packages, its neighbors seem to hold back on their own expenses. This behavior indicates that countries are aware of possible spillovers when their trade relations are relatively tight. Other countries that show very similar business cycles and share common political and historical developments, such as Slovenia and Slovakia, are almost perfectly correlated.

	Mean	Standard Deviation	AUT	BEL	DEU	ESP	EST	FIN	FRA	GRC	IRL	ITA	LUX	NLD	PRT	SVK
AUT	-0.00	0.23														
BEL	-0.00	0.40	0.3502													
DEU	0.00	0.12	-0.2435	0.7692												
ESP	-0.00	0.11	0.1769	0.8719	0.7966											
EST	0.00	0.28	0.0628	-0.1744	-0.1862	-0.2336										
FIN	-0.00	0.09	0.8853	0.7111	0.1678	0.4967	-0.0901									
FRA	-0.00	0.09	0.8518	0.0897	-0.3469	-0.1010	0.1055	0.6916								
GRC	-0.00	0.03	0.8293	0.4946	0.1182	0.3349	0.1259	0.8219	0.8305							
IRL	-0.00	0.19	0.7489	0.7989	0.3580	0.6363	-0.0865	0.9135	0.5019	0.7215						
ITA	-0.00	0.08	0.4733	0.9012	0.6364	0.8893	-0.2256	0.7482	0.2038	0.5352	0.8142					
LUX	-0.00	0.17	0.7007	0.8590	0.4675	0.7681	-0.1110	0.8976	0.4480	0.7335	0.9681	0.8990				
NLD	-0.00	0.23	0.8982	0.4676	-0.0079	0.4223	0.0262	0.8635	0.7901	0.8513	0.7956	0.6417	0.8243			
PRT	0.00	0.12	0.4507	0.6649	0.4928	0.5365	-0.1323	0.6418	0.4841	0.6714	0.6653	0.7587	0.6911	0.5674		
SVK	-0.01	0.34	0.9447	0.4864	-0.0677	0.3090	-0.0185	0.9171	0.7490	0.7699	0.8477	0.6070	0.7888	0.8690	0.5296	
SVN	-0.01	0.26	0.9380	0.4832	-0.0102	0.3221	0.0037	0.8977	0.7609	0.8607	0.8251	0.5811	0.7855	0.8735	0.5205	0.9655

Figure 2.4: Summary statistics government spending shocks across countries in Percentage of GDP

An additional analysis of the spending shocks yields insight into the relationship with the business cycle. Table 2.2 shows the cyclical behavior of the fiscal stimulus in each country. Not all members behave counter-cyclical as recommended by the Keynesian theory. While Austria, France, Finland, and the Netherlands have a negative correlation between GDP and spending in period t (ρ_{dy_t,dg_t}), Germany and the southern countries are pro-cyclical. This explains part of the negative correlation between Germany and its neighbors in their spending behavior.

	AUT	BEL	DEU	ESP	EST	FIN	FRA	GRC	IRL	ITA	LUX	NLD	PRT	SVK	SVN
ρ_{dy_t,dg_t}	-0.22	0.02	0.13	0.14	0.03	-0.20	-0.30	0.11	0.13	-0.08	-0.22	-0.19	0.03	-0.06	-0.06
ρ_{dy_{t-1},dg_t}	0.40	0.25	-0.01	0.12	-0.03	0.08	0.39	0.48	-0.03	0.28	0.06	0.38	0.39	0.20	0.29

Table 2.2: Correlation government spending shocks per GDP with Business cycle

2.5.2 Estimation Results

Table 2.3 displays the results for the baseline regression from equation 2.6. The analysis is separately done for two-time horizons. In one, I use the whole unbalanced sample from 1997 to the first quarter of 2020, while in the other, I leave out the years 2008-2009. Leaving out the periods of the financial crisis proves spillover multipliers to be regime- and not just cycle-dependent. Furthermore, this event was are rather extreme and, thus, cause concern for biased effects. Throughout this analysis, the resulting multipliers are relatively large this is due to the fact that they are displayed in terms of the amount of spending that spills over.

	(1)	(2)
Spillover Multiplier	0.99**	0.99**
	(0.51)	(0.51)
Without 2008/2009	No	Yes

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2.3: Regression Output Linear Analysis Eq. 2.6

Table 2.3 only displays the results for the fixed weights case where the import to government spending ratio is held constant over time. Using variable weights reduces the level of coefficients and their significance only marginally. Overall, the general spillover multipliers are positive but slightly below one, indicating a gain through foreign fiscal stimulus independent of the fiscal regimes in place. Thus, as fiscal stimulus is initiated in one country, the target country's GDP will increase by almost the same amount as the fiscal spending transferred through the trade channel. This result implies that either an expansive government will directly purchase some fraction of imported products, increasing the trade balance for the trading country, or the receiving country benefits indirectly through a relative depreciation of the real exchange rate. Moreover, since the targeted government does not need to finance the fiscal spending, there are only small negative wealth or substitution effects from rising taxes. Therefore, these spillover multipliers are likely to be larger than aggregate

effects.

Table 2.4 displays the results from regression equation 2.7. These results indicate a significant increase when allowing for regime dependence. In active targeted countries, the spillover multiplier increases by more than twice the size of the shock when leaving out 2008/09. Thus, when a country responds with higher taxes towards changes in its output, it creates a larger negative wealth effect. Furthermore, when these are distortionary income taxes, the reduction in net wages will decline labor supply while labor demand increases, causing a rise in marginal costs and prices. This then worsens the terms of trade, and the country loses competitiveness. Additionally to this analysis, I examine whether it matters for the targeted country to be within an active or passive union. The results indicate a weak benefit from a passive union supporting the gain in relative competitiveness compared to the other members. Hence, a member country benefits more from a gain in competitiveness than a decline in overall inflation and, thus, in real interest rates. This fact is further supported by the fact that the multipliers of different monetary policy behavior are insignificant.

	Fiscal Policy TC		Fiscal Policy EMU		Monetary Policy	
	active	passive	active	passive	active	passive
Spillover Multiplier	1.64^{*}	-0.30	1.18	0.78^{*}	1.46^{*}	0.60
	(0.89)	(0.83)	(1.29)	(0.44)	(0.78)	(0.51)
Without 2008/2009	2.0^{**}	-1.09^{**}	0.56	0.87^{**}	1.12	0.71
	(0.97)	(0.52)	(1.71)	(0.44)	(0.77)	(0.55)

t- statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2.4: Regression Output Nonlinear Analysis Eq.2.7

Table 2.5 shows how fiscal behavior in the country of origin influences its spillover multipliers to other countries. Thus, whenever the country of origin is in a passive regime, the multiplier for the targeting country is, on average, almost twice as big as in the baseline regression. This result is fully in line with the idea of high taxes being responsible for a loss in terms of trade and hence, increasing the benefit through spending spillovers across the border. Furthermore, sharing one centralized monetary policy puts more weight on the behavior of others.

	Fiscal Policy OC	
	active	passive
Spillover Multiplier	0.94	1.50***
	(0.85)	(0.50)
Without 2008/2009	1.35	1.84***
	(0.86)	(0.77)

t- statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2.5: Regression Output Linear Analysis Eq. 2.8

The last analysis combines the previous results. Hence it describes the interacting effects between the receiving and originating country from equation 2.9. Table 2.6 displays the multipliers according to the countries' regime mix. The greatest multiplier, with 3.39, is reached when the targeted country is active, and the country of origin is passive. These results imply a strong impact of the trade channel on the benefit of government stimulus spillovers.

	Fiscal Policy Regime Mix (OC/TC)			
	active/active	passive/active	active/passive	passive/passive
Spillover Multiplier	0.62	2.70***	−0.22	−0.08
	(0.87)	(0.87)	(1.20)	(1.06)
Without 2008/2009	0.92	3.46***	−2.37***	0.09
	(0.97)	(0.93)	(0.97)	(1.02)

t- statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2.6: Regression Output Linear Analysis Eq. 2.9

Furthermore, the resulting multipliers indicate a ranking of regime mixes to generate larger spillover multipliers. While a passive/active mix generates the largest results, it is still beneficial for the targeted countries to behave actively when the other country is active. The worst regime mix is achieved under a passive targeted country and an active country of origin, leading to the greatest loss in terms of trade. Overall these high differences in multipliers suggest that since government stimulus is quite expensive, it might be beneficial to participate in a coordinated fiscal action across the union, especially for countries facing low fiscal space (Hebous and Zimmermann (2013)).

2.5.3 Highly Indebted Countries

As Huidrom et al. (2020) claims, fiscal multipliers tend to be lower with a high debt burden, for one, because expenses need to be mostly financed by taxes, which induces a large negative wealth effect. Secondly, the risk premium on bonds is relatively higher. However, spillover effects might resolve this issue when national solutions cannot yield the required stabilization. I restrict the sample to a subset of members to analyze the final impact of such spillovers in

highly indebted countries. Thus, I apply the previous regressions to France, Italy, Greece, Spain, Portugal, and Belgium, all of which have higher debt-to-GDP ratios than the average level of the Euro-Zone, which lies at around 95% in 2021. Since fiscal spillover shocks are not restricted, they still measure the overall inflow of foreign government spending through trade independent of the country of origin. Therefore, only the country indicator i is restricted to these six members.

	(1)	(2)
Spillover Multiplier	1.71**	1.24**
	(0.82)	(0.64)
Without 2008/2009	No	Yes

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2.7: Regression Output Linear Analysis Eq. 2.6 for highly indebted Members

The general non-regime-dependent spillover multipliers are significantly larger for highly indebted countries than for the whole union (Figure 2.7). With a multiplier of 1.71, it reaches far above one, even when leaving out the Great Recession. These results imply a larger benefit through spillovers for debt-intensive countries, supporting coordinated fiscal policy solutions instead of national ones.

When including regime dependence in country i, Table 2.8 emphasizes the large benefit of active behavior within the receiving country. However, the behavior of the rest of the union is more important for the effect of spillovers. In contrast to the analysis before, highly indebted countries benefit largely from an active union. This leads to an overall lower price level, reducing the pressure on monetary policy to increase interest rates and, with it, the costs for refinancing. Thus, the monetary channel is more important than the trade effect for this set of countries. The results of regime switching country of origin furthermore support this. It is still more beneficial when the spending shock comes from a passive country, but this difference is not as high as before. Hence, high debt increases the transmission through the financial market, and thus, the union's behavior becomes important for business cycle stabilization within such countries.

	Fiscal Policy TC		Fiscal Policy EMU		Monetary Policy		Fiscal Policy OC	
	active	passive	active	passive	active	passive	active	passive
Spillover Multiplier	1.96**	0.86	2.35**	1.23**	1.84	2.43***	3.74***	3.49***
	(0.98)	(0.81)	(1.16)	(0.57)	(1.28)	(0.64)	(1.41)	(1.28)
Without 2008/2009	1.91**	−0.73	6.02***	1.04*	−0.07	2.58***	2.52	3.50***
	(0.92)	(1.33)	(1.67)	(0.55)	(0.82)	(0.78)	(1.75)	(1.26)

t- statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2.8: Regression Output Nonlinear Analysis Eq. 2.7& 2.8

The results on monetary policy show that for countries with high debt levels, monetary

behavior is important to keep the pressure from debt low. This finding is consistent with the literature on how uncertainty through larger debt declines the benefit of government spending. Part of this large effect can be attributed to the fact that economic downturns were occurring simultaneously with the passive monetary policy, and they yield larger multipliers in general (Auerbach and Gorodnichenko (2013)).

Table 2.9 shows the regime mixes that generate the highest multipliers for countries with high debt levels. The results are qualitatively the same as in the analysis for the general member. However, they are much larger.

	Fiscal Policy Regime Mix (OC/TC)			
	active/active	passive/active	active/passive	passive/passive
Spillover Multiplier	1.77	5.73^{***}	-0.56	-0.12
	(1.62)	(2.45)	(1.87)	(0.66)
Without 2008/2009	1.69	5.07^{***}	-3.24^{*}	-1.81^{***}
	(1.59)	(2.02)	(1.89)	(0.66)

t- statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2.9: Regression Output Linear Analysis Eq. 2.9

Hence, these results show that a well-coordinated fiscal policy program can benefit countries with low fiscal states. Through high trade linkages, some members will benefit greatly from a sudden increase in spending across the country, but only when both countries are in the preferred regime and the whole union focuses on price level stability.

2.6 Conclusion

In conclusion, spillover multipliers within the EMU are highly regime dependent, not just on the business cycle, as previous literature has shown, but also based on fiscal policy behavior. Spillovers are not just influenced by the regime of the targeted country and the country of origin but also by the fiscal behavior of the union. In contrast, the behavior of a monetary policy is insignificant for the average member. A Euro Area member can generate substantial spillovers when in the right regime. The largest impact on output is achieved when the targeted country is behaving actively, and the foreign country is passive such that the terms of trade benefits are the largest. The same argument supports the finding that a passive union-wide fiscal policy is beneficial.

The results and obvious transmission channels differ for highly indebted members. While multipliers are generally larger, they show an even greater regime dependence than their more sustainable neighbors. As Blanchard et al. (2017), I find evidence for a significant increase in production in the periphery through spending shocks across their border. Again, the active and passive mix for the targeted and country of origin generates the largest multipliers. However, highly indebted countries benefit largely from an active union, so overall inflation is kept low. Additionally, the central bank regime has a strong and significant effect on the size of multipliers. Since an inflation-targeting monetary policy would cause even greater pressure on their budget balance, a passive regime guarantees larger benefits

from government spending increases.

Overall, the results suggest the great importance of coordinated fiscal stimulus programs in currency unions since multipliers can vary substantially with the behavior of each participant. Since fiscal spillovers are a way to stimulate an economy without increasing one's expenditures, countries with low fiscal space can benefit from a cross-border stimulus under certain conditions. It enables these countries to wait for free-riding possibilities when certain regimes are in place. This yields new insight into the topic of fiscal stabilization mechanisms. In order to prevent this free lunch for highly indebted countries, the ECB should maintain its aim for price level stability while the members should strictly initiate fiscal deficit regulations.

Chapter 3

Stable Equilibrium Paths for Monetary-Fiscal Interactions in a Monetary Union

3.1 Introduction

The previous Chapter provided empirical evidence that there exists a significant impact of monetary and fiscal regimes on spillover multipliers across the Euro Area members. Particularly for highly indebted countries, the effect on various transmission channels is highly regime dependent. Furthermore, the last regression equation 2.9, covering the interacting regime mixes across fiscal policies, showed the need to identify these regimes together. Hence, Chapter 3 of this dissertation covers the underlying mechanisms in each regime combination using a two-country New Keynesian DSGE model. Furthermore, it extends the analysis by identifying monetary and fiscal behavior conditions necessary to yield stable and unique equilibria in the model. Lastly, based on the previous Chapter's regime probabilities for each country, I identify different explosive, indeterminate, and stable periods and their influence on fiscal multipliers.

Davig and Leeper (2011) have shown the beneficial impact of an ideal regime mix during recessionary times in the context of a closed economy: A passive central bank keeps interest rates low, while an active fiscal policy stimulates with low tax rates. Despite the ECB keeping interest rates low when the sovereign debt crisis started, Euro Area members recovered relatively slower than the US. A part of this problem is the imperfect coordination within currency unions. A single monetary policy and multiple small countries, each with their independent government, make the regime mix between aggregate fiscal behavior and monetary policy rather exogenous than endogenous. Even if one argues that the central bank adapts its policy towards the overall economic conditions, the union is just an aggregate result of multiple decision-making countries. Thus, there are more than two authorities to be considered but rather multiple small countries making decisions and influencing economic conditions across their borders (Dixit and Lambertini (2003)).

Thus, while a passive monetary authority allows these countries to finance their debt to relatively low costs and, thus, reduces pressure when experiencing spillovers or initiating their stimulus programs, the union's behavior can yield opposing effects. On the one hand, a highly passive union guarantees large benefits for trade-dependent countries, which are often small and economical. Conversely, the overall inflation must be kept low for countries such as Greece, Portugal, or Spain. However, when considering a model with income taxation,

a passive-behaving fiscal policy reduces the net benefit of wages and, thus, raises marginal costs for producers if they need to increase production. Consequently, inflation rises and forces the monetary authority to react with higher interest rates if price stability is their main objective. Higher costs of debt lead to a loss for highly indebted countries through the interest rate channel. Therefore, the importance of various transmission channels depends on each country and the union's and central bank's behavior (Corsetti et al. (2019)). Therefore, I identify the regime mixes as multiple partial equilibria. I take the regime for each country in combination with the states of the aggregate union and monetary authority. Considering these three players that determine the regime mix in each country in a certain period yields new insights into the influence of regime interdependence on the size of multipliers.

Aside from the transmission channels, the introduction of multiple fiscal policies yields new insight into the determinacy of the model. Taylor (1993) argued for strong inflation targeting to guarantee determinacy in models such that a stable and unique equilibrium exists. However, a large strand of literature found ways to circumvent this necessity with either different monetary policy specifications (Barnett and Eryilmaz (2023)), the inclusion of time variation (Davig and Leeper (2007), Foerster (2016), Barthelemy and Marx (2017), Roulleau-Pasdeloup (2020)) or learning processes (Bullard and Mitra (2007)). Whereas, Barthelemy and Marx (2019) show that there can be indeterminacy despite the Taylor principle when the switching regimes are too different.

Another way to ease the requirements for the central bank is to include fiscal policy. Usually, to guarantee determinacy, fiscal policy needs to adjust with its surplus to any changes in the price level, which is fully determined by the monetary authority (Schmitt-Grohe and Uribe (2000)). According to the *Fiscal Theory of the Price Level* (FTPL), however, the fiscal policy can take over and determine the price level through its budget constraint (i.e., Woodford (1995), Sims (1994) and Cochrane (2001)). Hence, following the theory, rather than on the central bank alone, it depends on the mix between fiscal and monetary behavior whether the model paths are explosive or stable (Leeper (1991), Woodford (2000) and Woodford (2001)). Thus, the coordination of the authorities involved is crucial to guarantee stability (Bullard and Schaling (2009), Canzoneri et al. (2010)).

This Chapter will extend the literature by first introducing openness through a two-country New Keynesian Model as in Jensen and Beetsma (2002) and Barnett and Eryilmaz (2023), secondly covering the effect of automatic stabilizers in this framework, and third, explaining the impact of the resulting equilibria on fiscal multipliers. As Bergin (1997), I find three stable regime mixes, one with monetary dominance and two with fiscal dominance. Hence, not every member needs to be fiscally solvent to guarantee stability in its paths (Sims (1997), Bergin (2000)). Since in a two-country model and two fiscal authorities, each can pin down the price level as in the FTPL. Furthermore, as in Colciago et al. (2008), I show that automatic stabilizers can effectively complement and even compensate monetary policy. Using these results, I measure the impact of the three stable regime mixes on the efficacy of fiscal multipliers (closed economy: Beck-Friis and Willems (2017), Davig and Leeper (2011)). Regarding the previous empirical analysis, I will not restrict the analysis to national multipliers but will focus on spillover effects across countries and the union. Lastly, this Chapter identifies different regime periods for chosen countries and detects explosive periods during the sovereign debt crisis for Greece, Portugal, and Ireland.

Chapter 3 of this dissertation is structured as follows: I will first present the two-country New Keynesian DSGE Model and the different monetary and fiscal policy specifications. A sub-chapter about the calibration of the model accompanies this. Chapter 3.3 will cover the determinacy analysis of monetary-fiscal interactions and describe its parameter dependence. Using these results, I identify the stable and explosive periods for selected countries in the following chapter 3.4. In Chapter 3.5, I will finish with a simulation of government spending shocks and their efficacy within stable equilibria.

3.2 Model

My model adopts the two-country open economy framework proposed by Rabanal (2009) and Lubik and Schorfheide (2005), which simulates the European Monetary Union using two open countries. Specifically, I present the system of equations for the home country, representing one union member. I define both countries as symmetric; however, in contrast to Gali and Monacelli (2005), they differ in parameters. A star in the exponent distinguishes foreign from domestic variables. Given the high level of inner European trade, a two-country model is appropriate to capture the relevant channels. However, it is worth noting that including extra-EU trade would significantly impact the resulting multipliers for some countries. I exclude non-tradable goods, as in Lubik and Schorfheide (2005), and introduce an endogenous government sector in both countries, which is essential for my analysis.

3.2.1 Households

The following describes the behavior of households in both countries.

Preferences

Households maximize a standard CRRA utility function consisting of a consumption C_t and labor L_t,

$$E_t \sum_{i=0}^{\infty} \beta^i \Big[\frac{(C_{t+i})^{1-\sigma}}{1-\sigma} - \frac{(L_{t+i})^{1+\omega}}{1+\omega} \Big] \tag{3.1}$$

with β as the inter-temporal discount factor, σ as the inter-temporal inverse elasticity of substitution and ω defining the inverse elasticity of intra-temporal substitution. Agents seek to maximize their lifetime utility over an infinite horizon with respect to the following budget constraint, which equates their net labor income and return to governmental bonds with their expenditures,

$$C_t + \frac{B_t}{P_t} \leq \frac{W_t}{P_t} L_t + \frac{(1+R_{t-1})B_{t-1}}{P_t}. \tag{3.2}$$

The channel for inter-temporal substitution works through government bonds, described by B_t, divided by the national price level P_t, and yield a nominal return of R_t, which the central bank sets. Maximizing 3.1 with respect to the budget constraint 3.2 of the representative agent yields the following optimality conditions describing the household's intra- and inter-

temporal behavior:

$$L_t^{\omega} = \frac{W_t}{P_t} C_t^{-\sigma} \tag{3.3}$$

$$C_t^{-\sigma} = \beta E_t \big[C_{t+1}^{-\sigma} (1 + R_t) \frac{P_t}{P_{t+1}} \big]. \tag{3.4}$$

Both equations describe the inter- and intra-temporal optimal behavior of the rational agents. Hence, equation 3.3 describes equality conditions for the marginal utility and disutility of labor. This ensures the household's indifference between labor and leisure within each period. By introducing distortionary income taxes, fiscal policy directly affects real labor supply and, thereby, consumption. Thus, a higher tax rate causes a negative wealth effect on leisure and consumption, amplified by the negative substitution effect. Equation 3.4 describes the agent's optimal inter-temporal consumption path, which depends on the interest rate R_t. As the central bank sets it, the nominal interest rate is equal across both countries. However, the real return can vary.

Log linearizing both equations then yields the following expressions in deviations from their steady state,

$$c_t = E_t[c_{t+1}] - \frac{1}{\sigma}(r_t - E_t[\pi_{t+1}]) \tag{3.5}$$

$$\omega l_t = w_t - \sigma c_t, \tag{3.6}$$

where all variables are displayed in their real terms. By using their optimality conditions, households determine the optimal size of a consumption basket. Hence, a change in taxes or interest rates directly affects aggregate private demand. As the consumption index C_t then consists of domestically produced and imported products weighted by their share and the elasticity of substitution, a shock transfers accordingly. Thus the overall aggregate consumption in both countries sums up to,

$$C_t = \Big[(1-\lambda)^{\frac{1}{\nu}} (C_t^H)^{\frac{\nu-1}{\nu}} + \lambda^{\frac{1}{\nu}} (C_t^F)^{\frac{\nu-1}{\nu}} \Big]^{\frac{\nu}{\nu-1}}. \tag{3.7}$$

and

$$C_t^* = \Big[\lambda^{*\frac{1}{\nu}} (C_t^{H*})^{\frac{\nu-1}{\nu}} + (1-\lambda^*)^{\frac{1}{\nu}} (C_t^{F*})^{\frac{\nu-1}{\nu}} \Big]^{\frac{\nu}{\nu-1}}. \tag{3.8}$$

The superscript H and F for home and foreign define the two kinds of consumption. The value of $(1-\lambda)$ (i.e., $(1-\lambda^*)$) indicates the level of home bias or the degree to which households prefer domestically produced goods over imported ones. Both firms produce a variety of goods, which are substituted based on the parameter ν. This price elasticity ν shows how responsive these consumption choices are toward price changes.

Consumption Choice

The consumption of home and foreign-produced goods consists of a continuum of slightly different products which are imperfectly substitutable according to Dixit-Stiglitz's monopolistic competition. This setup ensures each producer some market power among their goods:

$$C_t^H = \Big[\Big(\frac{1}{s}\Big)^{\frac{1}{\nu}} \int_0^s c_t(h)^{\frac{\nu-1}{\nu}} dh \Big]^{\frac{\nu}{\nu-1}}; \quad C_t^F = \Big[\Big(\frac{1}{1-s}\Big)^{\frac{1}{\nu}} \int_s^1 c_t(f)^{\frac{\nu-1}{\nu}} dh \Big]^{\frac{\nu}{\nu-1}}. \tag{3.9}$$

Simultaneously, for the foreign country, it holds that,

$$C_t^{H*} = \Big[\Big(\frac{1}{s}\Big)^{\frac{1}{\nu}} \int_0^s c_t^*(h)^{\frac{\nu-1}{\nu}} dh\Big]^{\frac{\nu}{\nu-1}}; \quad C_t^{F*} = \Big[\Big(\frac{1}{1-s}\Big)^{\frac{1}{\nu}} \int_s^1 c_t^*(f)^{\frac{\nu-1}{\nu}} dh\Big]^{\frac{\nu}{\nu-1}}. \tag{3.10}$$

The index notation of h for home and f for foreign describe whether a single variety of consumption good c_t is produced domestically or in the foreign market. The parameter s $((1-s))$ defines the size of each country and, thus, also the size of the domestic (foreign) market. The elasticity of goods substitution, the home bias, and the size of the market significantly impact the effect of price differentials and, consequently, on trade between both countries. The demand for single varieties in home and foreign country evolve as,

$$c_{jt}^H = \Big(\frac{p_{jt}^H}{P_t}\Big)^{-\nu}\Big(\frac{1}{s}\Big)^{\chi} C_t^H; \quad c_{jt}^F = \Big(\frac{p_{jt}^F}{P_t}\Big)^{-\nu}\Big(\frac{1}{1-s}\Big)^{\chi} C_t^F. \tag{3.11}$$

$$c_{jt}^{H*} = \Big(\frac{p_{jt}^H}{P_t^*}\Big)^{-\nu}\Big(\frac{1}{s}\Big)^{\chi} C_t^{H*}; \quad c_{jt}^{F*} = \Big(\frac{p_{jt}^F}{P_t^*}\Big)^{-\nu}\Big(\frac{1}{1-s}\Big)^{\chi} C_t^{F*}. \tag{3.12}$$

which depend on the relative prices of foreign and home-produced goods to the aggregate price level within the country. Hence, consumption declines with each variety's sector-specific relative price level and the value of s, both weighted by the elasticity ν. Additionally the consumption of a domestic or foreign variety is influenced by the elasticity of substitution among these χ. Rewriting these equations, I then receive the demand functions for both countries by type of origin as,

$$C_t^H = (1-\lambda)\big(\frac{P_t^H}{P_t}\big)^{-\nu} C_t, \tag{3.13}$$

$$C_t^F = \lambda\big(\frac{P_t^F}{P_t}\big)^{-\nu} C_t \tag{3.14}$$

$$C_t^{H^*} = \lambda^*\big(\frac{P_t^H}{P_t^*}\big)^{-\nu} C_t^*, \tag{3.15}$$

$$C_t^{F^*} = (1-\lambda^*)\big(\frac{P_t^F}{P_t^*}\big)^{-\nu} C_t^*. \tag{3.16}$$

The consumption of domestic and foreign households for domestically produced goods is then captured by C_t^H and C_t^{H*} and for foreign goods through C_t^F and C_t^{F*}. The demand for these goods declines in the relative price of the goods price level relative to the aggregate CPI in the respective country P_t and P_t^*. These indices are constructed by a weighted average of the imported and domestic price levels given by

$$P_t = \big[(1-\lambda)(P_t^H)^{1-\nu} + \lambda(P_t^F)^{1-\nu}\big]^{\frac{1}{1-\nu}} \tag{3.17}$$

$$P_t^* = \big[\lambda^*(P_t^H)^{1-\nu} + (1-\lambda^*)(P_t^F)^{1-\nu}\big]^{\frac{1}{1-\nu}} \tag{3.18}$$

Due to trade relations, goods, and their price level are imported into the partner country. Thus, the difference between the price level of domestic (foreign) production from the country's aggregate CPI increases in λ (λ^*). Since the foreign country represents the rest of the union, λ is significantly larger than λ^*, which creates a relatively large dependence on foreign goods prices. Hence, price level spillovers can be observed mostly from the union and less from the single member and differences in price levels across countries increase in

the home bias. In log linearized form we can transform 3.17 and 3.18 to

$$\pi_t = (1-\lambda)\pi_t^H + \lambda\pi_t^F \tag{3.19}$$

$$\pi_t^* = \lambda^*\pi_t^H + (1-\lambda^*)\pi_t^F, \tag{3.20}$$

thus, both CPIs are a weighted average of the different goods' price levels.

Trade Channel and International Risk Sharing

The trade channel between both countries is an important mechanism in open economies since the terms of trade play a crucial role in affecting a country's economy. Thus, I define the relative competitiveness of each country by the relative difference between the prices of foreign and domestically produced goods, such that

$$Q_t = \frac{P_t^F}{P_t^H}. \tag{3.21}$$

where a value larger than one indicates a gain in terms of trade for the domestic country. Since there is no price discrimination and only one currency, the law of one price has to hold such that the prices of the goods are the same in both countries. International risk sharing across both countries guarantees that the real exchange rate (RER_t) is,

$$RER_t = \frac{C_t^{*-\sigma^*}}{C_t^{-\sigma}} = \frac{P_t^*}{P_t} \tag{3.22}$$

where the ratio of marginal consumption needs to equal the relative price, such that no arbitrage is possible and goods are worth the same across countries. This can be derived using the Euler equations from both countries, given that the nominal interest rate is the same under the central monetary policy. The marginal utility must be equalized in equilibrium, as the price level will be the same throughout the union. Whenever domestic inflation increases, with diminishing marginal returns, foreign consumption must surpass domestic demand to maintain balance. Log-Linearizing the previous equation around the steady state, I get,

$$c_t = \frac{1}{\sigma} rer_t + \frac{\sigma^*}{\sigma} c_t^* \tag{3.23}$$

Combining 3.23 with equations 3.19 and 3.20 and using 3.13 to 3.16 to substitute for consumption, I get an expression for the exchange rate in dependence on the terms of trade, given by

$$rer_t = (1-\lambda-\lambda^*)q_t. \tag{3.24}$$

Hence, with greater shares of imports in both countries, the difference between both variables increases. In the case of closed economies, the real exchange rate would be equal to the terms of trade.

3.2.2 Firms

In both countries, monopolistic competitive firms produce tradable goods for domestic consumption and export. I restrict the notation to the home country since the optimization

problem is symmetric for the rest of the union. Firms produce at constant returns to scale using labor as the only input factor,

$$y_t^H = AL_t \tag{3.25}$$

where A denotes a constant parameter for productivity. I use price rigidities to induce market imperfections, a la Calvo (1983), where only a share $(1-\theta)$ of firms can adjust prices in response to marginal cost variation in a certain period. Thus, money loses its neutrality, and monetary policy has real implications.

Firms seek to maximize their expected present value of future profits, considering the possibility of price adaptions in some periods. Therefore, the optimal price level does not just equal the marginal costs of labor, weighted by the firms' market power, as in the fully price-flexible economy but takes into account the imperfect and inter-temporal structure of the optimization problem. Hence, they maximize,

$$Max_{p_t^H(n)} E_t \sum_{k=0}^{\infty} \theta_H^k \beta^k \frac{C_{t+1}}{C_t}^{-\sigma} \left[\left(\frac{p_t^H(n)(\frac{P_{t+k-1}^H}{P_{t-1}^H})}{P_{t+k}} - MC_{t+k}^N \right) y_{t+k}^{H,d}(n) \right], \tag{3.26}$$

subject to their variety of demand functions for home-produced goods:

$$y_{t+k}^{H,d}(n) = \frac{1}{s} \left[\frac{p_t^H(n)}{P_{t+k}^H} \left(\frac{P_{t+k-1}^H}{P_{t-1}^H} \right) \right]^{-\sigma} Y_{t+k}^H, \tag{3.27}$$

which depends on the respective good's relative price level and willingness to substitute across them. The higher their price, the lower the share of overall demand for these goods. Solving this maximization problem yields the relative variety's price for domestic firms as

$$\frac{\bar{p_t}^H}{P_t^H} = \frac{\nu}{\nu - 1} E_t \left[\frac{\sum_{k=0}^{\infty} \beta^k \theta^k \mu_{t+k} \left(\prod_{s=1}^{k} \frac{(\Pi_{t+s-1}^H)}{\Pi_{t+s}^H} \right)^{-\nu} \frac{MC_{t+k}^N P_{t+k}}{P_{t+k}^H} Y_{t+k}}{\sum_{k=0}^{\infty} \beta^k \theta^k \mu_{t+k} \left(\prod_{s=1}^{k} \frac{(\Pi_{t+s-1}^H)}{\Pi_{t+s}^H} \right)^{1-\nu} Y_{t+k}} \right], \tag{3.28}$$

with nominal marginal costs of $MC_t^N = \frac{W_t}{A}$. Firms base their decisions on changes in the real marginal costs $MC_t^R = \frac{W_t}{A} \frac{P_t}{P_t^H}$, which are expressed in relative domestic goods prices. At the same time, this creates wage dispersion as agents observe them in terms of the CPI. μ defines the marginal utility of aggregate consumption in the home country. In a flexible price environment, no inter-temporal structure is necessary, and the optimal price would equal the marginal costs, including the price markup for imperfect substitutability.

The aggregate price index of domestically produced goods, taking into account the rigidities then yields,

$$P_t^H = [\theta (P_{t-1}^H)^{1-\sigma} + (1-\theta) \bar{p_t^H}^{1-\sigma}]^{\frac{1}{1-\sigma}}. \tag{3.29}$$

Under full flexibility, the aggregate price level of those goods would equal the optimal price since all firms could choose accordingly. In the foreign country, firms face the same problem, but the share of firms that cannot adapt their prices is θ^*. Log-linearizing the solution to the maximization problem 3.28 and combining it with the linearized expression of 3.29, I

get,

$$\pi_t^H = \beta E_t[\pi_{t+1}^H] + \frac{(1-\theta_H)}{\theta_H}(1-\beta\theta_H)(mc_t), \tag{3.30}$$

with the definition of the marginal costs from the inter-temporal optimality equation from the households,

$$mc_t = w_t - t_t^H, \tag{3.31}$$

where $t_t^H = p_t^H - p_t$ thus, states the relative price of home goods. For the foreign country, this is symmetrical with,

$$\pi_t^F = \beta E_t[\pi_{t+1}^F] + \frac{(1-\theta_F)}{\theta_F}(1-\beta\theta_F)(mc_t^*) \tag{3.32}$$

$$\text{and } mc_t^* = w_t^* - t_t^{F*}, \text{ with } t_t^{F*} = p_t^F - p_t^*. \tag{3.33}$$

Due to the introduced rigidities, prices adapt slowly towards any changes in the marginal costs in both countries. While the firms have a direct impact only on their own prices p_t^H and p_t^F, marginal costs are to increase with greater aggregate CPI. Households demand imported and domestic products and require larger wages even when only foreign prices increase. This implies the possibility for price increases even when domestic goods are not facing greater demand.

3.2.3 Monetary Policy

For the behavior of monetary policy, I differentiate between two different specifications. One with output stabilization efforts and one without it. While the monetary authority is responsible for aggregate price level stability, it sets the nominal interest rate R_t. Hence, more generally, the policy rule is a standard Taylor rule, which can react toward deviations in the union-wide inflation rate and the union's output. The central bank follows the linearized policy rule as follows,

$$r_t = \rho_\pi \pi_t^{EMU} + \rho_y y_t^{EMU}. \tag{3.34}$$

Thereby, the reaction coefficient towards output ρ_y might be set to zero in some specifications of this chapter. Equation 3.34 shows that the monetary channel is inflexible. The ECB does not react directly to changes in domestic inflation or output but only to aggregate changes, such that the perceived effect deviates from the actual. This effect comes through the centralization of the monetary authority dealing with multiple independent countries at once. Thus, their decision is more or less independent of country-specific shocks and individual deviations from steady state. Instead, the reaction of the interest rate is based upon a weighted average price level of the whole union,

$$P_t^{EMU} = P_t^s (P_t^*)^{1-s}, \tag{3.35}$$

which can be linearized and combined with the reaction toward the union-wide output gap,

$$\pi_t^{EMU} = s\pi_t + (1-s)\pi_t^* \tag{3.36}$$

$$y_t^{EMU} = sy_t + (1-s)y_t^*, \tag{3.37}$$

where s can be interpreted as the relative economic strength. Therefore, a larger value of the parameter s indicates a greater influence of the respective country on the monetary policy implications, resulting in a higher level of alignment between the required and actual reaction. Contrary to a conventional open economy model, the interest rate may not respond to inflationary pressure in each economy, despite the central bank's inflation targeting. Thus, a lower λ^* or s in my model allows single countries to experience declining real interest rates as national inflation increases despite inflation targeting monetary policy.

3.2.4 Government

As government spending is restricted to domestic consumption goods only, it evolves as a simple AR(1) process with identical and independently distributed error terms,

$$g_t = \rho_g g_{t-1} + \epsilon_t^g + \epsilon_t^{gU}, \tag{3.38}$$

$$\epsilon_t^g \sim i.i.d.N(0, \sigma_g^2), \quad \epsilon_t^{gU} \sim i.i.d.N(0, \sigma_{gU}^2) \tag{3.39}$$

where all variables are expressed in deviations from their steady state. ϵ_t^g defines country-specific shocks and ϵ_t^{gU} government spending shocks that affect both countries so act on a union-wide level. Moreover, union-wide measures become more important with greater interdependence between the countries. Similarly to households' consumption, governments choose from a continuum of varieties, given by,

$$G_t^H = \Big[\int_0^s g_t(h)^{\frac{\nu-1}{\nu}} dh \Big]^{\frac{\nu}{\nu-1}}; \tag{3.40}$$

where again ν defines their substitutability. Like monetary policy, I allow fiscal policy to differ between policy rule specifications: The first will cover the temporary spending shock without any stabilization efforts, the second will stabilize simply by adapting taxes towards debt, and the third will follow a full specification including automatic stabilization.

1. Government spending is solely financed by debt; thus, there are no stabilization efforts and no taxes within the economy ($\tau_t = 0$). Hence, the budget evolves according to

$$G_t = \frac{B_t}{P_t} - \frac{(1 + R_{t-1})B_{t-1}}{P_t}. \tag{3.41}$$

Thus, a non-negative interest rate will imply a stable path for government debt. Fiscal policy will not alter their behavior towards debt or government spending. The only channel through which fiscal policy changes macroeconomic variables is the temporary government spending shock.

2. Government Spending is financed through debt and taxes. Hence, stabilization is introduced by the change of taxes. The government is then constraint by the following flow budget constraint:

$$G_t = \tau_t w_t L_t + \frac{B_t}{P_t} - \frac{(1 + r_{t-1})B_{t-1}}{P_t}. \tag{3.42}$$

Thus, the expenditures and the costs for existing debt can be financed by tax revenues and new debt. Iterating on equation 3.42 and expressing the surplus S_t as the difference between

tax revenue and spending, the real bond holdings can be expressed as,

$$\frac{B_t}{P_t} = \sum_{i=0}^{N} \frac{S_{t+i}}{(1+R_t)^i} + \frac{B_{t+N}}{P_{t+N}((1+R_t)^i)} \tag{3.43}$$

When N goes to infinity, the last term approaches zero, so the present value of surpluses equals the current liabilities to guarantee stability. Moreover, the increase in government spending in period t leads to a decrease in primary surpluses when an increase in tax revenue does not fully finance them.

Creating some fiscal-monetary interaction, I rely on the definition from Davig and Leeper (2011) that focuses on whether governments were fulfilling budget balance through surpluses with taxes as their main instrument. However, in contrast to the previous work, taxes are not lump sum but distortionary income taxes. For the first case, I restrict fiscal policy to behave according to,

$$\tau_t = \gamma_b b_t + \gamma_g g_t + \epsilon_t^\tau \tag{3.44}$$

$$\epsilon_t^\tau \sim i.i.d.N(0, \sigma_t^2). \tag{3.45}$$

Thus, taxes respond to the increase in spending and show debt reduction efforts to satisfy the budget constraint.

3. Government is financed by debt and spending, and automatic stabilizers are in place; thus, I keep the budget constraint the same as in case 2 but extend the policy rule. By including automatic stabilizers, there are now more ways to satisfy the budget balance.

$$\tau_t = \gamma_y y_t + \gamma_b b_t + \gamma_g g_t + \epsilon_t^\tau \tag{3.46}$$

$$\epsilon_t^\tau \sim i.i.d.N(0, \sigma_t^2). \tag{3.47}$$

Equation 3.46 characterizes fiscal policy in each country, wherein the tax rate adjusts in response to changes in output, debt level, and government expenditures.

Depending on the size of the coefficient, fiscal policy is switching between a state where it passively takes the price level as given and adjusts the surplus to meet the budget and one where it actively pins down the price level, which often is referred to as the *Fiscal Theory of the Price Level*. This theory allows multiple equilibria for joint monetary and fiscal interaction. Since this model features two open economies, the interaction with the monetary authority differs significantly. All equations are symmetric in the foreign country.

3.2.5 Equilibrium

Monetary Stabilization

The demand for domestically and foreign-produced goods from both countries as well as government consumption, then sums up to the overall production in the respective country

as in,

$$Y_t = C_t^H + C_t^{H*} + G_t \tag{3.48}$$
$$Y_t^* = C_t^F + C_t^{F*} + G_t^* \tag{3.49}$$

where G_t and G_t^* define the government consumption of each country and are restricted to consuming its own goods only. Log-Linearizing the aggregate market clearing conditions for the goods market yields the following expressions,

$$y_t = (1-\eta)[(1-\lambda)c_t^H + (\lambda)c_t^{H*}] + \eta g_t \tag{3.50}$$
$$y_t^* = (1-\eta^*)[(\lambda^*)c_t^F + (1-\lambda_t^*)c_t^{F*}] + \eta g_t^*, \tag{3.51}$$

where η and η^* define the share of government spending in the overall output generated by each country. Using the aggregate demand in equation 3.50 (3.51) and combining it with the log linearized expression of the equations in 3.11 and 3.12 and substituting c_t^* and rer_t through 3.23 and 3.24, I get

$$\begin{aligned} y_t = (1-\eta)(1-\lambda+\lambda\frac{\sigma}{\sigma^*})c_t + \\ +(1-\eta)\lambda(\nu-\nu(1-\lambda-\lambda^*)-\frac{1}{\sigma^*}(1-\lambda-\lambda^*))q_t + \eta g_t \end{aligned} \tag{3.52}$$

and for the foreign country, it follows that,

$$\begin{aligned} y_t^* = (1-\eta^*)(1-\lambda^*+\lambda^*\frac{\sigma^*}{\sigma})c_t^* + \\ +(1-\eta^*)\lambda^*((\frac{1}{\sigma}-\nu)(1-\lambda-\lambda^*)-\nu)q_t + \eta^* g_t^* \end{aligned} \tag{3.53}$$

since $t_t^{H*} = t_t^H - rer_t$ and $t_t^H = -\lambda q_t$ and simultaneously, $t_t^F = t_t^{F*} + rer_t$ and $t_t^{F*} = \lambda^* q_t$. To receive the output only in dependence on consumption and the terms of trade q_t. With symmetric countries (λ=λ^*) and no government spending, the multiplier in front of the domestic consumption would be one. Solving this expression in response to c_t and inserting this into the inter-temporal optimality condition 3.5, then gives the IS curve for the domestic country,

$$\begin{aligned} (\frac{a}{(1-\eta)}+\frac{\rho_y s}{\sigma})y_t - \frac{a\eta}{(1-\eta)}g_t - \lambda b(1-\eta)q_t = \\ = \frac{a}{(1-\eta)}E_t[y_{t+1}] - \frac{a\eta}{(1-\eta)}E_t[g_{t+1}] - \lambda b(1-\eta)E_t[q_{t+1}] - \frac{\rho_\pi}{\sigma}((s(1-\lambda)+(1-s)\lambda^*)\pi_t^H + \\ +(s\lambda+(1-s)(1-\lambda^*))\pi_t^F) + \frac{\rho_y}{\sigma}(1-s)y_t^* - \frac{(1-\lambda)}{\sigma}E_t[\pi_{t+1}^H] - \frac{\lambda}{\sigma}E_t[\pi_{t+1}^F] \end{aligned} \tag{3.54}$$

where $a = (1-\lambda+\lambda\frac{\sigma}{\sigma^*})^{-1}$ and $b = a(\nu-\nu(1-\lambda-\lambda^*)-\frac{1}{\sigma^*}(1-\lambda-\lambda^*))$. This IS curve then sets the expected change in output to changes in government spending, foreign output, inflation, and trade terms. The latter can be rewritten in differences and substituted by the

fact that $q_t - q_{t-1} = \pi_t^F - \pi_t^H$, which gives me,

$$\begin{aligned}(\frac{a}{(1-\eta)} + \frac{\rho_y s}{\sigma})y_t = \frac{a}{(1-\eta)}E_t[y_{t+1}] + \frac{a\eta}{(1-\eta)}(1-\rho^g)g_t - \\ -(\frac{\rho_\pi}{\sigma}((s(1-\lambda)+(1-s)\lambda^*)\pi_t^H + (s\lambda+(1-s)(1-\lambda^*))\pi_t^F)) - \\ -\frac{\rho_y(1-s)}{\sigma}y_t^* + (\frac{(1-\lambda)}{\sigma}(1-\lambda)+\lambda b)E_t[\pi_{t+1}^H] + (\frac{\lambda}{\sigma}-\lambda b)E_t[\pi_{t+1}^F] \end{aligned} \tag{3.55}$$

Using equation 3.23 and 3.24 together with expressions 3.50 and 3.51 to substitute for c_t and c_t^*, I get the value for the terms of trade q_t in terms of output, government spending

$$q_t = \frac{\sigma a f}{1-\eta}y_t - \frac{\eta\sigma a f}{1-\eta}g_t - \frac{\sigma^* a^* f}{1-\eta^*}y_t^* + \frac{\eta^*\sigma^* a^* f}{1-\eta^*}g_t^* \tag{3.56}$$

where $a^* = (1-\lambda^*+\lambda^*\frac{\sigma^*}{\sigma})^{-1}$, $b^* = a^*((\frac{1}{\sigma}-\nu)(1-\lambda-\lambda^*)-\nu)$ and $f = ((1-\lambda-\lambda^*)+\sigma b\lambda - \sigma^* b^*\lambda^*)^{-1}$. The equation for the terms of trade can then be inserted into the foreign demand equation 3.53 to substitute q_t and then use the expression of 3.23 to substitute c_t^*. Use the inter-temporal expression of q_t such that,

$$\frac{\sigma^* a^*}{\sigma a}\Delta y_t^* = \frac{1-\eta^*}{1-\eta}\Delta y_t - \frac{1-\eta^*}{1-\eta}\eta\Delta g_t + \frac{\sigma^* a^*}{\sigma a}\eta^*\Delta g_t^* - \frac{1-\eta^*}{\sigma a f}\pi_t^F + \frac{1-\eta^*}{\sigma a f}\pi_t^H. \tag{3.57}$$

Equation 3.56 describes the real exchange rate process in terms of foreign and domestic output, fiscal consumption and inflation.

To get the Philips Curves, I first substitute the production function for labor and c_t (c_t^*) with equation 3.52 (3.53) such that the marginal costs can be expressed by,

$$mc_t = w_t - t_t^H = (\omega + \frac{\sigma a}{1-\eta})y_t - \lambda(\sigma b - 1)q_t - \frac{\sigma\eta a}{1-\eta}g_t \tag{3.58}$$

$$mc_t^* = w_t^* - t_t^{F*} = (\omega^* + \frac{\sigma^* a^*}{1-\eta^*})y_t^* + \lambda^*(1-\sigma^* b^*)q_t - \frac{\sigma^* a^s \eta^*}{1-\eta^*}g_t^* \tag{3.59}$$

To get rid of the terms of trade, I then insert equation 3.56 and insert the resulting marginal cost functions into the optimality condition in 3.30 and 3.32 regarding the price setting from the firms' problem. This gives me the Phillips curves of both countries.

$$\begin{aligned}\pi_t^H = \beta E_t[\pi_{t+1}^H] + \frac{(1-\theta_H)}{\theta_H}(1-\beta\theta_H)[(\omega + \frac{\sigma a}{1-\eta}(1+f\lambda(1-b\sigma)))y_t - \\ -(\frac{\sigma a\eta}{1-\eta}(1+\lambda f(1-b\sigma)))g_t - (f\lambda(1-b\sigma))\frac{\sigma^* a^*}{1-\eta^*}y_t^* + (\lambda f(1-\sigma b))\frac{\eta^* a^* \sigma^*}{1-\eta^*}g_t^*] \end{aligned} \tag{3.60}$$

$$\begin{aligned}\pi_t^F = \beta^* E_t[\pi_{t+1}^F] + \frac{(1-\theta_F)}{\theta_F}(1-\beta^*\theta_F)[(\omega^* + \frac{\sigma^* a^* h^*}{1-\eta^*}(1+\lambda^* f(1+\sigma^* b^*)))y_t^* - \\ -\frac{\sigma^* a^* \eta^*}{1-\eta^*}(1+f\lambda^*(1+b^*\sigma^*))g_t^* + (\lambda^* f(1+\sigma^* b^*))\frac{\eta\sigma a}{1-\eta}g_t - (\lambda^* f(1+\sigma^* b^*))\frac{\sigma a}{1-\eta}y_t] \end{aligned} \tag{3.61}$$

Thus, the model spans by the four equations 3.55, 3.57, 3.60 and 3.61, as well as the

government spending processes:

$$\frac{a}{(1-\eta)}E_t[y_{t+1}] + \frac{a\eta}{(1-\eta)}(1-\rho^g)g_t - \frac{\rho_y(1-s)}{\sigma}y_t^* + \\ +(\frac{(1-\lambda)}{\sigma}(1-\lambda)+\lambda b)E_t[\pi_{t+1}^H] + (\frac{\lambda}{\sigma}-\lambda b)E_t[\pi_{t+1}^F] = \\ (\frac{a}{(1-\eta)}+\frac{\rho_y s}{\sigma})y_t + (\frac{\rho_\pi}{\sigma}((s(1-\lambda)+(1-s)\lambda^*)\pi_t^H + (s\lambda+(1-s)(1-\lambda^*))\pi_t^F)) \tag{3.62}$$

$$\frac{\sigma^* a^*}{\sigma a}y_t^* + \frac{1-\eta^*}{1-\eta}\eta g_t - \frac{\sigma^* a^*}{\sigma a}\eta^* g_t^* = \frac{\sigma^* a^*}{\sigma a}y_{t-1}^* + \frac{1-\eta^*}{1-\eta}y_t - \frac{1-\eta^*}{1-\eta}x_t + \\ +\frac{1-\eta^*}{1-\eta}\eta g_{t-1} - \frac{\sigma^* a^*}{\sigma a}\eta^* g_{t-1}^* - \frac{1-\eta^*}{\sigma a f}\pi_t^F + \frac{1-\eta^*}{\sigma a f}\pi_t^H \tag{3.63}$$

$$-\beta E_t[\pi_{t+1}^H] = -\pi_t^H + \frac{(1-\theta_H)}{\theta_H}(1-\beta\theta_H)[(\omega+\frac{\sigma a}{1-\eta}(1+h*\lambda(1-b\sigma)))y_t - \\ -(\frac{\sigma a\eta}{1-\eta}(1+\lambda*h(1-b\sigma)))g_t - (h*\lambda(1-b\sigma))\frac{\sigma^* a^* f}{1-\eta^*}y_t^* + (\lambda h(1-\sigma b))\frac{\eta^* a^* \sigma^* f}{1-\eta^*}g_t^*] \tag{3.64}$$

$$-\beta^* E_t[\pi_{t+1}^F] = -\pi_t^F + \frac{(1-\theta_F)}{\theta_F}(1-\beta^*\theta_F)[(\omega^*+\frac{\sigma^* a^* h^*}{1-\eta^*}(1+\lambda^* h(1+\sigma^* b^*)))y_t^* - \\ -\frac{\sigma^* a^* \eta^*}{1-\eta^*}(1+h\lambda^*(1+b^*\sigma^*))g_t^* + (\lambda^* h(1+\sigma^*+b^*))\frac{\eta\sigma a}{1-\eta}g_t - (\lambda^* h(1+\sigma^* b^*))\frac{\sigma a}{1-\eta}y_t] \tag{3.65}$$

$$g_t = \rho_g g_{t-1} + \epsilon_t^g \tag{3.66}$$

$$g_t^* = \rho_g g_{t-1}^* + \epsilon_t^{g*} \tag{3.67}$$

$$x_{t+1} = y_t \tag{3.68}$$

where $\Delta E[g_{t+1}]$ was substituted by the fact that $E[\epsilon_t^g] = 0$. Ans since domestic output y_t follows a second order difference equation I substitute the realization in period $t-1$ through a contemporaneous variable x_t. This way all variables are transformed into first order difference equations.

Adding Fiscal Stabilization

When including a Taylor-style fiscal policy rule and distortionary taxes to finance part of government spending, the equilibrium conditions offer new insight into the model. According to equation 3.46 taxes respond to output, debt, and government spending. Furthermore, adding taxes to the model extends the government flow budget constraint to 3.42. This add-on yields new results for the marginal cost equation since instead of 3.6 we now have,

$$\omega l_t = w_t - \frac{\tau}{1-\tau}\tau_t - \sigma c_t \tag{3.69}$$

and vice versa for the foreign country. Then including the policy rule 3.42 the marginal cost function changes to,

$$mc = (\omega + \frac{\gamma_y \tau}{1-\tau} + \frac{\sigma a}{1-\eta} + (1-\sigma b)\lambda \frac{\sigma a h}{(1-\eta)})y_t + \frac{\tau \gamma_b}{1-\tau} b_{t-1} + \frac{\gamma_g \tau}{1-\tau} + \\ +(1-\sigma * b)\lambda \eta^* \frac{\sigma^* a^* h}{(1-\eta^*)} g_t^* - \sigma a \frac{\eta}{(1-\eta)} - (1-\sigma b)\lambda \frac{\eta \sigma a h}{(1-\eta)} g_t - (1-\sigma b)\lambda \frac{\sigma^* a^* h}{(1-\eta^*)} y_t^* \tag{3.70}$$

and for the foreign country,

$$mc_t^* = (\omega^* + \frac{\tau^* \gamma_y^*}{(1-\tau^*)} + \frac{\sigma^* a^*}{1-\eta^*} + (1+\sigma^* b^*)\lambda^* \frac{\sigma^* a^* h}{(1-\eta^*)})y_t^* + \frac{\tau^* \gamma_b^*}{1-\tau^*} b_{t-1}^* + \\ +(1+\sigma^* b^*)\lambda^* \frac{\eta \sigma a h}{(1-\eta)} g_t + (\frac{\tau^* \gamma_g^*}{(1-\tau^*)} - \frac{\sigma^* a^s \eta^*}{1-\eta^*} - \\ -(1+\sigma^* b^*)\lambda^* \frac{\eta^* \sigma^* a^* h}{(1-\eta^*)}) g_t^* - (1+\sigma^* b^*)\lambda^* \frac{\sigma a h}{(1-\eta)} y_t \tag{3.71}$$

Hence, the marginal costs now depend on the behavior of fiscal policy and are increasing in all three variables. The other equations that span the model will not differ from the baseline case, but there will be an addition through the extension of the government flow budget constraint.

$$b_t - \frac{b_{ss}}{\pi_{ss}} \rho_\pi (s(1-\lambda) + (1-s)\lambda^*)\pi_{t-1}^H - \frac{b_{ss}}{\pi_{ss}} \gamma_\pi (s\lambda + (1-s) * (1-\lambda^*))\pi_{t-1}^F - \frac{b_{ss}}{\pi_{ss}} \gamma_y s y_{t-1} - \\ - \frac{b_{ss}}{\pi_{ss}} \gamma_y (1-s) y_{t-1}^* = g_t - w_{ss} y_{ss} \tau_t - \tau y_{ss} w_t - w_{ss} \tau y_t + \frac{1}{\beta} b_{t-1} + \frac{b_{ss}}{\pi_{ss} \beta} ((1-\lambda)\pi_t^H + \lambda \pi_t^F) \tag{3.72}$$

Inserting the wage equation and the policy rule of the governments, then yield the expression for government debt defining the model yields,

$$b - \frac{b_{ss}}{\pi_{ss}} (\rho_\pi (s(1-\lambda) + (1-s)\lambda^*)\pi_{t-1}^H - \frac{b_{ss}}{\pi_{ss}} \rho_\pi (s\lambda + (1-s)(1-\lambda^*))\pi_{t-1}^F - \frac{b_{ss}}{\pi_{ss}} \gamma_y s y_{t-1} \\ - \frac{b_{ss}}{\pi_{ss}} \gamma_y (1-s) y_{t-1}^*) = (1 - w_{ss} y_{ss} \gamma_g + (\sigma b \lambda h - 1)\sigma a \frac{\eta}{1-\eta} - \tau y_{ss} \frac{\tau}{1-\tau} \gamma_g) g_t - \\ -(w_{ss}\tau + w_{ss} y_{ss} \gamma_y + \tau y_{ss} (\psi - \frac{\sigma a}{1-\eta}(1 - \sigma a \lambda h) + \tau y_{ss} \frac{\tau}{1-\tau} \gamma_y)) y_t + \tau y_{ss} \sigma b \lambda \frac{\sigma^* a^* h}{1-\eta^*} y_t^* - \\ - \tau y_{ss} \sigma b \lambda \frac{\eta^* a^* \sigma^*}{1-\eta^*} g_t^* + (\frac{1}{\beta} - w_{ss} y_{ss} \gamma_b - \tau y_{ss} \frac{\tau}{1-\tau} \gamma_b) b_{t-1} + \frac{b_{ss}}{\pi_{ss} \beta} ((1-\lambda)\pi_t^H + \lambda \pi_t^F) \tag{3.73}$$

and for the foreign country vice versa. These two equations extend the model of 3.62 and 3.63 together with the new marginal costs expressions from 3.70 and 3.71, which can be inserted into 3.30 and 3.32. This addition changes the equilibrium path for output in both countries, which affects the relationship between ρ_π and ρ_y. Furthermore, by introducing two new endogenous variables b_t and b_t^*, there exist new eigenvalues which need to be analyzed.

3.3 Determinacy Analysis

I calibrate the model following Nakamura and Steinsson (2014). For that, I set the Frish labor elasticity and the inter-temporal elasticity of substitution to one. The elasticity of goods substitutability ν is set to 2. The country's weight in the union is 10%; thus, $s = 0.1$. Assuming that prices can be adjusted yearly, the price frictions are set to 0.75 in both countries. Furthermore, government spending takes up a share of 20% in both countries, and the home bias in private consumption in the member country is $\lambda = 0.31$ and only $\lambda^* = 0.076$ in the union, indicating the differences in the unions compared to the member's size. The discount value takes the value of 0.99, indicating an average of 1% real interest. For the steady-state values, I set all to 1, except from $b_{ss} = 0.6$, which follows from the stability criterion of the Maastricht criterion.

The rest of the analysis follows the setup by Barnett and Eryilmaz (2023) but extends the open economy by fiscal-monetary interactions. In a two-country model, the determinacy differs marginally from a closed model when stability is only the objective for monetary policy. The openness to trade and the size of the member are two parameters that influence the stability conditions of the model. Since most members are rather small, the system of π_t^F and its eigenvalue define its stability. When including fiscal stability measures, the open economy case differs significantly, allowing for an additional stable and unique equilibrium.

3.3.1 Stability Objective on Monetary Policy Only

Assuming economic stability is the objective of monetary policy only, there are different possible definitions to serve as the Taylor rule: One where the nominal rate only reacts to changes in inflation and one where the central bank considers variations in output.

1. Pure Inflation Targeting Rule Consider the model consisting of equations 3.62-3.68 together with the Taylor rule of monetary policy,

$$r_t = \rho_\pi \pi_t^{EMU} \tag{3.74}$$

where nominal interest rates react to changes in inflation only. This current-looking Taylor rule is the only equation that guarantees a pinning down of the price level in the economy. The stability of the model depends crucially on the Taylor principle. Thus, nominal interest rates react more than the change in inflation such that real interest rates increase and keep the system stable. However, the discount factors in both countries influence the space for unique and stable solutions: When looking at Figure 3.1 displaying the relationship with β and β^*, the Taylor principle is only enough as long as the discount factor is below one. As soon as it is larger than one, the coefficient ρ_π needs to increase significantly. Since the member is relatively small, the only significant influence comes from β^*, and this relationship declines with greater size s.

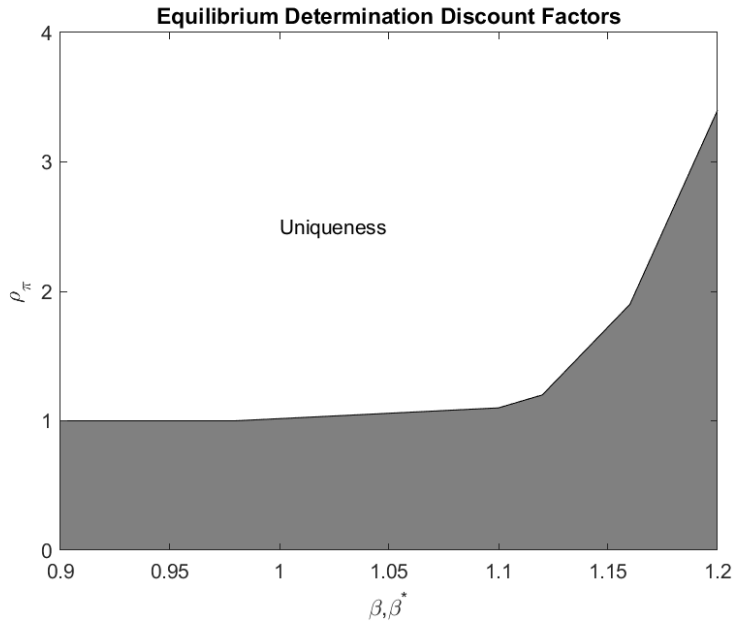


Figure 3.1: Determinacy region under inflation targeting Taylor rule in dependence on the discount factors

Thus, the model's uniqueness is guaranteed by a value of $\rho_\pi > 1$ as long as the discount factor in the union is below 1.04. Then, as the discount factors increase, the response of the interest rate toward inflationary pressure needs to be larger to guarantee the stability of the model. Values of β and β^* affect the friction multiplier of Phillips curves (62) and (63). The price friction is described by $\frac{(1-\theta^F)(1-\beta^*\theta^F)}{\theta^F}$ and $\frac{(1-\theta^H)(1-\beta\theta^H)}{\theta^H}$ which are turning negative once the discount parameters take on a certain value, which then requires stronger reaction towards inflation to pin down the price level.

Proposition 1 *Given the open economy New Keynesian model described by the system in equations 3.62-3.68 and a pure inflation targeting Taylor rule, there exists a unique and stationary equilibrium if the Taylor principle holds ($\rho_\pi > 1$) and households have a present bias.*

2. Standard Taylor Rule

Consider the model defined by equations (60)-(66) and the following standard Taylor Rule for monetary policy,

$$r_t = \rho_\pi \pi_t^{EMU} + \rho_y y_t^{EMU} \tag{3.75}$$

where the interest rate reacts to more than just the aggregate inflation but also to changes in the output. Thus, with this additional stabilization mechanism, ρ_π does not necessarily need to be larger than one to have an active monetary policy, but instead, the behavior toward output allows deviations. An increase in the output gap introduces inflationary pressure. Thus, a direct reaction of interest rates can prevent this transmission.

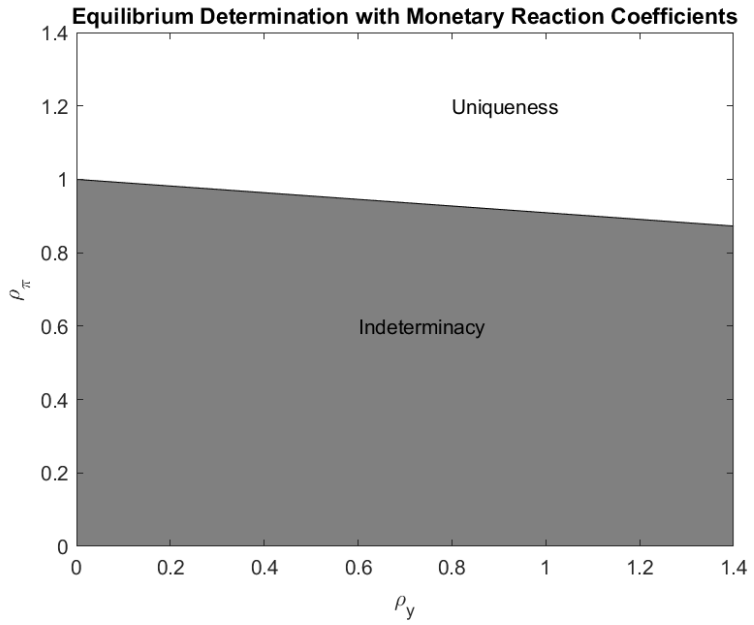


Figure 3.2: Determinacy region under classic current looking Taylor rule

Hence, to guarantee a unique equilibrium, the coefficient on the inflation ρ_π does not need to be larger than 1, as long as the central bank reacts towards output in a certain manner, as can be derived from Figure 2. Openness and trade intensity, thereby, do not change the stability threshold, but they influence the trade-off between ρ_π and ρ_y. The threshold line of indeterminacy becomes flatter with the larger size of the country s. Thus the following holds:

Proposition 2 *Given an open economy New Keynesian model as in 3.62-3.68 and a standard Taylor rule, it holds that the greater the member and larger its impact on the union-wide averages, the more important direct price stabilization through ρ_π is.*

Because a change in output transfers largely into inflation. Since the system's stability is decided by the process on π_t^F, the impact of the openness differs. While an increase in λ^* makes the line steeper such that an increase in ρ_y can compensate for a lower reaction to inflation. An increase in λ has the opposite effect. Because in the first case, a change in foreign output affects the foreign aggregate inflation less than before since the consumption basket contains a large share of imported products. In the latter case, the aggregate inflation consists largely of foreign inflation, and monetary policy needs to increase the focus on ρ_π. It adds to the finding of Llosa and Tuesta (2008) that openness increases the area for a unique equilibrium.

3.3.2 Monetary-Fiscal Interaction for Stability

1. Fiscal Debt Stability

Consider the open New Keynesian model from equation 3.62-3.68 and the inflation-targeting monetary policy rule and introduce fiscal stability mechanisms. For that, the government will generate tax revenue to pay its expenses and include stabilization of the debt path by

adapting taxes according to,

$$\tau_t = \gamma_b b_{t-1} + \gamma_g g_t \quad \text{and for the foreign country,} \quad \tau_t^* = \gamma_b^* b_{t-1}^* + \gamma_g^* g_t^* \tag{3.76}$$

Hence, economic stability is not solely done by the central bank; instead, fiscal authorities can adjust their surplus accordingly. This extends the possibilities for monetary policy and allows the existence of new stable equilibria. By introducing the new variables b_t and b_t^* into the model, two new eigenvalues determine the model's stability. From Equation 3.73 the two roots of the system are given by:

$$\frac{1}{\beta} - \gamma_b. \quad \text{and for the foreign country,} \quad \frac{1}{\beta^*} - \gamma_b^*.$$

Together with the root for monetary policy, this yields three eigenvalues around one. Since two eigenvalues have to be stable and one not, there are possible combinations between monetary and fiscal regimes. Hence, regarding the stability of the eigenvalues for monetary and fiscal policy, I can conclude the following:

Proposition 3 *Given an open New Keynesian model as in 3.62-3.68 with 3.70 and 3.71 and 3.73 and introducing fiscal policies to stabilize the economy 3.76 besides an inflation-targeting monetary policy into an open economy model allows the existence of* ***three*** *equilibria. Two of these do not require satisfaction of the Taylor principle.*

The first equilibrium is the active monetary policy and passive fiscal policy case. Hence, it has to hold that,

$$\rho_\pi > 1, \quad \gamma_b < \frac{1}{\beta} - 1, \text{ AND } \gamma_b^* < \frac{1}{\beta^*} - 1 \tag{3.77}$$

where the monetary authority is inflation targeting and actively determining the price level, and both governments of the member and union behave passively. This equilibrium is very similar to the closed economy case and is referred to as the equilibrium of monetary dominance. The model only yields a stable and unique solution if one authority is pinning down the price level. In this first and commonly used case, the central bank is setting π_t^{EMU}, and by taking the price as given, fiscal authorities will adjust their surplus such that the budget balance is satisfied. When one government is not adjusting taxes sufficiently, its expenses are not met by revenue, so the country or union follows an explosive debt path. Conversely, taking both governments as passive, a monetary authority that does not pin down the price level causes indeterminacy since it allows multiple solutions. Thus, for simplification, I display this equilibrium in Figure 3.3,

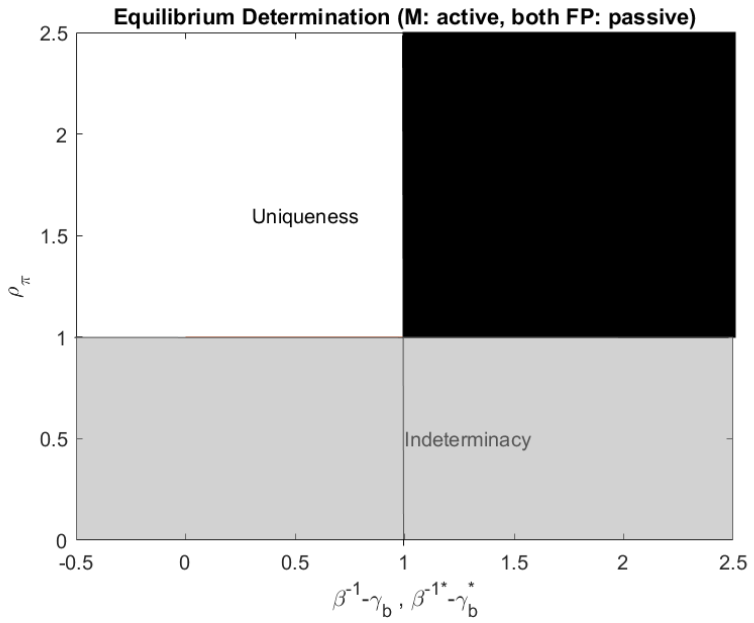


Figure 3.3: Equilibrium Space when Monetary Policy is active and fiscal policy is passive

where the black area defines the region where no equilibrium is possible, the gray part shows the combinations for indeterminacy, and the white area contains unique and stable equilibria.

The second and third equilibrium differ from the closed economy case as there are two options to determine the price level in the union without an inflation-targeting central bank instead of just one. When the monetary policy is not raising the real interest rates to respond to inflation, the budget balance can be satisfied through multiple solutions, and thus, the model is not determined. Hence, in the theory of the Fiscal Theory of the Price Level, the fiscal authority can take over and keep the surplus exogenous such that there exists a unique price level for which the budget balance is satisfied. In the case of an open economy, this procedure can be overtaken by either the member or the union such that there exist two possible fiscal dominant equilibria where,

$$\rho_\pi \leq 1, \quad \gamma_b < \frac{1}{\beta} - 1, \text{ OR } \gamma_b^* < \frac{1}{\beta^*} - 1. \tag{3.78}$$

One where the price level is pinned down by the union and the other where a member takes over. When one is active, the other country has to adjust to it by endogenously determining the surplus to satisfy the budget balance; otherwise, the model cannot solve. When no fiscal authority on the other side is taking the role of an active regime, the system becomes undetermined. Hence, Figure 3.4 displays possible values for which there exists a stable solution, assuming $\rho_\pi \leq 1$,

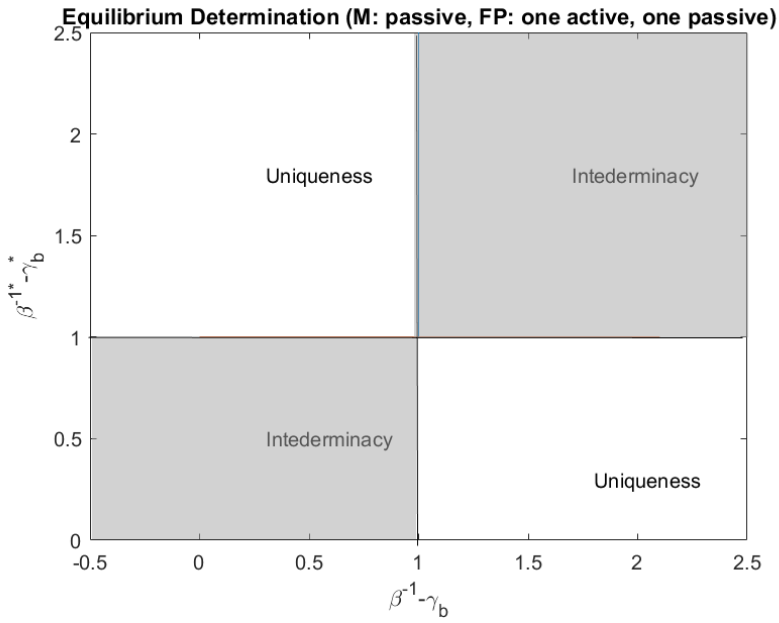


Figure 3.4: Equilibrium Space when Monetary Policy is passive and only one fiscal authority is passive

Overall, an equilibrium is stable if one but only one authority pins down the price level.

2. Full Fiscal Stabilization

Consider the model that is constructed by equations 3.62-3.73 and the standard Taylor rule to define the behavior of monetary policy as well as the full policy rule of fiscal policies,

$$\tau_t = \gamma_b b_{t-1} + \gamma_g g_t + \gamma_y y_t, \quad \text{and} \quad \tau_t^* = \gamma_b^* b_{t-1}^* + \gamma_g^* g_t^* + \gamma_y^* y_t^* \tag{3.79}$$

Adjusting the deficit to the revenues can be done via an increase in debt reduction efforts through γ_b and automatic stabilizers that guarantee larger taxes with greater output can push counties into passive behavior. Stability then depends on not just the reaction towards debt but also output. Automatic stabilizers increase the passiveness of a country independent of its debt reduction efforts. In contrast to the case without a fiscal policy, the trade-off between ρ_π and ρ_y is much steeper. Furthermore, including automatic stabilizers on the union level[1] shows an even stronger possibility to substitute inflation and output stabilization. Under the assumption of the first equilibrium where monetary policy is active and fiscal policies passive, the determinacy regions can be defined by Figure 3.5.

[1]The member country's reaction of γ_y has only a minimal effect.

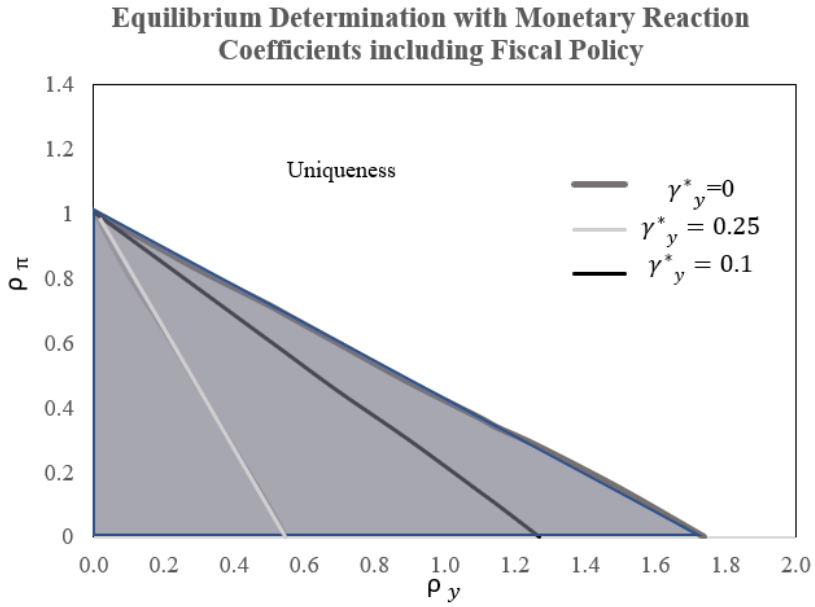


Figure 3.5: Gross public debt of general government over time for selective countries, data source: OECD, own display

When automatic stabilizers are set up counter-cyclical across the union, the automatic stabilization will balance the output and keep the price level determined. The larger the size of the union or the trade intensive it is, the stepper the line in the previous equation. Consequently, a value for γ_y^* exists in this model for which the price level is uniquely determined without any monetary stabilization, and both fiscal policies are passive.

Proposition 4 *In an open New Keynesian economy, defined by equations 3.62-3.73 and fiscal policy rule as in 3.79, automatic stabilizers in the union described by γ_y^* increase monetary space. Furthermore, there exists a level of automatic fiscal stabilizers for which monetary policy is obsolete to guarantee a stationary and stable equilibrium despite both governments being passive in the sense of $\gamma_b > 1/\beta$ and $\gamma_b^* > 1/\beta^*$.*

This allows me to conclude that within a currency union, the inflexibility created through a centralized monetary authority can be compensated by certain union-wide fiscal policies. Since no unified fiscal policy exists, it implies that many governments should be coordinated in times of instability to bring the union back to a stable path.

3.4 Equilibrium Detection in the EMU

Given the characteristics of unique and stable equilibria in contrast to indeterminacy and explosiveness, I now analyze different countries within the European Monetary Union concerning the regimes they were in. While some countries were recovering rather fast after the financial crisis, some members, especially the periphery, were struggling with increasing debt even as the European Central Bank lowered interest rates and additionally started on alternative stabilization methods. The estimation for the monetary policy behavior results in two distinct regimes, as can be deducted from Figure 3.6. One which prevails until about 2009/10 and one afterward.

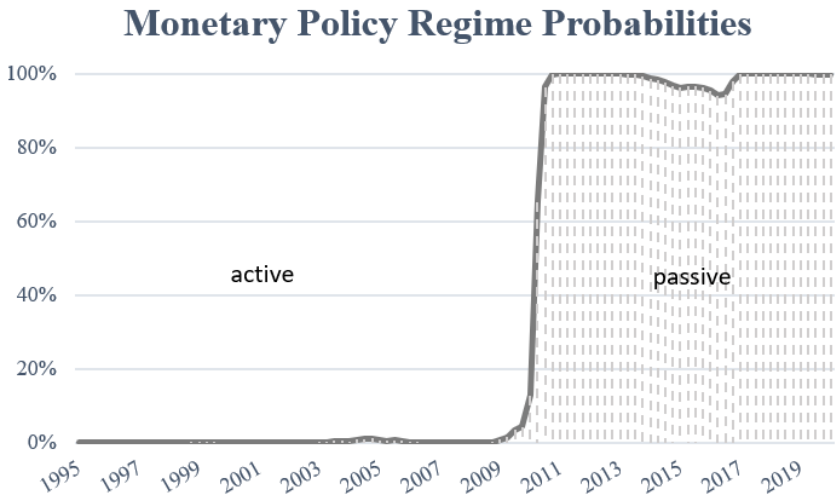


Figure 3.6: Estimated 2- State Markov Switching Regime Probabilities of the Behavior of the ECB over time

As can be deducted from the estimation output, the first period shows strong inflation targeting with $\rho_\pi = 1.34$ and an additional output stabilization of $\rho_y = 0.29$, while after 2010, the ECB was letting loose on its mandate and show now significant reaction. Thus, to be in a stable equilibrium, the members of the EMU should have behaved passively and adjusted the balance to maintain a stable debt path. Afterward, however, when monetary policy behaved passively, it depended on the aggregate union and how single members could respond to maintain a determined and stable equilibrium.

Using the determinacy conditions from the previous section, I can identify different periods for countries of the EMU and the whole union. Figure 3.7 displays different regime phases in France, Germany, Greece, Portugal, Spain, and the Union. The green areas describe periods of monetary dominance, thus, when monetary policy determines the price level as is commonly accepted in the literature. However, the union showed periods of explosiveness between 2001-2003 and 2007 to 2010. From this, one can conclude that the whole union's debt path was explosive during these times. While in the early 2000s, the explosiveness was shared by only some southern European countries. However, some members had experienced active regimes before the switch in the monetary policy regime and, thus, generated explosive debt paths. Besides an individual member's behavior, the union's behavior matters to define the regime mix a country lies in when talking about small open economies.

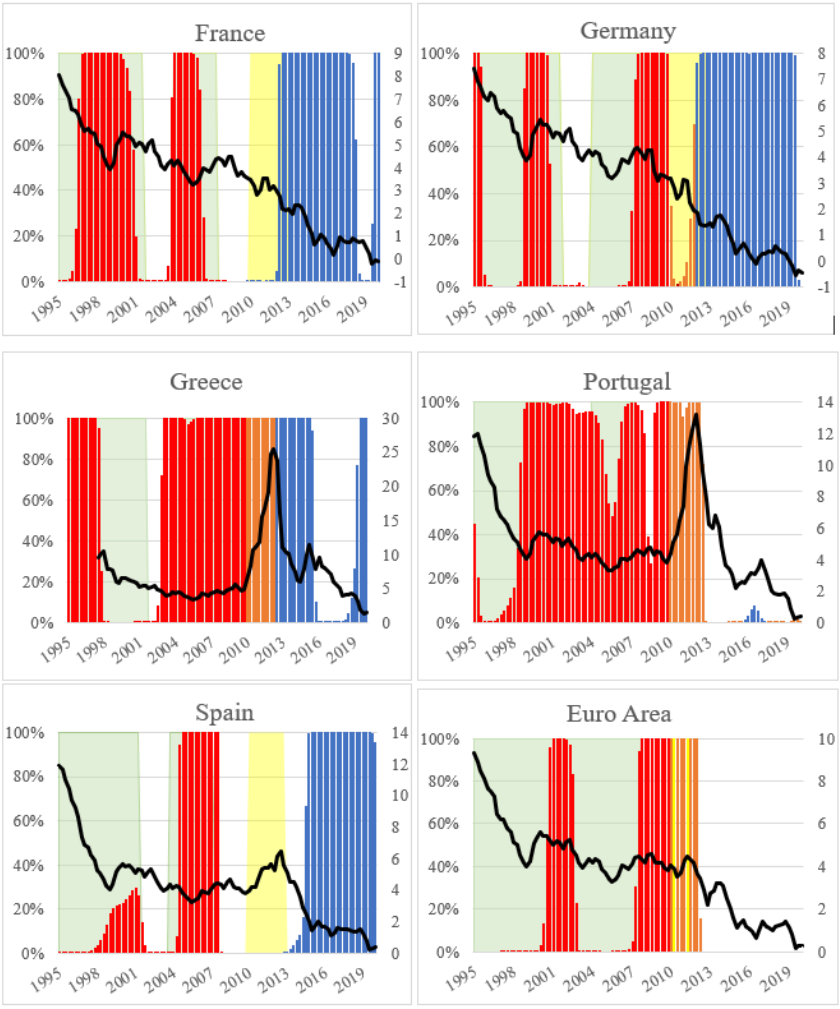


Figure 3.7: Regime Phases given a passive Union of certain countries (red: explosive, green: monetary dominance, blue: fiscal dominance of member, yellow: fiscal dominance of union, orange: explosive with passive monetary policy, white: indeterminacy) and Government Bond Interest Yield (black)

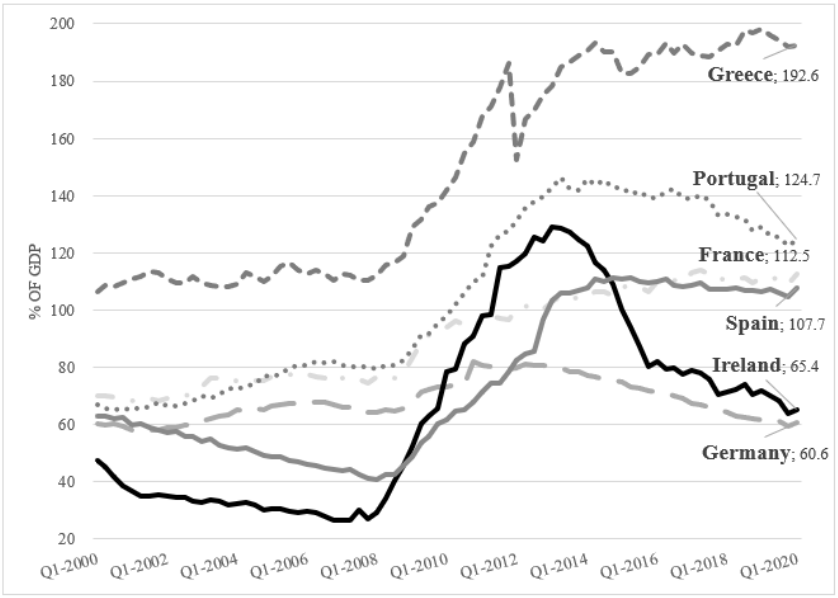


Figure 3.8: Gross public debt of general government over time for selective countries, data source: OECD, own display

The orange area defines a region where all three parties, the monetary policy, the union's fiscal policy, and the member, behaved actively and failed to satisfy their budget constraint. At the same time, interest rates were kept high. Only three countries during this period have experienced such periods: Greece, Portugal, and Ireland. Looking at Figure 3.8, it becomes clear that these countries are also suffering from the strongest rise in debt starting in 2008. While Spain and Italy also showed significant increases in debt, the rise was less drastic than in those three members. While France has also had periods of explosiveness before 2007, their long-term bond yields declined, increasing their gross debt but on a slower level. Before the monetary policy regime switch, these countries experienced an explosive debt path by behaving actively during active monetary times.

3.5 Multipliers across Regime Mixes

I rely on the estimation results from Chapter 2 for the reaction coefficients of monetary and fiscal policy. To receive an average result for a midsize European country and allow for a qualitative switching, I take the result from the union for both countries such that $\gamma_b = 0.01$ in an active regime and $\gamma_b = 0.02$ in the passive regime. The reaction towards changes in spending will be set to zero, and so is the regard for automatic stabilizers γ_y. For monetary policy, I take the estimates of $\rho_\pi = 1.3$ in an inflation-targeting state and $\rho_\pi = 0.3$ in all other periods. Since I restrict the analysis from any automatic stabilizers for monetary and fiscal policy such as $\rho_y = 0$ and $\gamma_y = 0$, the following effects are just through different reactions towards debt and inflation.

In the following, I calculate different multipliers: The national, spillover, and union multipliers. The first gives the result of a government spending shock of 1% of domestic GDP on domestic output. Hence, the impact and the cumulative multiplier are calculated

as,

$$\text{Impact Multiplier} = \frac{\Delta Y_t}{\Delta G_t}, \quad \text{Cumulative Multiplier} = \frac{\sum_{t=0}^{k} \Delta Y_{t+k}}{\sum_{t=0}^{k} \Delta G_{t+k}} \tag{3.80}$$

For the spillover multipliers and the multiplier from a union-wide shock, the interpretation can be done in either terms of foreign or domestic GDP. I will display the union multiplier as an increase in domestic GDP through an increase in government spending of 1% of foreign GDP. Hence the Spillover and Union Multiplier follow,

$$\text{Impact Multiplier} = \frac{\Delta Y_t}{\Delta G_t^*}, \quad \text{Cumulative Multiplier} = \frac{\sum_{t=0}^{k} \Delta Y_{t+k}}{\sum_{t=0}^{k} \Delta G_{t+k}^*} \tag{3.81}$$

This result can further be weighted so that all results can be expressed in terms of domestic output. According to Alloza et al. (2020) the destination spillover is defined "as the ratio of the (cumulative) sum of the total impact on the output of a given country originated by fiscal actions in the rest of the countries to the sum of the respective domestic effects in the originating countries". As foreign government spending is expressed in terms of foreign GDP, it includes the domestic effects from the union of origin.

The impulse response function for all regimes can be found in the Appendix.

3.5.1 Active Monetary / Passive Fiscal Policy

The A/P/P equilibrium is referred to as the equilibrium of monetary dominance. Hence, the central bank actively determines the price level through inflation-targeting behavior. After an increase in demand, the generated inflation is mitigated by increasing real interest rates. As Christiano et al. (2011) shows, multipliers decline as monetary policy reacts more aggressively towards inflation. This finding is consistent with the results in Table 3.1. The standard domestic multiplier is relatively small since government spending crowds out private demand and induces negative wealth and distortion effects through increased taxes.

Thus, consumption in both countries declines significantly in all shock specifications due to the inflation-targeting central bank. Additionally, a domestic shock increases the price level and worsens the terms of trade. In contrast, the spillover shock benefits the member's competitiveness. Hence, domestic output increases over time.

A/P/P		Cumulative		
	Impact	1 year	2 years	3 years
Multiplier	0.20	0.15	0.12	0.09
Spillover Multiplier	-0.05	-0.02	0	0.01
Union Multiplier	0.14	0.13	0.11	0.09

Table 3.1: Impact and Cumulative Multipliers, different definitions for A/P/P equilibrium

The small difference between the union-wide and national spending shock has two reasons: One, the monetary policy reacts much more when the whole union is affected, such that consumer shift their consumption to the future. This reduces the final effect on production under a union-wide spending shock. Second, keeping the terms of trade constant has an opposing effect on increasing production in the union-wide shock. If only the member

increases spending, the price level for domestic goods rises above the foreign price level. Due to its size, it will lose competitiveness, and hence, foreign demand for domestic goods decline for a national spending shock. Hence, the monetary channel promotes a larger difference while the trade channel decreases it.

The effect of the simple spillover is first negative and then turns positive over time. The initial drop is solely due to the strong inflation targeting of the central bank since the rest of the union contains 90% and, thus, has a large influence on inflation and interest rates. The loss in consumption decreases a member's output in current periods. Hence, in this model, the influence of the high real interest rate takes away the benefit through the increase in competitiveness over the other country.

3.5.2 Passive Monetary Policy / Active Union, Passive Member Fiscal Policy

In the fiscally dominated regime through the union, a spending shock in the member country has similar effects as in the previous equilibrium. The increase in demand is crowding out private consumption, and through the relatively strong increase in domestic CPI, the member is losing competitiveness. This initially shifts up foreign consumption and production before returning to its steady state. The debt level is relatively high in the domestic country. However, higher inflation and low-interest rates keep the budget balance stable.

When monetary policy does not engage in strong inflation targeting, multipliers increase (Table 3.2). However, while the effect is still small for the domestic multiplier, the outcome for both spillover multipliers is significantly larger. The national multiplier does not differ much from the previous equilibrium since, in any case, the central bank reacts only very slightly (with 10%) towards changes in the member's inflation. However, the slight benefit through an improvement of terms of trade increases the domestic multiplier marginally.

P/P/A		Cumulative		
	Impact	1 year	2 years	3 years
Multiplier	0.21	0.17	0.13	0.10
Spillover Multiplier	1.86	1.50	1.22	1.08
Union Multiplier	2.08	1.67	1.35	1.18

Table 3.2: Impact and Cumulative Multipliers, different definitions for P/A/P equilibrium

The large spillover multiplier is again fully driven by the interest rate, despite the passive central bank. As only the union is shocking its economy with a demand shock, the aggregate price level will be shifted upwards such that interest rates will react. As the member behaves passively, its price level will shift so that the real interest rate will be minimal. The trade channel has only a small effect since the interest rate channel is the main driver. This supports the finding in Chapter 2 for highly indebted countries as they must be situated within an active union and passive monetary policy. Behaving actively would likely increase the multiplier even more since it would minimize the loss in competitiveness. However, in this Chapter, I only rely on stable equilibria.

3.5.3 Passive Monetary Policy / Passive Union, Active Member Fiscal Policy

Table 3.3 displays the multiplier in the opposite fiscal case, where the member is active, and the union is passive. In this case, the member is actively determining the price level instead of the central bank. Through the temperate behavior of the central bank, multipliers are relatively large. Additionally, this equilibrium yields the largest gains in terms of trade. Hence the domestic multiplier is relatively big. Comparing the national multipliers with the previous results indicates a relatively large trade effect when the interest channel is small.

As monetary policy is passive, there are gains in trade through fiscal behavior and negative wealth effects are kept to a minimum, consumption is increasing, at least initially in all kinds of spending shocks. The drop in domestic private consumption after a shock in the rest of the union is due to the crowding out of c_t^F. The gain in terms of trade for firms is, at the same time, a loss for household consumption variety.

P/A/P		Cumulative		
	Impact	1 year	2 years	3 years
Multiplier	2.03	1.61	1.29	1.10
Spillover Multiplier	0.04	0.05	0.05	0.06
Union Multiplier	2.08	1.66	1.34	1.16

Table 3.3: Impact and Cumulative Multipliers, different definitions for P/A/P equilibrium

However, the effect of the spending shock in the rest of the union declines through the influence of the interest rate channel. This is still consistent with the findings of Chapter 2 since it analyzed partial effects in line with mechanisms over the trade channel. Though, just as in the previous equilibrium, the interest rate channel dominates. The difference in the Union-wide spillover effect between the equilibrium P/P/A and P/A/P lie in the gain in competitiveness but the loss in interest rates. When the member is active, there are gains through trade since the price level will not increase as strongly as the one in the rest of the union. However, a passive union will also increase aggregate inflation leading to higher real interest rates.

3.6 Conclusion

An open New Keynesian Model with fiscal stabilization changes the determinacy conditions significantly. Furthermore, it extends the standard Taylor principle by allowing fiscal policy to take over price level determinacy and creating two stable and unique equilibria under fiscal dominance. As the two-country model enables the member or the union to take over price level determination to solve the model, a multi-country model allows for multiple stable equilibria. This indicates that first, monetary policy is not required to take over the stabilization solely and second, that not each member has to satisfy its budget at all times (Bergin (2000)). Furthermore, automatic stabilizers are shown to be capable of compensating monetary policy in stabilizing the price level.

Using these results, I showed different periods of selected European members. While most countries had stable regimes before the financial crisis, some landed in a highly explosive setting. Especially Greece, Portugal, and Ireland behaved actively during an active

union fiscal policy and an inflation-targeting central bank. At the same time, all three countries experienced steeply rising debt levels. These declined slowly when monetary policy became passive, keeping interest rates low. Hence, such explosive combinations influence the evolution of debt.

Lastly, this chapter analyzed various multipliers for the three stable equilibria. The largest domestic multiplier is reached when the member behaves actively and the rest passively. Especially the behavior of the central bank matters significantly for the size of multipliers. Spillovers are transmitted through the trade channel and yield large benefits if the terms of trade are large, and the monetary policy does not engage in inflation targeting. Overall the inflation channel plays a larger role when the union increases spending since the member is only small. However, since both fiscal policies behave identically in each regime, the trade effects cannot be easily detected. Additionally, the large influence of the interest rate channel between the regimes with monetary switches and how the union affects overall inflation hides trade effects. Hence, the following chapter will cover a quantitative analysis within one regime, where both fiscal policies differ in their level of passiveness. This modification allows me to identify the transmission channel via trade further and complete the analysis of fiscal and monetary interactions on fiscal multipliers and spillovers across a monetary union.

Appendix

A Matrix Notation of the Equilibrium

Equations (60)-(65) can then be written in matrix form, such that the structural equation looks like,

$$\mathbf{A}(x_{t+1}) = \mathbf{B}(x_t) + \mathbf{C}u \tag{3.82}$$

with $x_{t+1} = [y_{t+1}, y_t, \pi^H_{t+1}, \pi^F_{t+1}, g_t, g^*_t, x_{t+1}]'$ where $x_t = y_{t-1}$

$$\mathbf{A} = \begin{pmatrix} a/(1-\eta) & -\frac{\rho_y*(1-s)}{\sigma} & \lambda*b+\frac{(1-\lambda)}{\sigma} & \frac{\lambda}{\sigma}-\lambda b) & \frac{a\eta}{(1-\eta)}(1-\rho_g) & 0 & 0 \\ 0 & -\frac{\sigma^* a^*}{\sigma*a} & 0 & 0 & -\frac{\eta(1-\eta^*)}{(1-\eta)} & -\frac{\sigma^* a^* \eta^*}{\sigma a} & 0 \\ 0 & -\alpha h \frac{\sigma^* a^*}{(1-\eta^*)} & \beta & 0 & -\alpha(1+h)\frac{\sigma a \eta}{1-\eta} & \alpha h \frac{\sigma^* a^* \eta^*}{1-\eta^*} & 0 \\ 0 & \alpha^*(\omega^*+\frac{\sigma^* a^*}{1-\eta^*}(1+h^*) & 0 & \beta^* & \alpha^* h^* \frac{\sigma a \eta}{1-\eta} & -\alpha^*(1+h^*)\frac{\sigma^* a^* \eta^*}{1-\eta^*} & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix}$$

with $\alpha = \frac{(1-\theta_H)}{\theta_H}(1-\beta\theta_H)$ and $\alpha^* = \frac{(1-\theta_F)}{\theta_F}(1-\beta^*\theta_F)$ and with $h = \lambda f(1-\sigma b))$ and $h^* = f\lambda^*(1+\sigma^* b^*))$.

$$\mathbf{B} = \begin{pmatrix} \frac{a}{1-\eta}+\frac{\rho_y s}{\sigma} & 0 & \frac{\rho_\pi}{\sigma}(s(1-\lambda)+(1-s)\lambda^*) & \frac{\rho_\pi}{\sigma}(s\lambda+(1-s)(1-\lambda^*)) & 0 & 0 & 0 \\ -\frac{1-\eta^*}{1-\eta} & -\frac{\sigma^* a^*}{\sigma a} & -\frac{1-\eta^*}{\sigma a f} & \frac{1-\eta^*}{\sigma^* a^* f} & -\eta\frac{1-\eta^*}{1-eta} & -\frac{\sigma^* a^* \eta^*}{\sigma a} & \frac{1-\eta^*}{1-\eta} \\ \alpha(\omega+\frac{\sigma a}{1-\eta}(1+h) & 0 & 1 & 0 & 0 & 0 & 0 \\ \alpha^* h^* \frac{\sigma a}{1-eta} & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \rho_g & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \rho^*_g & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$\mathbf{C} = \begin{pmatrix} 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{pmatrix}$$

where the $u = (\epsilon^g_t, \epsilon^{g*}_t)'$. This results in 7 eigenvalues that describe the stability of the system.

B Impulse Response Functions

Active MP, Passive FP

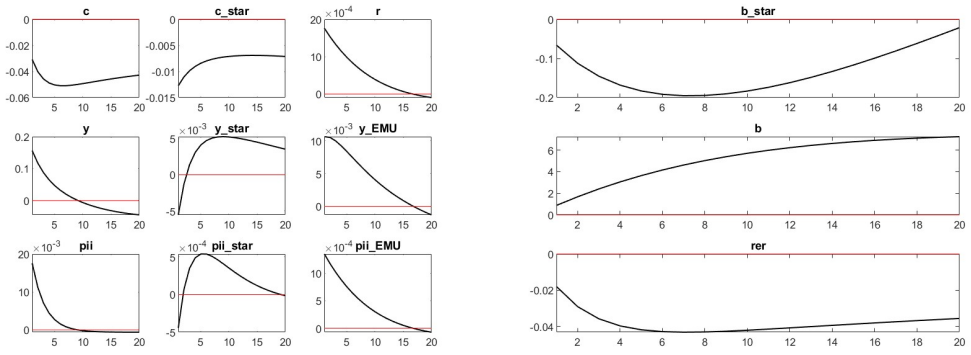


Figure B1: IRF to a domestic government spending shock in the A/P/P equilibrium

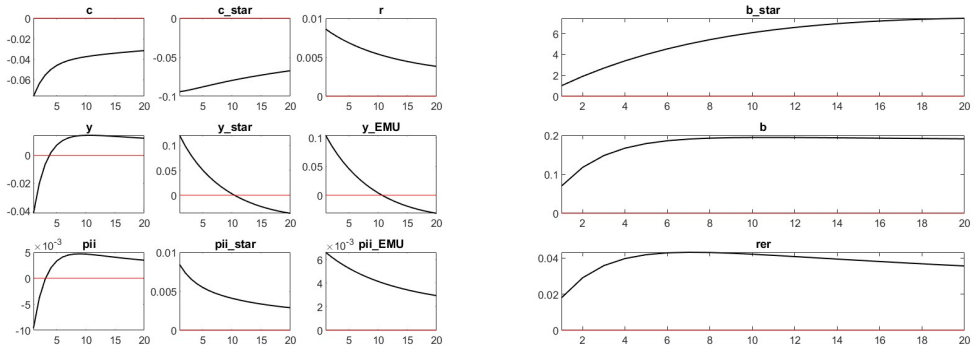


Figure B2: IRF to a foreign government spending shock in the A/P/P equilibrium

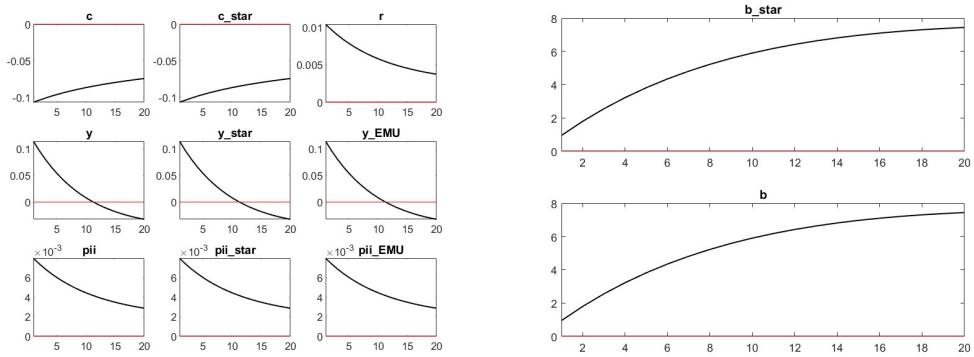


Figure B3: IRF to a union government spending shock in the A/P/P equilibrium

Passive MP, Passive Member FP, Active Union FP

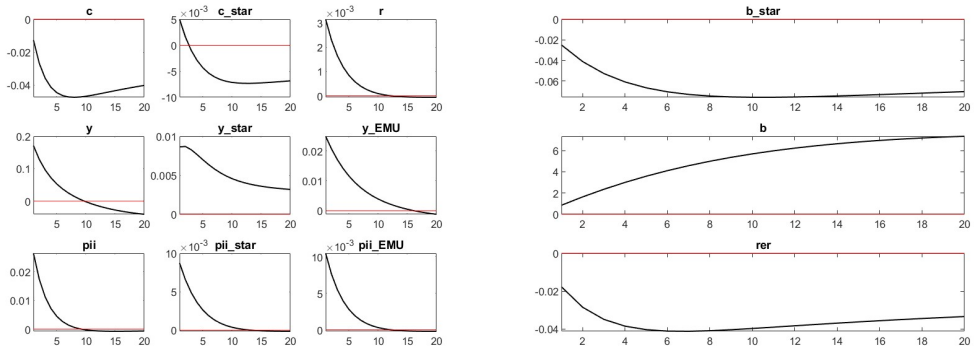


Figure B4: IRF to a domestic government spending shock in the P/P/A equilibrium

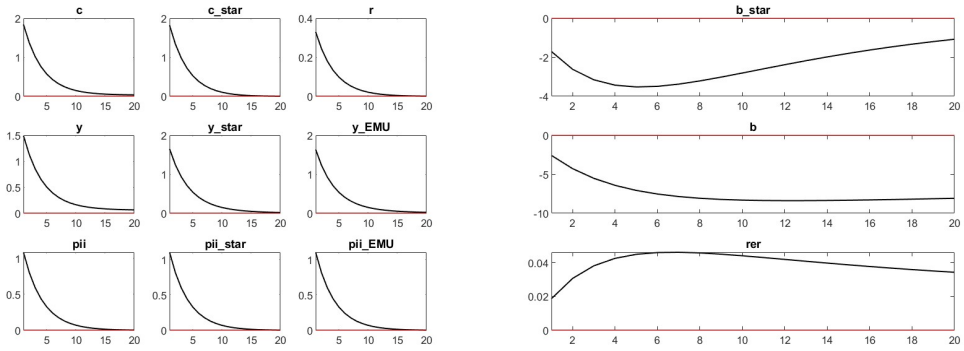


Figure B5: IRF to a foreign government spending shock in the P/P/A equilibrium

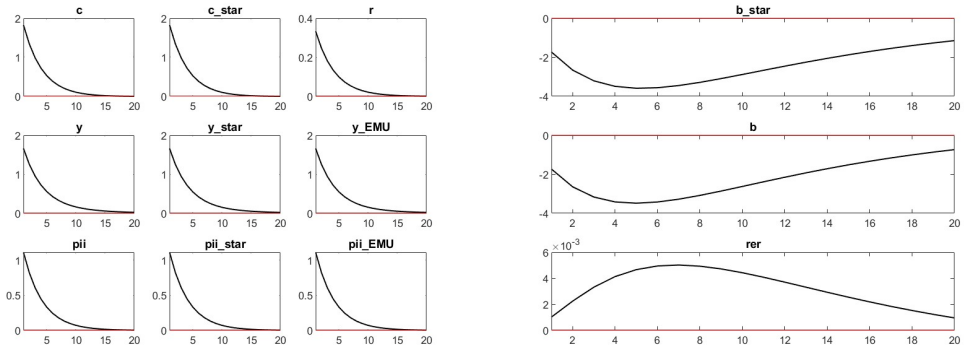


Figure B6: IRF to a union government spending shock in the P/P/A equilibrium

Passive MP, Active Member FP, Passive Union FP

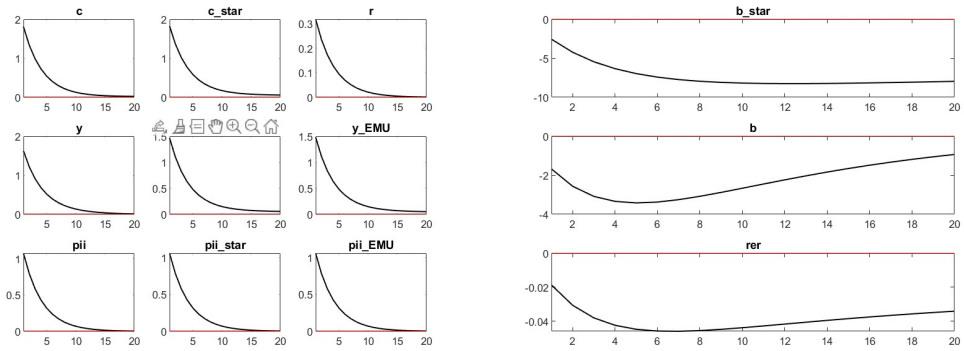


Figure B7: IRF to a domestic government spending shock in the P/A/P equilibrium

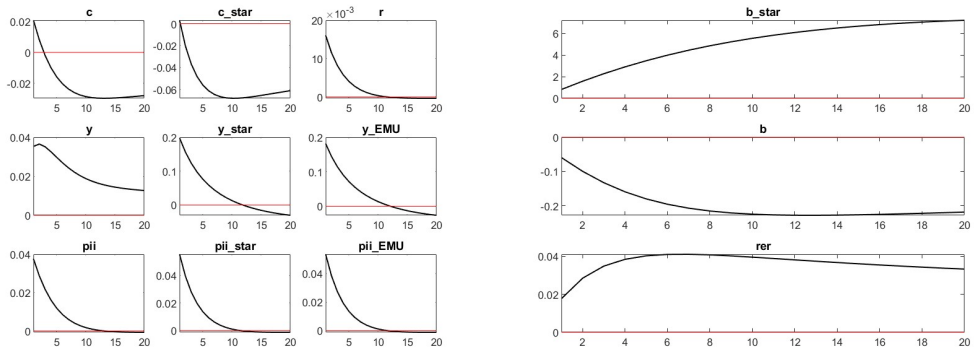


Figure B8: IRF to a foreign government spending shock in the P/A/P equilibrium

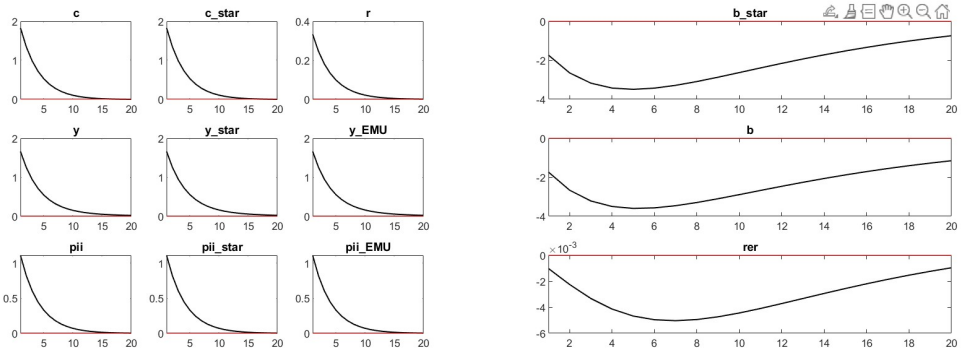


Figure B9: IRF to a union government spending shock in the P/A/P equilibrium

Chapter 4

Effects of Cross Country Fiscal Interdependence on Multipliers within a Monetary Union

4.1. Introduction

The previous chapters provided an empirical and theoretical assessment of fiscal spillover multipliers and their dependence on different fiscal and monetary regimes. Specifically, I showed that time-varying reactions toward inflationary and budgetary conditions change the efficacy of fiscal spending shocks within a country and its transmission across borders. Multipliers were shown to be largest under an *active* government with a *passive* country of origin. A non-inflation-targeting monetary authority increased these outcomes for highly indebted countries. The two-country New Keynesian DSGE model in Chapter 3 proved this to be mainly driven by the interest rate and trade channel.

The previous Chapter explains the mechanisms responsible for differences between fiscal-monetary regime combinations. However, as the empirical results in Chapter 2 show, countries do not all switch qualitatively, but some just quantitatively in their tax response to debt. Hence, there might be more to the story than across-equilibrium variation. The conventional view on monetary-fiscal interactions supports the consensus of an inflation-targeting central bank that maintains price level stability while fiscal authorities engage in automatic stabilizers and keep debt stable. This regime of monetary dominance is advantageous in times without large economic disturbances (Debrun et al. (2021)). Additionally, regarding the target of the European Central Bank and the restrictions through the Stability and Growth Pact, all authorities aspire to the prevalence of this equilibrium. This implies that union members will most likely not always switch between an *active* and *passive* state but maintain different levels of passive behavior, such that the budget stays controlled. However, the strength in consolidation varies across both regimes.

As shown in Chapter 3, with monetary policy having a dominant role in New Keynesian models, a clear assessment of the trade effects is impossible when comparing results across the three stable and unique equilibria. Additionally, as the size of the foreign country is significantly larger than the member, a regime switch in the union or the central bank causes immense influence through the interest rate channel. A switch of either large authority captures the whole effect. Hence a comparison within one equilibrium allows me to quantify the influence of the trade channel clearer. Fiscal policies can then fulfill their budgetary conditions but still differ in the intensity of the tax response towards debt, spending, and

their automatic stabilizers. Hence, instead of a direct influence through the trade channel, I investigate the influence of different levels of debt reduction on the transmission of spending shocks. As governments increase their spending and demand for domestic goods, it directly impacts the prices and competitiveness of their country. Furthermore, it also affects the demand for foreign production and trade relations (Canova and Pappa (2007)). Hence, the influence of these spillover effects on real exchange rate appreciation and price differentials may also depend on the behavior of the foreign country.

Therefore, this Chapter adds to the theoretical analysis by providing a quantitative approach to regime-dependent multipliers and spillover effects across countries using a two-country NKDSGE model as in Chapter 3. Again it allows both fiscal policies to vary in their behavior toward macroeconomic variables. The financing decision and consolidation efforts are again combined in a Taylor-style policy rule, though, it varies according to a Markov Process. In contrast to Davig and Leeper (2011); however, I categorize fiscal behavior rather by the *strength* in its reaction of taxes towards spending and debt. Hence, while both fiscal policies are passive in the original sense of Leeper (1991) and comply with the rules of the fiscal restrictions in the EMU, they show phases of different intensities. I, therefore, define one state as a *low intensity*- and the other as *high intensity*-regime.

In this model, governments are switching between both regimes over time. This allows me to evaluate the ideal regime mix of both governments to generate the highest national multipliers for the currency union member and its spillovers. The implementation of Markov Switching is mainly supported by the data and the fact that regime mixes will only prevail for a while. At the same time, it also reintroduces some level of Ricardian equivalence to prevent overestimating regime differentials. Additionally, in contrast to Corsetti et al. (2010), this paper studies the influence of imperfections through a centralized monetary policy on the interaction mechanisms that affect the efficacy of government stimulus. As union-wide averages orient interest rates, it may be crucial for small countries to maintain low prices, whether other union members are consolidating strongly or not. As in the previous sections, in addition to examining national multipliers, the paper analyzes the impact of coordinated fiscal stimulus shocks across the union with and without the member to determine which countries receive the greatest benefits and how their spillover adherence to their policy rule affects the outcome.

Overall, this Chapter is the first to analyze the influence of time-varying fiscal interaction effects between a union and its member depending on their tax responsiveness and consolidation efforts in combination with a centralized monetary channel on the quantitative nature of national but also spillover multipliers. Additionally, by investigating these effects under different fiscal spending shocks, this paper examines the preferred behavior of a small open economy within a monetary union.

The Chapter's main findings are as follows: When government stimulus is carried out only within a small member country, the impact of foreign fiscal policy is negligible. However, the country benefits from a centralized monetary authority, which results in declining real interest rates as national inflation surpasses nominal interest responses. This effect allows the multiplier to be larger than in the case of a closed economy. Furthermore, the regime mix that generates the highest output multiplier is low domestic and high foreign intensity fiscal policy, leading to an improvement in the terms of trade. However, having both

governments in a regime with low intensity will lead to the highest consumption multiplier. Since the increase in interest rates and the crowding out of domestic and foreign private consumption is lowest. Therefore, GDP in trade-intensive countries benefits the most from union-wide solutions to minimize the loss in competitiveness. At the same time, consumption prefers domestic solutions to keep foreign goods cheap and real interest rates declining. The mechanisms responsible for these results are driven by the relative price level, which determines the reaction of labor demand, the monetary channel, and goods demand for domestic and foreign products. Consequentially, externalities such as insufficient demand through free riders and high debt are possible consequences.

The Chapter is structured as follows: Chapter 4.2 presents a literature review on fiscal multipliers, spillovers, and their regime dependence. Section 4.3 motivates using Markov Switching fiscal policy rules within the EMU. Chapter 4.4 presents a standard New Keynesian Model with distortionary taxes and fiscal policy rules with time-varying coefficients. Chapter 4.5 describes the calibration and estimation of the model. Section 4.6 shows the results of a country's individual and a union-wide fiscal shock and their spillovers. Chapter 4.7 illustrates the Spanish spending shock sequence after the Great Financial Crisis. Section 4.8 concludes with various robustness checks in the Appendix.

4.2. Literature Review

I briefly outline Keynesian and Neoclassical literature dealing with fiscal policy multiplier effects. In the neoclassical view, an increase in government spending leads to a negative wealth effect reducing consumption and raising labor supply, which causes wages to decline. This *crowding out* of private spending is argued by the shift in labor supply and the succeeding decline in wages (Christiano and Eichenbaum (1992), Baxter and King (1993)). On the other side, the Keynesian view focuses on the channel through labor demand, which increases as a response to public spending and shifts wages up. However, the fully pro- and counter-cyclical movements of wages are not consistent with actual data (Christiano and Eichenbaum (1992), Fatas and Mihov (2001)). Thus, whether consumption is crowded in or out also depends on other factors.

Baxter and King (1993) and Fatas and Mihov (2001) argue that a standard RBC Model leads to fiscal output multipliers of around one and a crowding out of private consumption. This effect is larger, the less productive, the longer its persistence, and the higher the share financed by distortionary taxes. While under Ricardian Equivalence, it does not matter whether taxes or deficit is increased since households face a dynamic maximization problem considering future revenue increases. However, financing matters for the private agent's decision when the market faces imperfections or distortions such as income taxes. Kirsanova et al. (2007) and Ferrero (2009) show this result using a New Keynesian model. Gali et al. (2007) and Christiano et al. (2011) find that output multipliers are to be larger than one whenever taxes are lump sum instead. Tax-financed spending is a forwarded financing method, causing a dynamic effect but no distortions.

The difference between tax and deficit-financed stimulus increases when Rule-of-Thumb households are added. These agents fully consume their current income and are directly affected by increased taxes due to the loss of intertemporal substitutability. Thus, increasing

lump-sum taxes rather than deficit induces a negative wealth effect for those households, while others can smooth consumption. Consequently, the inclusion of Rule of Thumb agents leads to severe differences in multipliers depending on the way of financing (e.g., Eggertsson and Krugman (2012), Gali et al. (2007), Corsetti et al. (2010)).

Another feature of the model is the fiscal policy rules following Davig and Leeper (2011). I define fiscal policy by a rule that lets the average income tax rate react to spending, debt, and output changes as Davig and Leeper (2011). By including debt, the rule captures debt stabilization mechanisms while the coefficient on output measures automatic stabilizers. This identification is subject to much controversion. Despite the great need to identify this fiscal behavior, there is no commonly accepted rule such as the Taylor rule for monetary policy. Thus, the fiscal instrument and the general setup differ significantly across papers. According to Ferrero (2009) and Portes and Wren-Lewis (2015), countries within currency unions should compensate for monetary inflexibility through inflation control and shock absorption. The large efficacy through the price channel and inflexibility of the monetary channel can be supported by this work. Kirsanova et al. (2007), which uses a similar NK-Model as the one in this paper, analyzes the optimal policy rule. The authors find support for a rule that reacts to output, inflation, and also terms of trade to stabilize the economy due to the large importance of trade in currency unions (Gali et al. (2007)).

Furthermore, unlike the previous works, I allow the coefficients to switch between regimes. Previous literature has mostly dealt with regime-dependent monetary policy (e.g., Davig and Doh (2014), Petersen (2007), Malmendier et al. (2021), and Bianchi (2012)). However, empirical evidence shows the existence of regime instability not just in the monetary but also in the fiscal sector (for the US: Leeper et al. (2017) and Chang et al. (2021), for the EU: Hauptmeier et al. (2010)). Blanchard and Perotti (2002), Gechert and Rannenberg (2018) and Mittnik and Semmler (2012) also find that the size of multiplier varies across the business cycle, Auerbach and Gorodnichenko (2013) further account for the time-varying character of fiscal coefficients, where the aforementioned papers base their analysis on the business cycle. Favero and Monacelli (2005) provide further support for a regime-switching model by showing that a VAR Regime switching fiscal rule matches the existing data much better than a constant regime, where the results are characterized by a high response of taxes to a government spending increase. My paper is based upon the New Keynesian model from Davig and Leeper (2011) implementing time-varying fiscal coefficients. Fiscal policy is said to respond with taxes towards changes in debt, output, and government spending. Based on the aggressiveness in which taxes respond, I define two states: A *highly intense* regime shows higher responsiveness towards spending and debt than a regime with *low intensity* regime. This definition refers to the definition of Leeper (1991); however, my model stays in the stable equilibrium of monetary dominance, and fiscal policies differ in their degree of debt reduction.

Thus, I subtract from monetary regime switching in contrast to Davig and Leeper (2011). Since monetary policy is central within a currency union, fiscal policy remains the only option to counteract individual shocks. While in the US, the central bank can perfectly adapt to the federal government's behavior and vice versa, the currency union members, however, take monetary policy as given. Consequently, as the union consists of numerous small countries, a larger focus should be given to trade and neighboring countries' behavior

(Kirsanova et al. (2007), Vetlov et al. (2017)). Having a monetary union then leads to issues on spillover effects between the core members and the periphery (Blanchard et al. (2017), Coenen et al. (2012)). Auerbach and Gorodnichenko (2013) find proof for cross-country spillover effects on multipliers, as well, while in 't Veld (2013) argues these effects depend on each country's openness. While similar to this paper, Cwik et al. (2011) finds that spillovers between members are small and negative when the EURO is affected. However, in contrast to previous literature, I use a two-country model displaying only inter-EMU trade. Channels of fiscal shocks are then determined by the size and openness of the member as in Corsetti et al. (2010).

This paper, thus, focuses on fiscal multipliers for members within a currency union, where governments switch within different intensity states of passive behavior similar to Davig and Leeper (2011), of which households are fully aware. However, the regime mixes define the interdependence between a member's and the union's fiscal policy. I then compare the effect of country-specific, union-wide spending shock and their spillovers under these circumstances. The relative price level and monetary policy centralization are drivers of fiscal stimulus efficacy.

4.3. Motivation- Some Empirical Findings

The introduction of time-varying fiscal policy rules in my model is based upon the assumption that structural breaks exist in the data. Accordingly, I estimate whether the fiscal sector is switching in its responsiveness (*low vs. high intensity*) of taxes towards the following variables: debt, output gap, and government spending. Furthermore, I empirically estimate the correlation between output's reaction towards fiscal spending and the state of fiscal policy accounting for the tax elasticity on government spending.

I first apply a Markov Switching VAR(1) for 13 EMU members (N=13) to obtain state probabilities of fiscal behavior. Fiscal policy is defined by the rule as in Davig and Leeper (2011),thus, I let taxes net transfer on imports and goods τ_t respond towards changes in gross public debt b_t, output gap $\hat{y}_t$ and government expenditures g_t,

$$\{Y^{\tau}\}_{ti} = \boldsymbol{A_i}(\boldsymbol{S^{\tau}_{t,i}})\{Y^{\tau}\}_{t-1,i} + \epsilon_{t,i}, \text{ with } \{Y^{\tau}_t\} = \left\{1 \ \tau_t \ \hat{y}_t \ b_t \ g_t\right\}', \quad i \in [1, ..., N]. \tag{4.1}$$

A_i contains the resulting coefficients for each country i, and $S^{\tau}_{t,i}$ defines the state of country i in period t. I use quarterly data from 1995 to 2020 for most countries, with some series starting in the first quarter 1998. The reaction coefficients switch across both states according to their estimated transition probabilities. Depending on these coefficients, I allocate the resulting states into high and low-intensity regimes. Equation 4.1 is estimated for each member and on the union-wide level to determine its regimes across time. For example, when looking at Germany, the structural breaks in the data are supported by the changes in legislation. Figure 4.1 shows a highly intense behavior as its predominating regime throughout the past years. However, for some short time during recessions, the regime switched with a structural tax change in 1997. The financial crisis in 2008 and the introduction of the business cycle package (*Konjunktupaket 2*) reduced the lower income tax and increased the basic exemption. Consequently, fiscal policy lowered its intensity for consolidation. The third switch into a low-intensity regime is likely the response to the sovereign debt crisis and

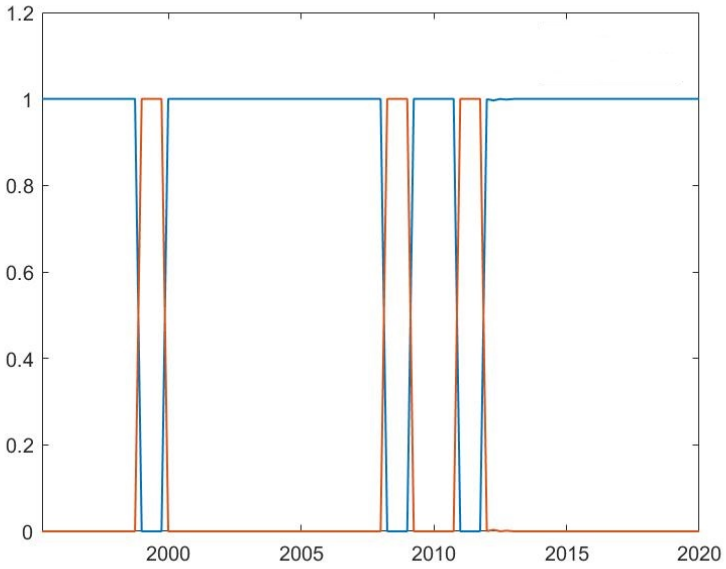


Figure 4.1: Transition Graph Fiscal Policy Germany, blue: High intensity, red: Low intensity

the aftermath of the financial stabilization mechanisms.

For a smaller economy such as Spain, Figure 4.2 shows a similar pattern, for which most time is spent within a regime of high intensity. However, Spain went into a low intensity regime primarily throughout the financial crisis to dampen the shock to its economy. Consequently, debt was going up, with 2013 hitting the mark of 100% of GDP. Large debt levels across the periphery introduced consolidation plans in 2011 to fulfill the Stability and Growth Pact. This consolidation then led to a transition into a high-intensity regime in 2012.

I also estimate monetary policy regime-switching to see whether different states' responsiveness to the real interest rates matters for the output reaction towards government spending. In my setting, active monetary policy is characterized by a larger reaction of nominal interest rate on union-wide inflation increases. Thus, the regime with the largest coefficient on π_t determines the inflation targeting one.

$$\{Y^m\}_t = \boldsymbol{A}(\boldsymbol{S_t^i})\{Y^m\}_{t-1} + \epsilon_t, \text{ with } \{Y_t^m\} = \left\{1 \; i_t \; \hat{y}_t \; \pi_t\right\}'$$

Since monetary policy is less flexible within a currency union, the nominal interest rate only reacts to the union-wide price level and output gap. I obtain state probabilities for both regimes in all three authorities, determining the likelihood of one in each period. Thus, this estimate serves as an indicator of when each state prevailed.

To show that these resulting regime switches serve as one indicator for different sizes of multipliers, I analyze whether the elasticity of GDP to spending significantly correlates with policy changes. Thus, I again estimate a Markov Switching VAR(1) of output on government expenditures to determine structural breaks in its relationship. Moreover, to correct for endogeneity, I include the country-wide inflation π_t and interest rate i_t, similar

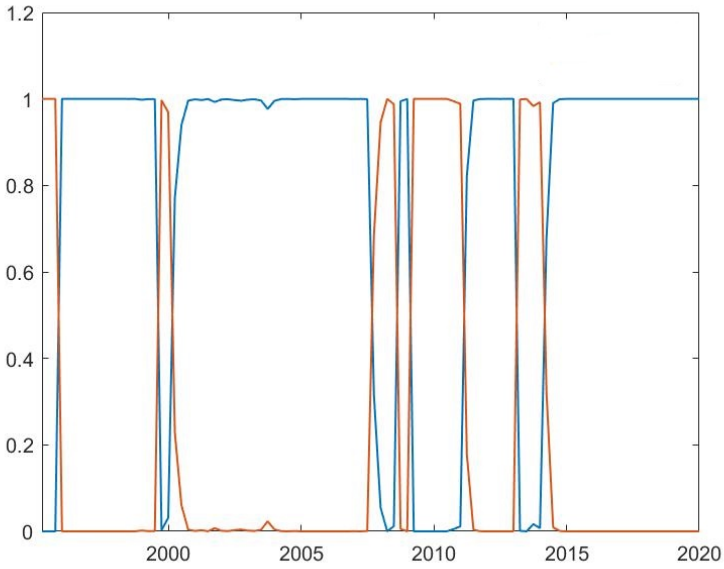


Figure 4.2: Transition Graph Fiscal Policy Spain, blue: High intensity, red: Low intensity

to Favero and Giavazzi (2010). For all countries $i \in [1; N]$,

$$\{Y\}_{i,t} = \boldsymbol{B_i}(\boldsymbol{S^y_{i,t}})\{Y\}_{i,t-1}, \text{ with } \{Y_{i,t}\} = [1, y_{i,t}, g_{i,t}, i_{i,t}, \pi_{i,t}]',$$

where B contains the coefficients and $S_{i,t}$ defines the state in period t. The resulting coefficients then serve as determinants for the regime classification. In this case, I divide them into a *high* and *low* elasticity state based on the coefficient on g_t. Thus, a larger output reaction towards increased government expenditures indicates a higher impact on spending measures. The respective state probabilities then serve as the dependent variable when analyzing the impact of regimes on them.

To measure the relationship between policy and elasticity regimes, I include the three state probabilities of active monetary policy and low-intensive fiscal policy regimes as independent variables and measure their impact on the likelihood of being in a high elasticity regime. And hence, I use a Fixed Effects Regression with Panel data, where ζ_i and η_t are included to correct for country and time-fixed effects,

$$\begin{aligned} Prob(S^y = 1)_{i,t} = \beta_0 + \beta_1 * Prob(S^\tau = 1)_{i,t} + \beta_2 * Prob(S^{\tau*} = 1)_t + \\ + \beta_3 * Prob(S^m = 1)_t + \zeta_i + \eta_t + D^{Rec}_{i,t} + \nu_{t,i}, \end{aligned} \tag{4.2}$$

where S takes the value of one whenever a regime is active or has a low intensity of debt reduction (domestic FP: S^τ, union FP: $S^{\tau*}$, MP S^m), or when GDP is reacting strongly towards spending (S^y). D^{Rec}_t describes the dummy variable that takes the value one whenever for times of recessions within the European Monetary Union. Multipliers might be overestimated in active/low-intensive regimes as this regime mostly prevails during recessions. By including a dummy variable, I correct for the impact of policies on multipliers through the business cycle. Monetary and union-wide state probabilities are equal across all countries

and, consequently, have no subscript i. The resulting coefficients $\hat{\beta}_k \forall k \in [1,3]$ describe the estimated probability increases of being in a high elasticity state by an increase in the state probabilities for low intensive fiscal and active monetary policies, compared to their passive/ high intensive opponent. I will, however, not imply causality here due to the parsimonious structure of the model but instead look for a correlation between the likelihood of being in an active/low intensive policy and simultaneously in a high elasticity state. Table 4.1 displays the estimation results of equation **??**, The first column indicates a positive correlation

active/low intensive policy	high Multiplier period ($Prob(S^y = 1)$)	
$S^\tau = 1$	0.145^{***}	0.147^{***}
	(0.029)	(0.031)
$S^{\tau *} = 1$	-0.106^{**}	-0.114^{*}
	(0.043)	(0.064)
$S^i = 1$	-0.020	-0.015
	(0.034)	(0.088)
$(S^\tau = 0)$x$(S^{*\tau} = 1)$	-	0.032
		(0.025)

Table 4.1: Results for the estimation of **??**, statistical significance at 1% ***, 5% ** and 10% *

between a domestic fiscal policy regime that shows a small reaction to debt or spending and the state for high spending impact. This correlation might be supported by the fact that debt-financed expenditures and low consolidation efforts will cause lower current costs of net wealth. Furthermore, on average, union-wide fiscal policy is in a high-intensity regime whenever GDP reacts strongly towards changes in country-specific spending. The statistically insignificant coefficients on monetary policy empirically support the assumption in this paper to restrict monetary policy to its active behavior.

4.4. Model

My model adopts the two-country open economy framework proposed in Chapter 3. However, the definition of monetary and fiscal policy will differ slightly. For one, I include automatic stabilizers in both policy rules. Secondly, while monetary policy stays constant over time in an active regime, fiscal policies vary between a very passive one and one that reacts only slightly toward changes in debt. Thus, fiscal policy is characterized by two states of different intensity. Hence, in the following sub-chapters, I define the setup for the central bank and both governments anew.

4.4.1. Monetary Policy

Within a monetary union, the central bank operates as a centralized actor controlling the interest rate for all member countries simultaneously. This decision is independent of country-specific shocks and their deviations from steady state. Instead, the reaction of the interest rate is based upon a weighted average price level of the whole union,

$$P_t^{EMU} = P_t^s (P_t^*)^{1-s}, \tag{4.3}$$

where s can be interpreted as the relative economic strength. Therefore, a larger value of the parameter s indicates a greater influence of the respective country on the monetary policy implications, resulting in a higher level of alignment between the required and actual

reaction. Contrary to a conventional open economy model, the interest rate may not respond to inflationary pressure in each economy, despite the central bank's inflation targeting. This outcome is consistent with the findings of Gali and Monacelli (2005), who demonstrate that when complete flexibility is not feasible, balancing the EMU-wide price level remains the optimal option. Consequently, the output of the EMU-wide is defined as,

$$Y_t^{EMU} = Y_t^s (Y_t^*)^{1-s}. \tag{4.4}$$

The central bank follows a standard Taylor rule reacting toward deviations in the union-wide inflation rate and the union's output. When expressed in log-linearized form, I obtain,

$$r_t = \rho_\pi \pi_t^{EMU} + \rho_y y_t^{EMU}. \tag{4.5}$$

Equation 4.5 shows that the monetary channel is inflexible. The ECB does not react directly to changes in domestic inflation or output but only to aggregate changes, such that the perceived effect deviates from the actual.

Davig and Leeper (2011) show that within a single closed economy and a fully flexible monetary policy, a reserved price level targeting leads to a larger multiplier through a lower interest rate rise and less intertemporal consumption substitution among the households. In contrast to Leeper (1991) or Favero and Monacelli (2005), monetary policy is not assumed to switch between active and passive regimes, since this paper only focuses on a quantitative analysis considering one stable equilibrium. Moreover, with price level stability being the official goal of the European Central Bank, this assumption matches the bank's main mandate. Thus, ρ_π is held fixed on a value greater than one so that the nominal interest rate moves larger than one for one towards changes in the inflation rate such that the real interest rate increases. A further discussion of existing equilibria for monetary and fiscal interactions within a monetary union can be found in the Appendix.

Nevertheless, despite the assumption of strict inflation targeting, monetary policy in my model might have passive effects for single countries due to its inflexibility in the reaction of the interest rate towards changes in inflation. Thus, a lower λ^* or s in my model allows single countries to experience declining real interest rates as national inflation increases.

4.4.2. Fiscal Policy

While monetary policy is commonly described by a Taylor rule, defining the behavior of fiscal policy differs across the literature. In this model, I rely on a similar definition from Davig and Leeper (2011) that explains how taxes respond to debt, spending, and the output gap. However, in contrast to the previous work, taxes are not lump sum but distortionary income taxes.

$$\tau_t = \gamma_y(S_t^\tau) y_t + \gamma_b(S_t^\tau) b_t + \gamma_g(S_t^\tau) g_t + \epsilon_t^\tau. \tag{4.6}$$
$$\epsilon_t^\tau \sim i.i.d.N(0, (S_t^\tau)\sigma_t^2)$$

Equation 4.6 characterizes fiscal policy in each country. The reaction coefficients on all three variables vary according to a two-state Markov chain. The variable $S_t^\tau \in (0, 1)$ denotes the fiscal policy's state at time t.

I assume there are two different states of fiscal behavior, one that shows a *high intensity* for debt reduction and one that does not (*low intensity*)[1]. The determination of these regimes mainly depends on the values of γ_g and γ_b: the larger they are, the greater the share of tax-financed expenditures, and the more significant any debt reduction efforts through additional tax revenues. A low-intensive fiscal policy is defined as one with a low or even negative reaction coefficient γ_b, and the government reacts weakly or not at all to increases in debt and output. This low-intensive policy is sometimes referred to as *expansionary* fiscal behavior. In contrast, a high-intensive regime is characterized by a tax-financed policy that keeps debt low. Thus, γ_g and γ_b should be large and positive. In both regimes, the coefficient on the output gap γ_y determines fiscal policy's counter or pro-cyclical behavior.

Government spending follows a simple AR(1) process with identical and independently distributed error terms,

$$log(G_t) = (1-\rho_g)log(\bar{G}) + \rho_g log(G_{t-1}) + \epsilon_t^g + \epsilon_t^{gU}, \tag{4.7}$$

$$\epsilon_t^g \sim i.i.d.N(0,\sigma_g^2), \quad \epsilon_t^{gU} \sim i.i.d.N(0,\sigma_{gU}^2) \tag{4.8}$$

where ϵ_t^g defines country-specific shocks and ϵ_t^{gU} government spending shocks that affect both countries so act on a union-wide level. Moreover, union-wide measures become more important with greater interdependence between the countries. The financial crisis and the current pandemic are just some examples of shocks affecting the whole union and increasing the need for EMU-wide fiscal policy measures. By analyzing shocks affecting the union, I combine general aggregate multipliers with their spillover and second-round effects.

The fiscal consumption index resembles the one from private households, but with the constraint that only domestically produced varieties can be demanded by fiscal authorities in each country,

$$G_t^H = \Big[\int_0^s g_t(h)^{\frac{\chi-1}{\chi}} dh\Big]^{\frac{\chi}{\chi-1}}; \tag{4.9}$$

where χ defines their substitutability. Using equation 4.9 for the aggregate domestic demand then yields the goods market clearing condition,

$$Y_t = C_t^H + C_t^{H*} + G_t \tag{4.10}$$

so the production is divided into domestic private and public demand and exports towards the rest of the union. As in the private sector, the government is constrained by its budget in each period.

$$G_t = \tau_t w_t L_t + \frac{B_t}{P_t} - \frac{(1+r_{t-1})B_{t-1}}{P_t}. \tag{4.11}$$

Thus, the expenditures and the costs for existing debt need to be financed by tax revenues and new debt. Hence, debt cannot explode and needs to be paid back eventually. Iterating on equation 4.11 and expressing the surplus S_t as the difference between tax revenue and

[1]This is based upon the approach by Leeper (1991), were fiscal policy regimes differ in whether an adaption of surplus fulfills the budget balance and if it requires an adjustment of prices. However, I assume both fiscal policy regimes maintain passive just in different intensities.

spending, the real bond holdings can be expressed as,

$$\frac{B_t}{P_t} = \sum_{i=0}^{N} \frac{S_{t+i}}{(1+r_t)^i} + \frac{B_{t+N}}{P_{t+N}((1+r_t)^i)} \tag{4.12}$$

When N goes to infinity, the last term approaches zero, so the present value of surpluses equals the current liabilities to guarantee stability. Moreover, the increase in government spending in period t leads to a decrease in primary surpluses when an increase in tax revenue does not fully finance them. So the lower the intensity of fiscal debt reduction, the greater the debt burden, which puts pressure on the flow constraint.

4.5. Calibration and Estimation

I calibrate and estimate my model using the Spanish economy and the rest of the EMU. The EMU was chosen due to its interesting features, such as a single monetary sector and fiscal restrictions, as part of the union's legal framework. Additionally, Spain is an appropriate example as it is an average-sized member that allows for comparisons with literature focusing on regional multipliers within the US (e.g., Nakamura and Steinsson (2014). Furthermore, on the one hand, Spain had one of the largest stimulus packages as a response to the Great Recession. On the other hand, with a debt ratio exceeding 120% of its GDP, Spain, in comparison to the Euro Area and Germany, has experienced large accumulations of debt under expansionary policies and periods of austerity, as shown in Figure 4.3.

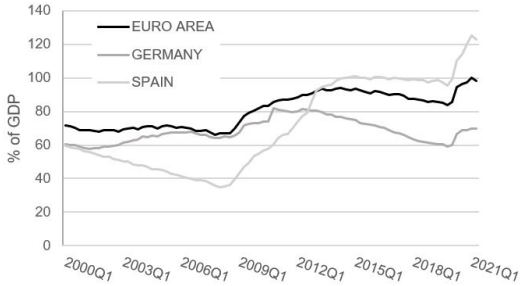


Figure 4.3: Debt to GDP ratio, Source: Eurostat

The model is calibrated to fit the actual data for Spain and the EMU, which is represented by the other country. Regarding the preference parameters, I calibrate σ and σ^* to be the inverse elasticity of consumption growth on the gross interest rate, yielding 6.98 and 7.4 respectively. For the parameter values of ω and ω^*, I use the Frish labor elasticity of 1 for both countries. Regarding the frequency $(1-\theta_H)$ with which firms can set their prices, I use the results from Alvarez et al. (2005), in which the authors find a frequency of 0.21 such that θ_H takes a value of 0.79. For the union-wide price rigidities, I define θ_F to be 0.849, which is taken from Dhyne et al. (2006). These two parameters indicate an average price adaption of more than a year, with the EMU taking longer. These parameter values are consistent with previous price rigidity literature. As ν defines the inverse elasticity of substitution between home-produced and imported goods for Spain and the EMU, I measure the response of import intensity towards changes in the relative prices of foreign goods, yielding a result of

1.3498. β and β^* are derived from the time discount parameter, which proxies the long-term steady-state real interest rate. I estimate their values to be 0.9635 for Spain and 0.9671 for the whole union. However, to maintain a stable equilibrium, I will set both discount factors to one such that both fiscal regimes will maintain passive throughout the analysis. The parameter value, η, takes the value of the long-term ratio of governmental consumption in overall gross domestic production in Spain and for the rest of the European Area: 0.182 and 0.206, respectively. The importance of each member and its weight in the decision-making process by the ECB is measured as its share of EMU's aggregate production. With an average size, Spain takes on about 10% of the total EMU-wide GDP. The share of imports λ and λ^* are set to 19,9% and 7% to match the share of imports to Spain from other member countries relative to overall private consumption spending. The same matching procedure is done for the Spanish exports relative to overall spending within the Euro Area. Table 4.2 summarizes the parameter values for the model calibration. Further sensitivity results on the impact of the calibrated parameter values on the multipliers can be found in the Appendix. However, all the appointed values are consistent with the literature on open New Keynesian DSGE models (Nakamura and Steinsson (2014)[2]).

Parameter	Calibrated Value	Data used
ρ_g, ρ_{g^*}	0.9965, 0.9877	Government Spending Persistence $ln(G_t) = \beta_0 + \rho_g ln(G_{t-1}) + \epsilon_t^G$
σ_g, σ_{g^*}	0.0143 ,0.00503	Standard Deviation of residual ϵ_t^G and $\epsilon_t^{G^*}$
ρ_z, ρ_{z^*}, $\rho_{z_E U}$	0.9766, 0.9667	GDP per Capita Spain, EA $ln(Z_t) = \beta_0 + \rho_z ln(Z_{t-1}) + \epsilon_t^z$
σ_z, σ_{z^*}, $\sigma_{z_E U}$	0.00821,0.00681	Standard Deviation of residual ϵ_t^Z and $\epsilon_t^{Z^*}$
η	0.1823	Ratio of Government Spending to GDP for Spain
η^*	0.2058	Ratio of Government Spending to GDP for EA no Spain
s	0.1013	Ratio of Spanish GDP in EMU
λ	0.199	Share of Imports from Euro Area of overall spending in Spain
λ^*	0.07	Share of Imports from Spain of overall spending in Euro Area
β	0.9635/1	Long run real Interest rate on Spanish Government Bonds $(1 + r = 1/\beta)$
β^*	0.9671/1	Long Run Real Interest Rates on European Government Bonds
ν	1.3498	Elasticity of substitution between Home and Foreign goods in Spain $ln(M/(D-M)) = \beta_0 + \nu ln(P_D/P_M) + \epsilon$
θ	0.79	Alvarez et al. (2005)
θ^*	0.849	Dhyne et al. (2005)
$1/\sigma$	0.1432 (0.0756)	Intertemporal Elasticity of Substitution Spain $\Delta ln(c_t) = \beta_0 + \frac{1}{\sigma} ln(1 + r_t) + \epsilon$
$1/\sigma^*$	0.1351 (0.0407)	Intertemporal Elasticity of Substitution EMU estimated as above
ω, ω^*	1	Frish Labor Supply Elasticity

Table 4.2: Parameter values used in the model, calibrated, estimated, and from literature

Since the states are unknown, the log-likelihood function differs across both regimes. The estimation procedure[3] uses a weighted average of the likelihood function in each state, where the state's probabilities give the weights. However, since the weighting scheme and so the probabilities themselves are unknown and follow a Hidden Markov Chain, the iterative algorithm starts with an a-priori guess and updates the probabilities in each period according

[2]Nakamura and Steinsson (2014) use a very similar model on relative multipliers on US regions but calibrate a lower elasticity of substitution as well as a slightly larger share of imports into both countries. This will serve as a benchmark calibration to my model and can be found in the Appendix.

[3]The Markov Switching policy parameters are obtained using the MATLAB package MS Regress by Perlin (2009) applying a unique equation log-likelihood estimation on the fiscal policy functions noted in (25) based on Hamilton (1994).

to,

$$Pr(S_t = j \mid \psi_t) = \frac{f(y_t \mid S_t = j, \psi_{t-1}) Pr(S_t = j \mid \psi_{t-1})}{\sum_{j=1}^{2} f(y_t \mid S_t = j, \psi_{t-1}) Pr(S_t = j \mid \psi_{t-1})}$$

for k=2 states. The probability of being in a state j, conditional on the current information set ψ_t, is the ratio of the state's weighted conditional density given previous information in the joint densities across both states. Perceiving the set of probabilities, we then receive the log-likelihood in the form of,

$$ln(L) = \sum_{t=1}^{T} ln[\sum_{j=1}^{2} f(y_t \mid S_t = j, \Theta) Pr(S_t = j \mid \psi_t)],$$

which denotes a weighted average of conditional densities and is described by the function $f(y_t)$ given the two states. For the fiscal switching, I use taxes on products and imports as a share of GDP from the OECD database. This differs from the estimation procedure in Chapter 2; however, it better fits the assumption of distortionary taxes. Furthermore, in previous Chapters, I covered 14 countries, for some of which taxes were only available as aggregate revenues. Government spending is constructed by adding general government consumption and investment and as gross public debt held by domestic creditors and the output gap divided by the production. However, the data for the output gap is taken from the AMECO database and interpolated into quarterly data. Results are displayed in Table 4.3 and 4.4, showing the different coefficients across both regimes in Spain and EMU, respectively.

	high intensity Regime	low intensity Regime
γ_y	0.2025***	-0.4312
	(0.0218)	(0.5695)
γ_b	0.0122***	-0.1005
	(0.0035)	(0.0994)
γ_g	0.5172***	0.3179***
	(0.0022)	(0.0867)
σ^t	0.00001***	0.00015**
	(0.0000)	(0.0001)

Table 4.3: Markov-Switching Fiscal Policy Coefficients Spain, Log-Likelihood 374.6472

Table 4.3 shows that the low-intensive regime has a smaller reaction coefficient of taxes to government expenditures than the other regime. Furthermore, the reaction coefficient on debt is negative and, hence, shows no sign of debt reduction effort, in contrast to the high-intensity regime[4]. Additionally, in the low-intensity regime, the higher output, which is usually causing inflationary pressure, is not controlled but rather stimulated by further reducing the real tax. The high-intensity regime, on the other side, is counter-cyclical.

The probability matrix below, which displays the probabilities of switching from one regime to the other, shows that fiscal policy overall is highly persistent:

$$P = \begin{bmatrix} 0.9947 & 0.0328 \\ 0.0053 & 0.9672 \end{bmatrix}$$

[4]Since only one coefficient on debt is positive in order to maintain within the equilibrium and prevent an explosive debt path I set γ_b in the low-intensity regime to zero.

The top left and bottom right corners thereby show the persistence of the first and second regimes, respectively. The other entries define the probability that fiscal policy will switch from low to high intensity.

	high intensity	low intensity
γ_y^*	0.0679***	-0.1118
	(0.0165)	(0.0277)
γ_b^*	0.0111*	0.0120
	(0.0068)	(0.0193)
γ_g^*	0.5164***	0.4401***
	(0.0043)	(0.0129)
σ^{*t}	0.000005***	0.000012***
	(0.0000)	(0.0000)

Table 4.4: Markov Switching Fiscal Policy Coefficients Euro Area, Log Likelihood 442.687

A similar pattern as in Table 4.3 can be seen when looking at the results for the fiscal policy coefficients in the Euro Area in Table 4.4. Again, the first state can be defined as a high-intensity regime with a stronger reaction of taxes toward changes in governmental expenditures and debt. The transition probabilities show again high persistence in the regimes, especially for high-intensity fiscal behavior:

$$P^* = \begin{bmatrix} 0.9963 & 0.0570 \\ 0.0037 & 0.9430 \end{bmatrix}.$$

Thus, being in a low-intensive government can be interpreted as debt financing and standard expansionary behavior. By holding back tax revenues and automatic stabilizers, the economy experiences larger debt that needs to be financed in future periods. This could lead to increases in prices and interest rates. However, increasing taxes immediately will decrease the return to labor, and wages will need to compensate for this, which might also increase prices. Furthermore, additional labor supply might pay back without the need for devaluation through inflation.

To allow for interacting regime switches across domestic and foreign countries, I constructed a total of 4 regimes: Low/Low, High/High, Low/High, and High/Low, where the first denoted the state of the member country and the latter the one of the union. To receive the respective transition probabilities, I build the Kronecker Tensor Product of the two matrices P^F and P^{F*},

$$\bar{P}^F = \begin{Bmatrix} 0.9910 & 0.0567 & 0.0327 & 0.0019 \\ 0.0037 & 0.9380 & 0.0001 & 0.0309 \\ 0.0053 & 0.0003 & 0.9636 & 0.0551 \\ 1.9e^{-5} & 0.0050 & 0.0036 & 0.9121 \end{Bmatrix} \tag{4.13}$$

where the diagonal displays the persistence of each regime and $p_{i,j}$ gives the probability to go to state i after being in j. From the top left to bottom right, it shows the probabilities of staying in the high/high, high/low, low/high, and low/low regime for the next period.

Households include this probability matrix in their expectations about future states. Thus, debt will be financed eventually. Including this interaction, the probability matrix allows some forms of Ricardian equivalence and prevents possible overestimating differences in the financing decision.

I also estimate a time-varying policy rule to define monetary policy coefficients. However, I choose the values for the active state to guarantee a stable equilibrium so that I obtain two states that can be easily classified by inflationary targeting and reluctant behavior towards inflationary pressure.

The monetary policy results for the European central bank can be seen in Table 4.5. With a coefficient α_π larger than one, the first regime is characterized by strong inflation targeting. This indicates that the nominal interest rate increases more than one-for-one when inflation rises, and hence, the real interest rate in the union rises to reduce the price level. The passive regime focuses less on maintaining price stability and cannot pin down

	active Regime	passive Regime
α_π	1.0537^{***}	-0.1785^{***}
	(0.0616)	(0.0054)
α_y	0.3115	-0.2233^{***}
	(0.1259)	(0.0060)
σ^r	2.4912	0.000618
	(1.3772)	(0.0003)

Table 4.5: Markov Switching Monetary Policy Coefficients Euro Area, Log-Likelihood -92.6495

the price level. Especially during recessionary periods, this policy is a common tool to help to stimulate present consumption by increasing the costs of saving. However, the transition probabilities and the duration of the latter regime show that inflationary targeting is the prevailing behavior over most of the horizon.

$$P^M = \begin{bmatrix} 0.9954 & 0.2500 \\ 0.0046 & 0.7500 \end{bmatrix}.$$

For my analysis throughout the model, I use the results for the active monetary regime, describing the ECB as inflation targeting throughout.

4.6. Results

The model incorporates various channels that impact both consumption and output multipliers differently. The income and substitution effects vary in size and direction depending on the two regimes and the type of shock. One of the main mechanisms is the crowding out of private demand through government spending, which increases the price of goods, reducing competitiveness. This effect is larger under the high-intensity regime and is accompanied by greater negative wealth and substitution effects due to distortionary income taxation. Under a domestic shock, the net return to labor decreases due to higher taxation. This leads to increased labor demand and an opposing effect on labor supply, particularly when the government has a high reaction intensity toward debt. Furthermore, as domestic

households shift their consumption towards imported goods, the crowding out of private demand worsens, and labor supply decreases, ultimately increasing wages. Due to high trade intensity and centralized monetary authority, the behavior of other members is crucial when analyzing interest rates and trade channels. Since relatively higher domestic goods prices and a reduction in purchasing power lead to a loss in competitiveness, the output multiplier declines. This effect is stronger for smaller countries and after national shocks. Trade linkages for consumers, on the other side, might be beneficial under a domestic spending shock since prices in the other country remain low. Hence, private consumption for foreign goods is only crowded out when the fiscal stimulus is on an aggregate level. Otherwise, households can substitute expensive domestic goods with cheaper imports. Therefore, the trade channel generates opposing advantages and disadvantages from domestic and union-wide shocks on output and consumption multipliers.

The impact of the real interest rate hinges on both the nominal interest rate and the price level in a given country. The nominal interest rate will experience a significant change only when the overall increase in the price level is sufficiently high. This effect is most pronounced when both regimes show a great debt reduction intensity and government spending affects both countries. In such cases, the rise in the price level fails to compensate for the change in the nominal rate, leading to intertemporal substitution of consumption towards future periods. However, in the case of a domestic shock, the nominal increase in the interest rate needs to be larger to counterbalance the domestic price increase and even stimulate current consumption. Therefore, even though monetary policy is designed to target inflation, its response to the price level is lower for a single member due to its centralization. This result leads to a decline in the real value of debt and allows governments to borrow larger sums of money.

4.6.1. Closed Economy

First, I analyze the effects of different domestic fiscal policy regimes on their multipliers. To achieve this, I simplify the model by considering a closed economy NK model without any trade and with a single monetary authority. This enables monetary policy to react directly to fluctuations in the country's inflation rate and output. Additionally, consumers are restricted to domestically produced goods, and government consumption is a direct substitute for private consumption.

Since domestic firms are the sole suppliers in the economy, the CPI and domestic goods prices are equivalent. This implies that any changes in inflation will be met by monetary policy through the nominal interest rate. The fiscal policy rule is simplified to a 2 state Markov switching process with its transition probabilities, where it switches between high and low-intensity states. Consequently, only one government spending shock needs to be considered.

In the highly intensive regime, taxes significantly impact households, leading to a distortion away from labor and a greater negative wealth effect. As a result, consumption and output are slightly lower in this regime. However, the differences between the two regimes are relatively small, and the time-varying nature of the model further reduces these variations. Figure 4.4 illustrates the impulse response functions of a government spending shock, indicating that taxes increase more with high-intensity governments, resulting in a

subsequent rise in domestic inflation.

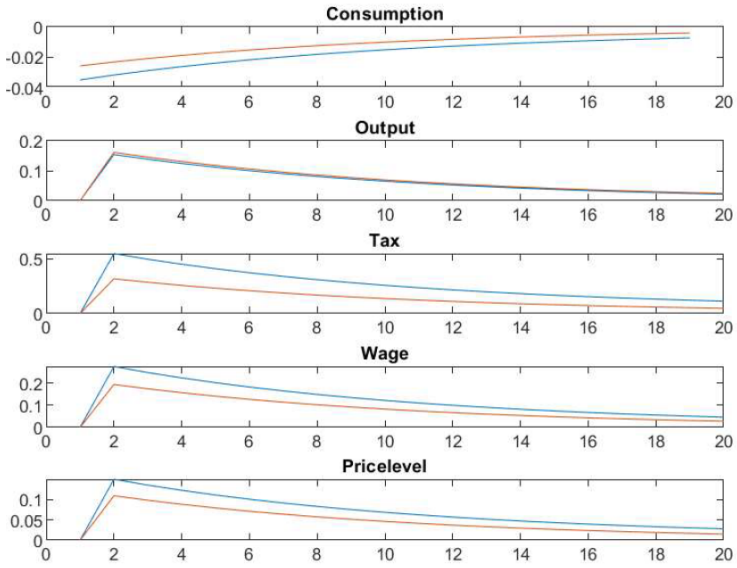


Figure 4.4: IRF to a high (blue) and low (red) intensity fiscal policy regime

As a result, the monetary authority will respond to the increase in inflation by raising the nominal interest rate by more than the inflationary change. This dispersion, in turn, causes the real interest rate to rise, leading to a decrease in current consumption. Moreover, the increase in government spending boosts the demand for domestic goods, stimulating production. However, it also leads to a rise in prices, crowding out private consumption.

To define the final effect of government stimulus on output and consumption, I use the standard cumulative multiplier, calibrated to display everything in output percentages.

$$\text{Cumulative Multiplier:} \quad \frac{\sum_{t=0}^{k} \Delta Y_{t+k}}{\sum_{t=0}^{k} \Delta G_{t+k}} \quad \text{and} \quad \frac{\sum_{t=0}^{k} \Delta C_{t+k}}{\sum_{t=0}^{k} \Delta G_{t+k}} \tag{4.14}$$

where the multiplier is a cumulative sum over k periods. Table 4.6 and 4.7 present the resulting multiplier within a closed economy. Concerning distortionary taxes and a monetary-fiscal regime mix of active/passive, these results are consistent with previous literature (Davig and Leeper (2011)). The effect on output is positive but below one, while government spending slightly crowds out private consumption.

Regime	1 quarter	1 year	3 years	5 years
High	0.84	0.84	0.83	0.83
Low	0.89	0.89	0.88	0.88

Table 4.6: Output Multipliers

Regime	1 quarter	1 year	3 years	5 years
High	-0.04	-0.04	-0.05	-0.05
Low	-0.03	-0.03	-0.03	-0.03

Table 4.7: Consumption Multipliers

In a closed economy, households do not have the option to switch to alternative products. Furthermore, the country experiences a stronger reaction to monetary policy regarding interest rate increases. However, in contrast to an open economy, firms do not face any loss in competitiveness due to increased prices.

4.6.2. Open Two Country Model

Domestic Fiscal Stimulus

Although fiscal independence is diminished upon joining a monetary union, individual countries can still implement their own stimulus packages. Therefore, this section will focus on the impact of a temporary increase in ϵ_t^g, which represents a shock to government consumption of domestically produced goods only. Since government spending at the union level remains unaffected, the foreign coefficients in the fiscal policy rule have minimal influence. As a result, the multipliers vary depending on the domestic regime but show only minor differences with changes in the foreign fiscal state.

A sudden increase in government purchases boosts demand for domestically produced goods since the government cannot acquire imports [5]. The excess demand drives up the price of domestic goods P_t^H, leading to a crowding-out effect on private domestic and foreign consumption. Simultaneously, domestic production and labor demand rise. These effects are consistent across all regime mixes. Domestic regimes differ in their tax responsiveness: Higher initial tax rates generate a greater negative wealth effect, as well as additional distortions away from labor, thereby reducing labor supply. Consequently, the contrast between the effects on labor supply and demand is more pronounced in the high-intensity regime, leading to higher wages. However, these wages cannot offset the negative effects of taxation, and consumption declines more than in an relatively lower intensity state. Thus, fiscal stimulus crowds out private consumption to a greater extent with larger difference in intensity.

Due to low trade interdependence (small λ and λ^*), there is barely any price level spillover, creating a large gap in prices and competitiveness. Hence, domestic firms suffer largely from increased prices since these crowd out domestic and foreign private consumption. Thus, the output multiplier is lower independent of the regime than the closed economy. This is the exact opposite of the consumption multiplier. Since there are other goods available in an open economy, households in both countries can substitute the cheaper options, depending on the substitutability parameter ν. Additionally, due to Spain's relatively small size, with around 10% of EMU-wide GDP, monetary policy does not react with a one-for-one rise in the interest rate towards changes in Spain's inflation. Instead, the real interest rate will decline, yielding intertemporal substitution of consumption towards the current period. With greater intertemporal elasticity of substitution, this effect increases and affects multipliers positively. In the long run, however, consumption declines, adding to the reduction in output over time.

[5] The Impulse Response Functions, which illustrate the responses to a domestic fiscal policy shock when both fiscal policies are changing, can be found in the Appendix.

Regime Mix	1 quarter	1 year	3 years	5 years
H/H	0.810	0.644	0.423	0.3414
H/L	0.810	0.643	0.421	0.3388
L/H	0.860	0.738	0.583	0.529
L/L	0.860	0.738	0.583	0.529

Table 4.8: Output Multipliers

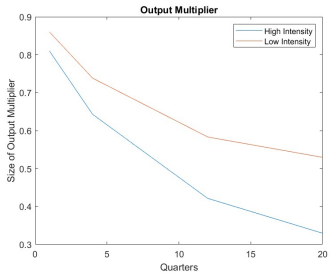


Figure 4.5: Output Multiplier over Time

Figure 4.5 and 4.6 show that the high initial taxation in the passive state causes greater losses in both output and consumption multiplier. Consumption multipliers are small and negative due to the higher price of their most required goods, the negative wealth effect, and the dominance of the distortions. In Figure 4.5 and Table 4.8, the impact multiplier on output is positive but declines over time. Due to limited price level spillover, there are large differences in the real exchange rates, decreasing consumption and output further over time. These results are consistent with empirical literature as shown in Burriel et al. (2010).

The longer the horizon of the multipliers, the more it matters to have low-intensity domestic fiscal policy. Intensive pressure on domestic inflation solely leads to a strong decline in the marginal rate of intertemporal substitution by increasing expected inflation. Thus, with negative interest rates, demand declines long after the shock.

Regime Mix	1 quarter	1 year	3 years	5 years
H/H	-0.016	-0.024	-0.034	-0.039
H/L	-0.016	-0.024	-0.035	-0.039
L/H	-0.012	-0.018	-0.025	-0.027
L/L	-0.012	-0.018	-0.025	-0.027

Table 4.9: Consumption Multipliers.

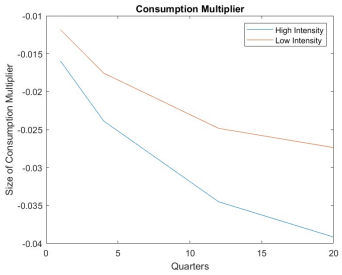


Figure 4.6: Consumption Multiplier over Time

Figure 4.5 and Table 4.8 also show that a domestic fiscal stimulus is generally ineffective (less than one) in open, incomplete markets when taxes are distortionary, and trade is low. Nonetheless, the low/high-intensity regime mix, where price increases are dampened in the domestic country and stimulated in the foreign country, is considered the best option for domestic production. Figure 4.6 and Table 4.9 show that consumption multipliers are largest under a low/low regime mix. It is crucial to determine which country is reacting relatively less intensely compared to the other. This result becomes more dominant when analyzing the effect of a union-wide spending shock.

Spillover Multipliers

In this model, countries such as Spain suffer from large crowding out through fiscal stimulus due to a loss in competitiveness. Loss in terms of trade decreases external demand and makes domestic households substitute for imports. Thus, foreign economies benefit from the

opposing change in terms of trade through a spending shock in another member country. These effects on foreign variables, initiated through changes in domestic government spending, are defined as spillover multipliers. Since fiscal policy is restricted to purchasing only domestically produced goods, governments only influence foreign variables through deviations in the real exchange rate and the real interest rate. These spillovers can go either way: From domestic spending to foreign output or vice versa. Hence, to measure these effects, I define the output spillover multiplier as,

$$\frac{\sum_{t=0}^{k} \Delta Y^*_{t+k}}{\sum_{t=0}^{k} \Delta G_{t+k}} \quad \text{and for the the foreign country} \quad \frac{\sum_{t=0}^{k} \Delta Y_{t+k}}{\sum_{t=0}^{k} \Delta G^*_{t+k}}$$

This definition follows Alloza et al. (2020) as destination spillovers "are constructed as the ratio of the (cumulative) sum of the total impact on the output of a given country originated by fiscal actions in the rest of the countries to the sum of the respective domestic effects in the originating countries." Hence, the following is expressed in terms of foreign increases in government spending in percent of foreign output. To express it not just in terms of effects in the countries of origin but also in domestic GDP, one can transform them by the multiplication with $\frac{\Delta Y^*_t}{\Delta G_t}$ by the relative share of the home country's GDP to the rest of the union ($\frac{Y}{Y^*} = \frac{s}{1-s}$), and the spillover from the union to the member by its inverse.

The resulting multipliers show the impact of a foreign government spending shock on output in the other country. Table E4 and E5 display the results for both kinds of shocks. In either case, one country benefits while it has no additional expenses.

Regime Mix	1 quarter	1 year	3 years	5 years
H/H	0.02	0.07	0.14	0.16
H/L	0.02	0.07	0.14	0.16
L/H	0.01	0.05	0.10	0.12
L/L	0.01	0.05	0.10	0.12

Table 4.10: Effects of a spending shock in the home country on foreign production.

Regime Mix	1 quarter	1 year	3 years	5 years
H/H	-0.01	0.10	0.24	0.30
H/L	-0.01	0.09	0.21	0.25
L/H	-0.01	0.10	0.25	0.31
L/L	-0.01	0.09	0.22	0.26

Table 4.11: Effects of a spending shock in the foreign country on home production.

While a fiscal spending shock in the small member changes foreign output only marginally, the influence of the rest of the union (foreign country) on Spain is relatively large, especially in the long run. The increasing nature of the multipliers has two reasons: First, price adaptions in both countries will take time and second, monetary policy causes intertemporal substitution. The latter effect is greater when the country of origin is larger because monetary policy will react with greater reaction on nominal interest rates. Since I abstract from any bond risk premium, the effects work mainly through the trade channel. Thus, the regime mix that yields the highest multipliers is again when the targeting country shows low intensity in debt reduction, and the country of origin does the opposite.

Government stimulus generates small effects under distortionary taxes and active monetary policy. Thus, the most efficient outcome for a country is achieved when every member except itself raises spending. The largest outcome is reached whenever foreign policy shows a high intensity during their spending shock. Consequently, no country has the ambition to increase fiscal stimulus but rather wait till other countries increase government spending. Because of this demand externality effect (Debrun et al. (2021)), a much larger output at

costs of lower private consumption for no costs might be preferred over previous results. This strategy leads to overall reluctant behavior and, in the end, might lead to only a small stimulus across the union.

Union Wide Fiscal Stimulus

Economic shocks are typically shared among members in a monetary union due to strong co-movement in business cycles. As a result of high trade interactions and a common currency, deviations in one country have quick spillover effects on partner countries. Therefore, stabilization mechanisms are often implemented and better analyzed at the union level. In the analysis of a domestic spending shock, the regime of foreign fiscal policy had no significant impact. However, with an increase in ϵ_t^{gU}, public demand for both goods rises, and both regimes are relevant for financing these expenditures. Thus, in this section, the multiplier represents a combination of domestic and spillover multipliers. However, the difference between γ_b and γ_b^* or γ_g and γ_g^* is relatively small in this calibration. Thus, the difference between the multipliers is small, particularly when trade interactions between the countries are low.

In contrast to the previous section, the demand shock across the union raises the price level not only for domestic but also for foreign goods [6]. Hence, this shock triggers a response from monetary policy, which increases interest rates, prompting households to substitute their consumption for future periods. Consequently, this effect minimizes differences in prices and deviations in both countries' marginal rates of intertemporal substitution. As a result, there is a lower consumption multiplier but an upward trend in their preferred regimes.

Regime Mix	1 quarter	1 year	3 years	5 years
H/H	0.801	0.758	0.696	0.666
H/L	0.802	0.745	0.661	0.616
L/H	0.853	0.856	0.867	0.878
L/L	0.853	0.844	0.832	0.827

Table 4.12: Output Multipliers after a rise in ϵ_t^{gU}

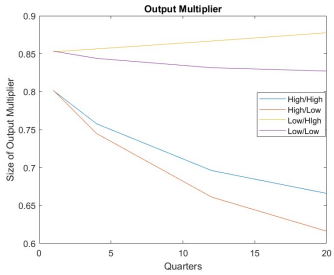


Figure 4.7: Output Multiplier over Time

Table 4.12 and Figure 4.7 illustrate that a union-wide demand shock leads to benefits for the GDP of the domestic country through foreign price increases. The most significant improvement in the terms of trade is achieved when the foreign state shows relatively larger intensity towards changes in debt and spending, resulting in relatively higher foreign prices. This mechanism increases demand for domestic goods and improves the output multiplier by enhancing competitiveness.

However, despite the output benefits, consumption still declines relative to the closed economy and the domestic spending shock. Households now face higher interest rates and overall expensive products, as both price levels are directly affected. In contrast to the previous analysis, where the price level of domestic goods surpassed the aggregate CPI, a

[6] The IRFs for a union-wide shock can be found in the Appendix.

union-wide shock causes the price level of domestic goods, particularly under low-intensity domestic behavior, to be lower than the aggregate CPI. As a result, marginal costs increase due to w_t becoming negative, leading to a decline in labor demand. Holding labor supply constant, wages drop in both regime mixes with active domestic government, further exacerbating the losses in the consumption multiplier.

Regime Mix	1 quarter	1 year	3 years	5 years
H/H	-0.046	-0.048	-0.052	-0.055
H/L	-0.043	-0.045	-0.050	-0.052
L/H	-0.041	-0.042	-0.042	-0.043
L/L	-0.038	-0.039	-0.039	-0.040

Table 4.13: Consumption Multipliers.

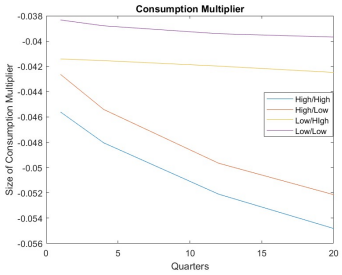


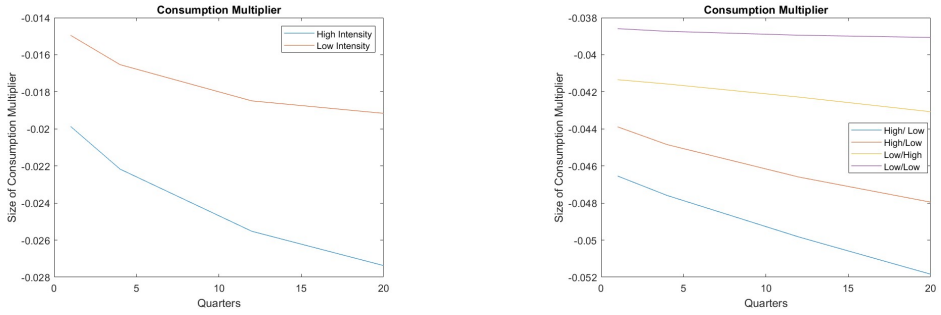
Figure 4.8: Consumption Multiplier over Time

In Table 4.13 and Figure 4.8, the resulting consumption multipliers are shown. Overall, firms benefit from improved terms of trade and higher exports, while households lose the option to substitute cheaper products and face lower net wages and higher interest rates. Thus, the regime mix with the greatest output multiplier is again the low/high-intensity state, while consumption is highest under an all-low intensive behavior.

Trade Intensive Countries

The previous analysis focuses on a small and less trade-intensive country like Spain. I now analyze the effects of fiscal stimulus on a large economy like Germany. Since larger trade intensity leads to greater importance of terms of trade, monetary policy will react stronger to price changes due to its size. Eurostat (2021) reports that German exports make up about 23% of total intra-Euro Area exports while showing a small home bias of only 60%. Furthermore, the country has a higher economic weight ($s = 0.2886$). Thus, given the high interactions with the union, changes in foreign variables would quickly lead to spillover effects.

Hence, independent of whether the shock propagates nationally or on a union-wide level, aggregate inflation will rise as the country is responsible for great spillovers through trade. Also, due to the country's larger size, the monetary authority (ECB) will respond with higher interest rates, causing intertemporal substitution of private consumption to change. Nevertheless, households benefit from their large share of cheaper import products under a domestic stimulus and experience larger consumption losses when foreign prices increase under a union-wide fiscal stimulus. Thus, independent of the type of shock, the consumption multiplier is largest when both governments maintain low intensity and keep goods prices low. This benefit is even more dominant in a trade-intensive country due to a large trade dependency and higher inflation targeting.

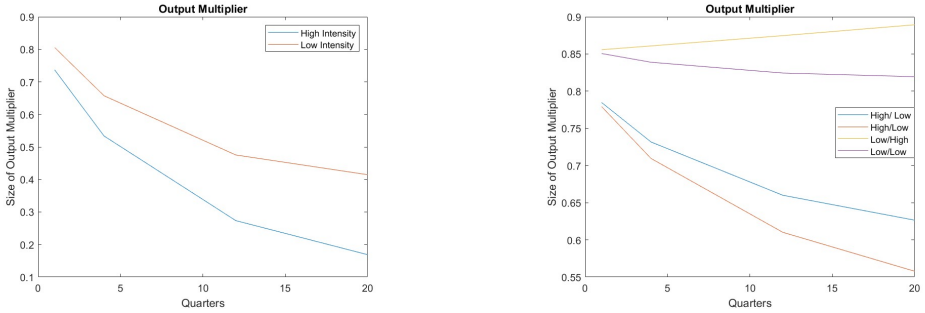


a) Domestic Fiscal Stimulus **b)** Union Wide Fiscal Stimulus

Figure 4.9: Consumption Multiplier

The effect of trade intensity is shown in 4.9, where the curvature is flatter compared to the small country example. These flatter curves are due to the international real exchange rate remaining relatively constant due to price level spillover.

In contrast, the output multiplier in Figure 4.10 benefits even more from a union-wide coordinated solution when the country is large and trade intensive, and thus, competitiveness and low relative prices are crucial. A union-wide fiscal stimulus can increase export demand and higher foreign price levels, benefitting output.



a) Domestic Fiscal Stimulus **b)** Union Wide Fiscal Stimulus

Figure 4.10: Output Multiplier

The overall difference between regime mixes increases with higher λ and λ^* because foreign policy becomes more important for countries that enjoy great trade relations. Furthermore, the opposing effects on the output versus consumption multiplier become stronger, increasing the spread between the advantageous regimes and type of shock. While a relatively lower intensity for the member leads to higher output, consumption decreases in foreign intensity to debt reduction; additionally, union-wide effects are great for stimulating production, but domestic effects dampen the loss in consumption.

4.7. Fiscal Stimulus during the Financial Crisis

In 2009, the Euro Area devised the European Economic Recovery Plan, a fiscal stimulus plan worth 200 billion euros. Around 170 billion euros were allocated to member states, while the remaining funds were kept at the EU level. In addition to this plan, each country provided its own form and degree of fiscal support to aid their respective economic recoveries. According

to Saha and von Weizsäcker (2009), Spain implemented the largest fiscal package in the Euro Area in 2009, relative to its GDP. Especially Spain's expenditures peaked in 2009 due to government stimulus programs that focused primarily on providing additional credit to firms. While Germany concentrated on direct tax reductions and fiscal expenditures, Italy implemented severe austerity measures. Overall, these stimulus measures had both EU-wide and country-specific impacts.

To assess the effect of these stimulus packages, I separate their combined effects into a domestic government spending shock for Spain and another for the rest of the Euro Area. The separation is done by extracting data on government purchases for Spain and the Euro Area from the OECD database and constructing an AR(1) process for each using equation 4.7. For the shock sequence, I use the residuals starting in the first quarter of 2009 for 40 quarters. The results are presented in Figure 4.11:

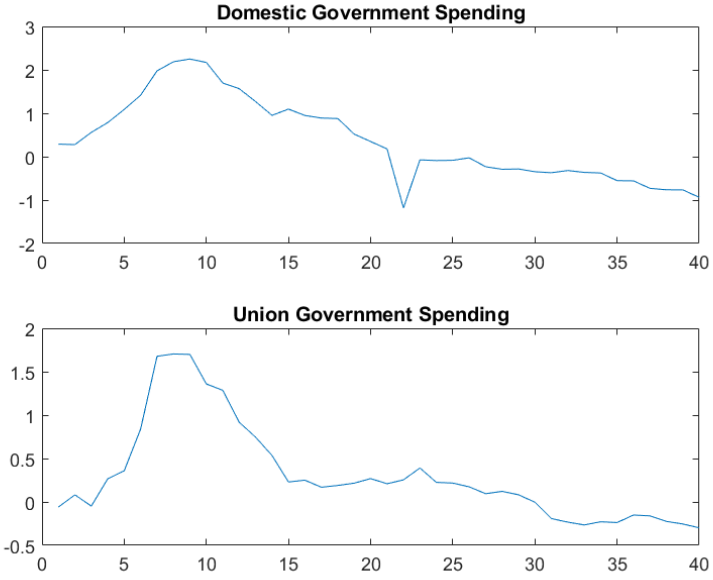


Figure 4.11: government spending shock sequence 2009, Upper: Spain

Despite Spain displaying a higher increase in purchases relative to its GDP than the Euro Area, the path is more gradual. This indicates a slower implementation of fiscal measures in Spain than the sudden union-wide introduction of the Recovery plan in 2010 and a fast consolidation phase afterward. The resulting residuals, ϵ_t^g and ϵ_t^{g*}, represent domestic and foreign GDP shocks, respectively. Both are incorporated into the model to examine the different responses depending on the regime in Spain and the union.

Figure 4.12 illustrates the impulse responses of economic variables in Spain and the rest of the Euro Area using the model from section 4. The significant increase in the interest rate, particularly in the case of a highly responsive union-wide policy, assumes active monetary policy. The overall effects on the Euro Area are mainly influenced by the regime within the union, although deviations relative to the size of Spain are still apparent. The overall inflation is primarily driven by the effect of the union, increasing the interest rate, and a substantial loss in consumption. During this time, fiscal policy maintained high intensity, and monetary policy stayed close to the zero lower bound.

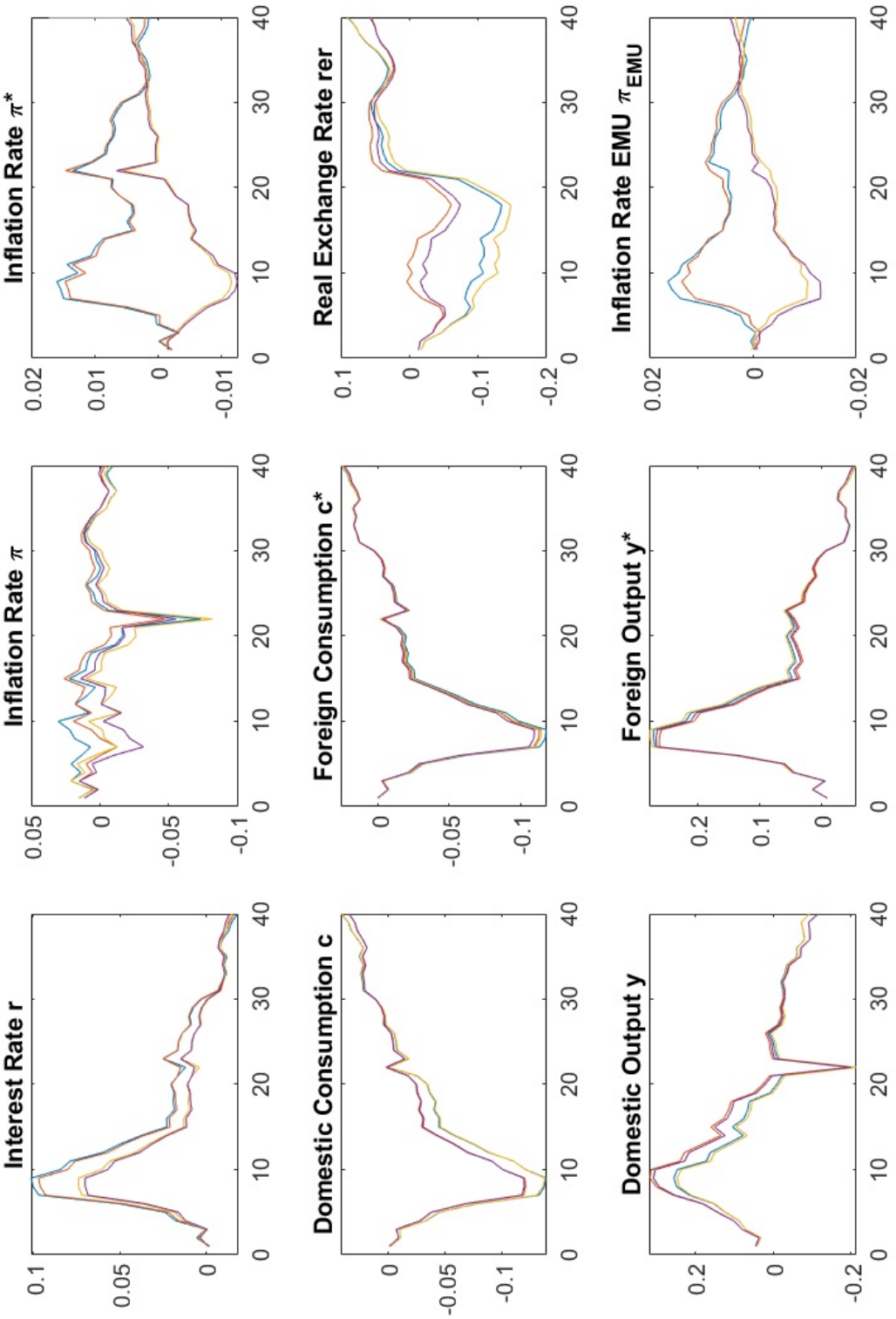


Figure 4.12: IRF of true shock sequence 2009, blue (H/H), red (L/H), yellow (H/L), purple (L/L)

The overall effects are consistent with the analysis in the previous section: It is important to evaluate the independent effects of different types of shocks in union-wide fiscal stimulus packages and to consider differences in regimes. While Spain and Italy were greatly involved in austerity measures in the years following the Great Recession, the rest of the union was likely not, at least not to the same extent. This behavior implied a relatively high intensity for Spain, generating the lowest possible multiplier and explaining the slow recovery in the periphery.

With the *Next Generation EU* plan, the union plans to implement another fiscal stimulus to support economic recovery after the pandemic. This plan, with a total of 800 billion euros, will be the largest fiscal plan in the existence of the Euro Area. Furthermore, various countries have announced similar fiscal measures to promote further stabilization (European Commission and Directorate-General for Budget (2021)). In contrast to the financial crisis, many countries are not constrained by austerity measures dictated by the EU authorities. Thus, Spain and other members will have a greater possibility to achieve higher multipliers due to the subjective improvement of the regime mix.

4.8. Conclusion

My results show that a low relative intensity of debt reduction and tax financing leads to the largest output multiplier. At the same time, the consumption multiplier is still negative but greatest under a low/low-intensity regime combination. Since I use a NK framework with distortionary taxes, my model suggests negative multipliers for consumption and positive ones for output in all cases. However, opposing effects influence the effect of government spending shocks on output and consumption. While firms benefit when the other country is affected by the shock and suffers larger increases in the price level, households prefer to keep foreign products cheap for cheaper consumption and lower real interest rates. These mechanisms are determined by the type of shock and the underlying regime mix and increase with larger trade dependence. Overall, including transition probabilities cannot compensate for the loss in Ricardian equivalence created by distortionary income taxation.

Two direct implications from the output multipliers effects are that a currency union may lead to higher debt and a demand externality (Debrun et al. (2021)). Through the individual superiority of regimes that show small tax reactions towards debt, overall debt levels will rise in the short run. As a response, the central bank will react on a union-wide level and increases interest rates. Thus, higher costs or the possibility of high union-wide future inflation are carried by all members while the country itself benefits. Additionally, low multipliers but relatively large spillovers might lead to a demand externality. Since countries gain the highest benefit relative to costs when there is a foreign demand shock, each country will wait for others to stimulate the economy with fiscal spending. This can imply a too-low union-wide stimulus, despite its largest benefit for all countries. Although stimulus packages need to be financed on the country level, each country benefits mostly through spillover effects. My results validate both aforementioned externalities. I showed that output multipliers are highest when a country has less intensity than the union. However, this would imply a second-best solution in which all members are in a low-intensity regime, and debt levels increase drastically across the union. In addition, multipliers from a stimulus are less

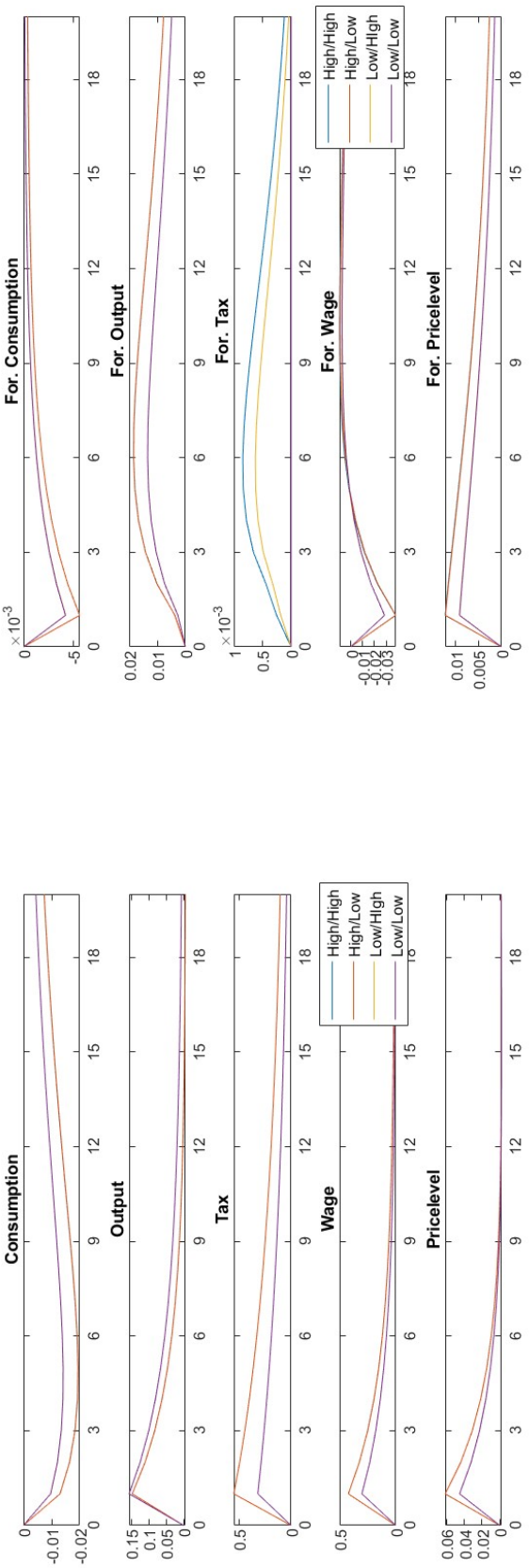
than one for the country of origin. However, they generate positive spillovers, leading to free-riding and low stabilization mechanisms within a currency union.

The Stability and Growth Pact and the Maastricht Treaty restrict fiscal authorities to prevent scenarios following the debt externality. However, the fact that a supra-national organization does not impose them makes possible penalties less credible. Another way to increase effectiveness for struggling countries is to impose a regime solely on their trade partners. Even countries with very high debt reduction efforts can benefit from a higher multiplier if others show an even larger intensity. Overall, the model shows that fiscal stimulus is best done on the union level. Thus, a coordinated fiscal policy for a currency union would benefit all members in times of recovery. An example was the European Economic Recovery Plan in 2008, launched by the European Commission.

With the centralization of the monetary authority, the fiscal behavior of a member and the union has important implications for the efficacy of fiscal stimulus. Without centralization, interest rates would rise regardless of the type of shock and foreign fiscal behavior. Thus, this Chapter emphasizes the importance of analyzing fiscal stimulus in the context of fiscal interdependence when in a currency union. Coordinated stimulus packages generate the highest output multiplier but, at the same time, cause the largest reduction in consumption due to strong inflation targeting, among other things. National solutions can even lead to a decline in real interest rates.

Appendix

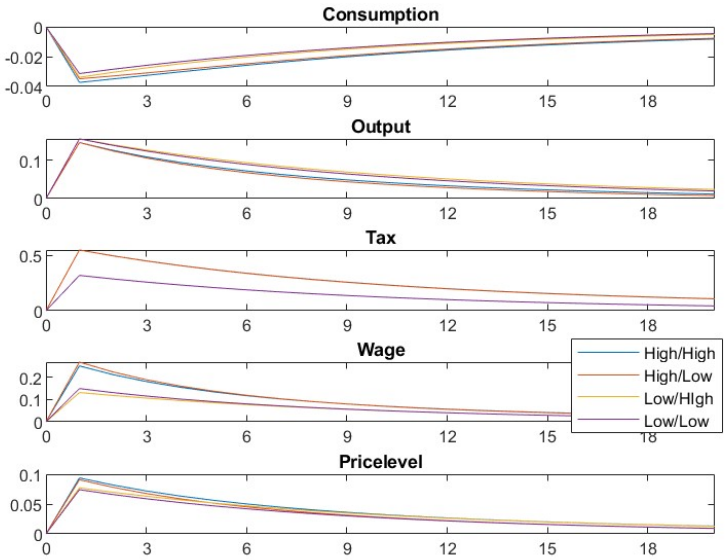
A Impulse Response Functions



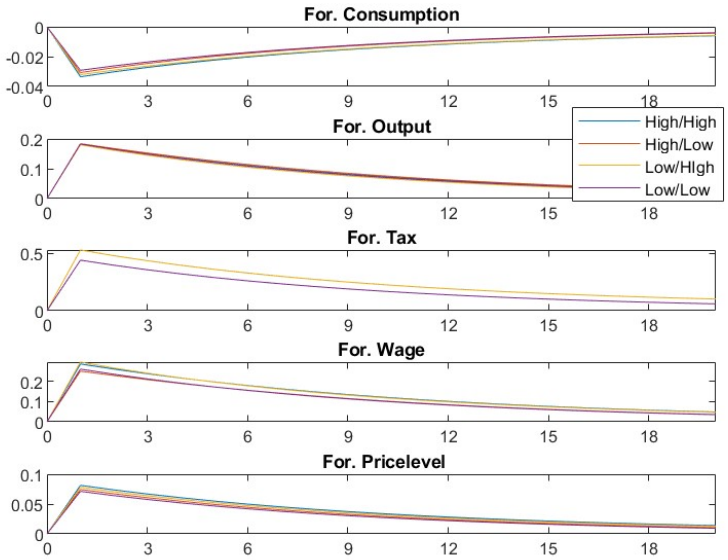
a) Domestic IRFs to a 1% Fiscal Policy Shock

b) Foreign IRFs to a 1% Fiscal Policy Shock

Figure A1: IRF for a Domestic Fiscal Stimulus.



a) Domestic IRFs



b) Foreign IRFs

Figure A2: IRF to a Union Wide Government Spending Shock

B Sensitivity Analysis

Price Rigidities

Increasing price rigidities should lead to an increase in wage and labor demand which is supported when observing the effects of different values of θ_H.

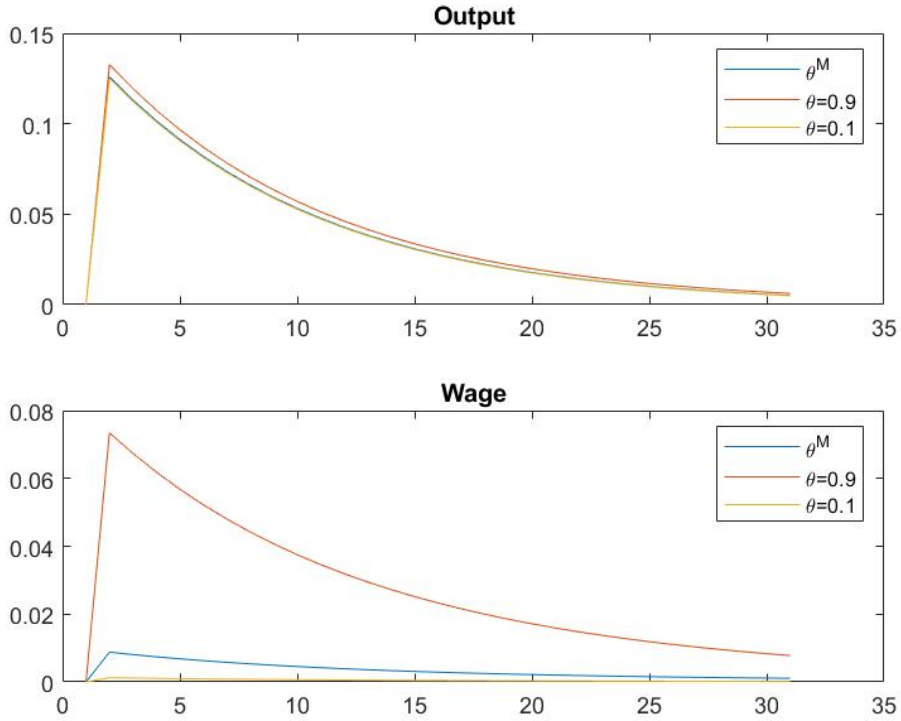


Figure B1: IRF of output and wages at different levels of θ_H, (0.85, 0.79 (calibrated), 0.7)

The initial value lies at 0.379; reducing the friction to 0.1 leads then a smaller effect, and the rise to 0.9, almost fully inflexible, lets wages go up as well as labor demand. When there would be no price frictions, the real wage and the labor demand would not respond other than to the demand increase.

Changing the frictions affects the firm's price-setting behavior. In the flexible price environment, firms would increase their prices so that the demand increase is fully offset. In the New Keynesian model, however, firms have to respond with increases in labor demand. Thus, the greater the friction, the larger the labor demand increase, and the greater the effect on wages. Consequently, output and consumption multipliers are larger under greater price rigidities.

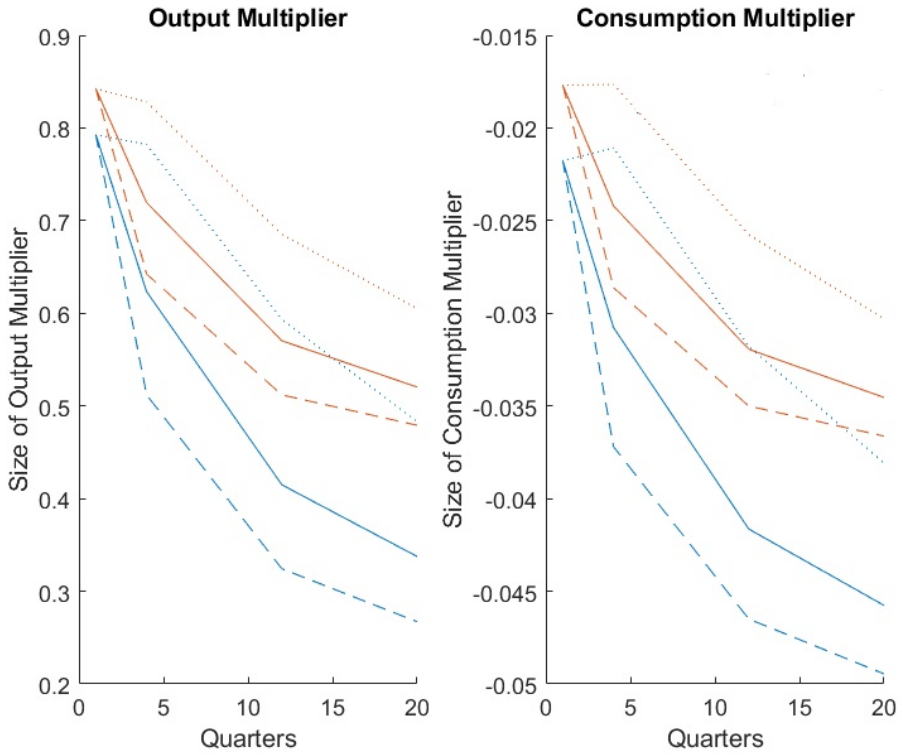


Figure B2: Output and consumption multipliers country spending shock: blue (High), red (Low)

However, independent of the type of shock, the ranking of the regimes stays the same for output multipliers.

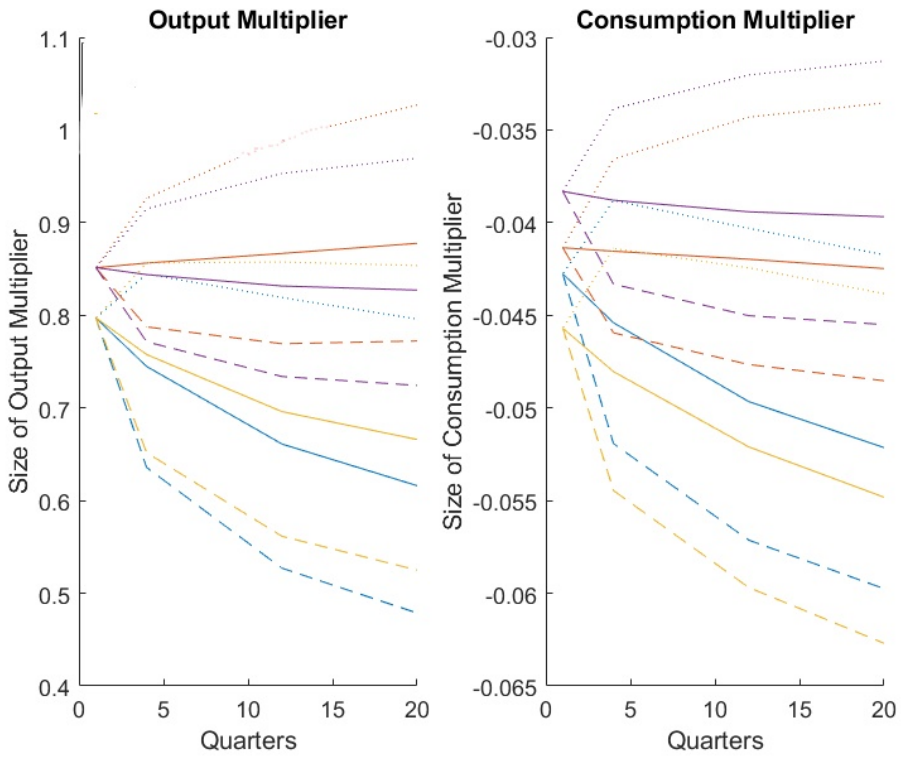


Figure B3: output and consumption multipliers union spending shock: blue (H/H), red (L/H), yellow (H/L), purple (L/L)

Under high-intensity foreign fiscal policy, the relative price level t^H, which determines the real marginal costs, declines. Rising costs let firms' labor demand decline, such that the effects of the price rigidities are reversed. Larger price frictions then lead to greater differences between the regime mixes. However, the ranking as such is not affected.

Share of Imports

The larger the share of imports in the consumer basket, the lower the price effect of the government spending shock on the aggregate price level since the CPI of a country consists of a weighted average. Due to the great contrast between π_t^H and π_t, the relative price level is substantial in a case of $\lambda = 0.9$. This decreases real marginal costs, and firms demand more labor.

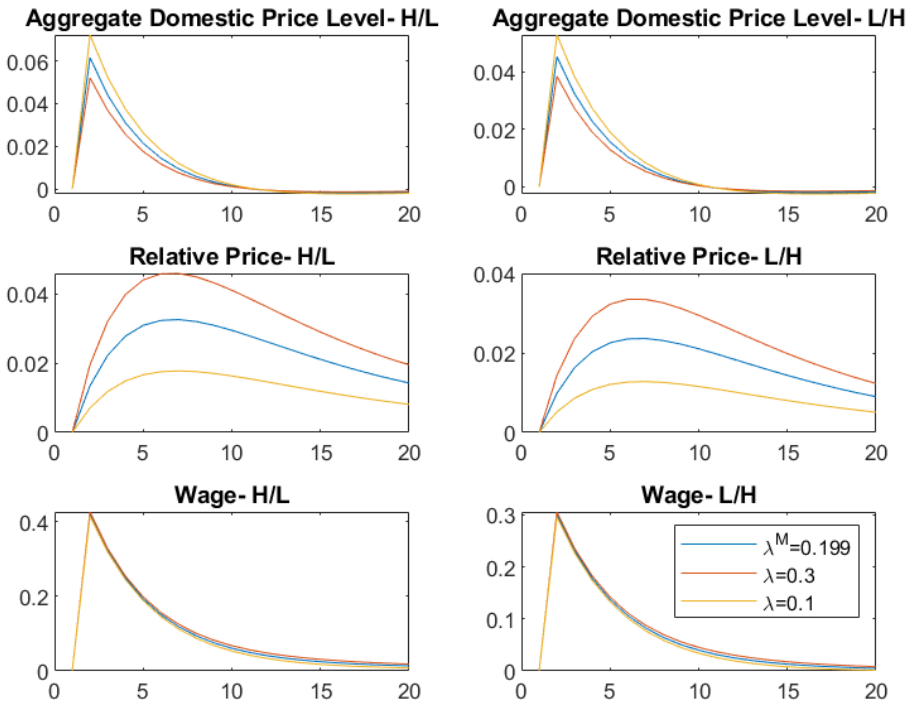


Figure B4: IRF at different levels of λ

The ranking of the regimes concerning the highest multipliers still prevails, independent of the size of λ. However, different effects work through lambda and change the results quantitatively. First, a higher share of imports makes consumers less affected by price changes in their home country, and producers face greater competition. Second, λ determines the relative price level. As imports increase, the price level spillover balances the price level across countries such that real marginal costs, based on the relative price level, increase in the share of imports.

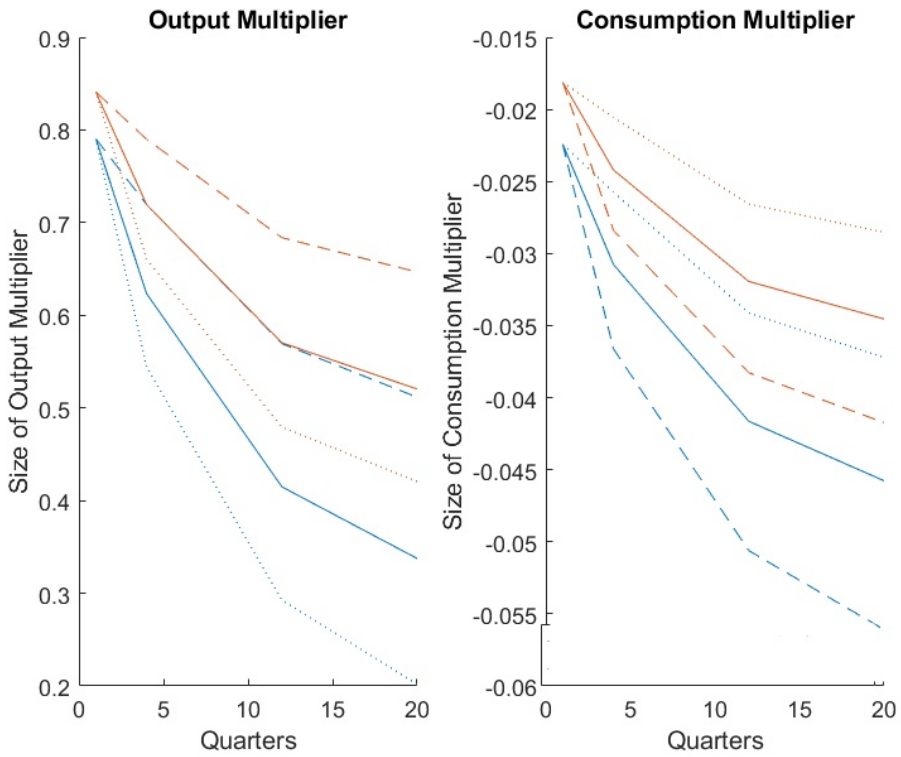


Figure B5: Output and consumption multipliers country spending shock: blue (High), red (Low)

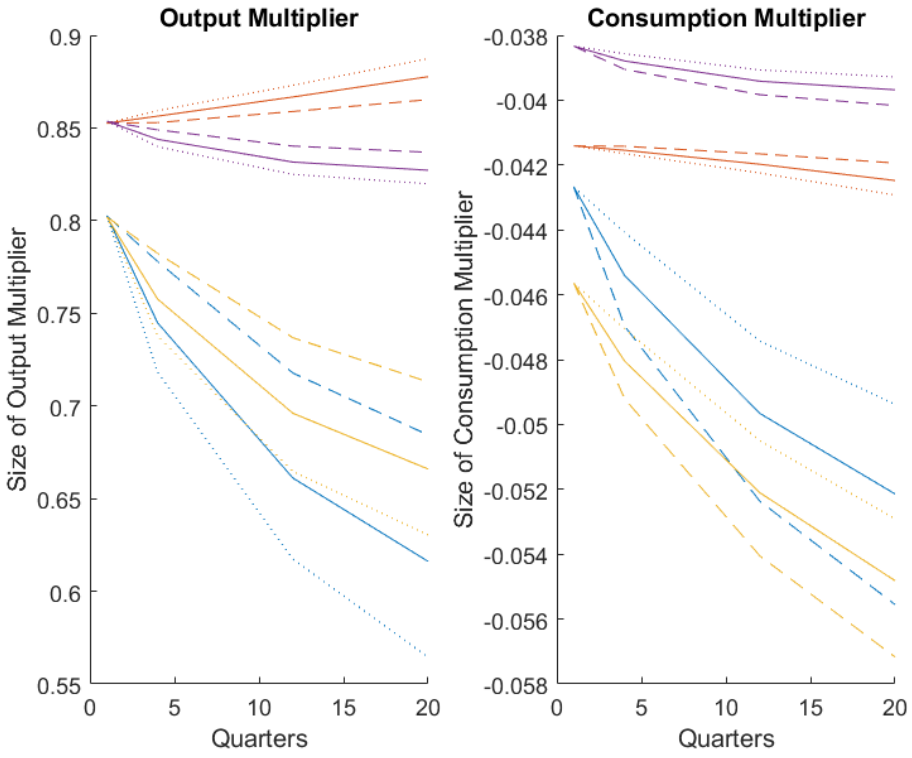


Figure B6: output and consumption multipliers union spending shock: blue (H/H), red (L/H), yellow (H/L), purple (L/L)

Consequently, the effect of a change in λ is the opposite for output and consumption multipliers and high and low-intensity fiscal policy. The channel of the first divergence is due to goods substitutability, and the second comes through the price effect. Both effects are working against each other for producers. However, the ranking stays the same.

Share of Exports

If the share of exports increases, it defines the level of spillover of the government spending shock. The crowding out of foreign consumers increases with the λ^*. On the other hand, firms face higher competitiveness when their products are more important for the foreign consumption basket.

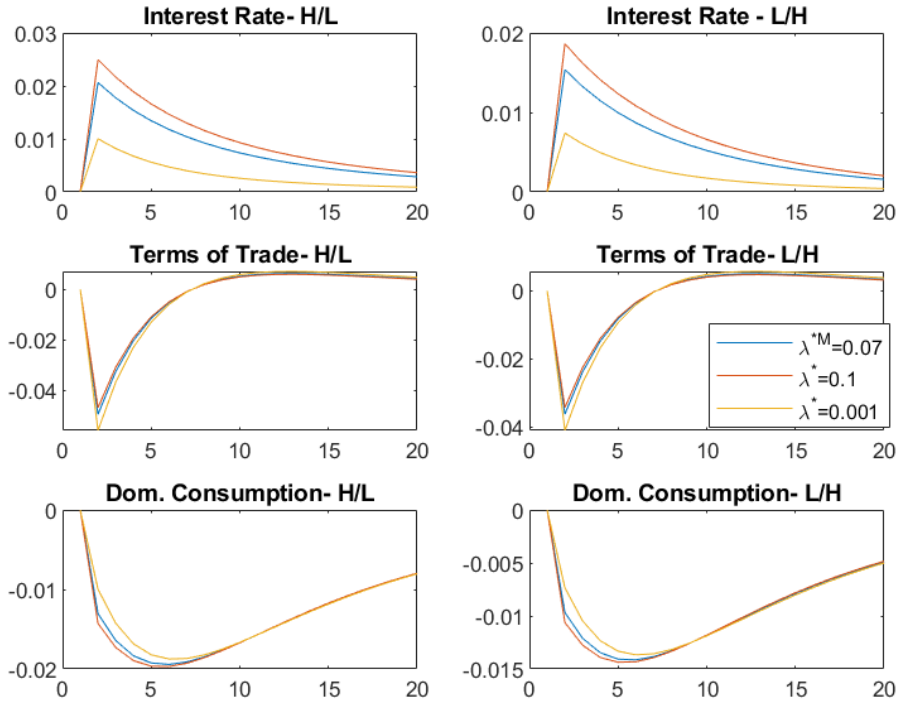


Figure B7: IRF at different levels of λ

With almost no export (λ^*=0.001), foreign producers face no reduction in their relative price level since the price of their products is almost equal to their aggregate price level. This increases real marginal costs and the foreign overall price level to the point where even monetary policy will react with an upward shift in nominal interest rates. Due to the limited spillover, the price level in the domestic country will be as large as to offset this increase, generating a negative real interest rate yielding a greater consumption multiplier.

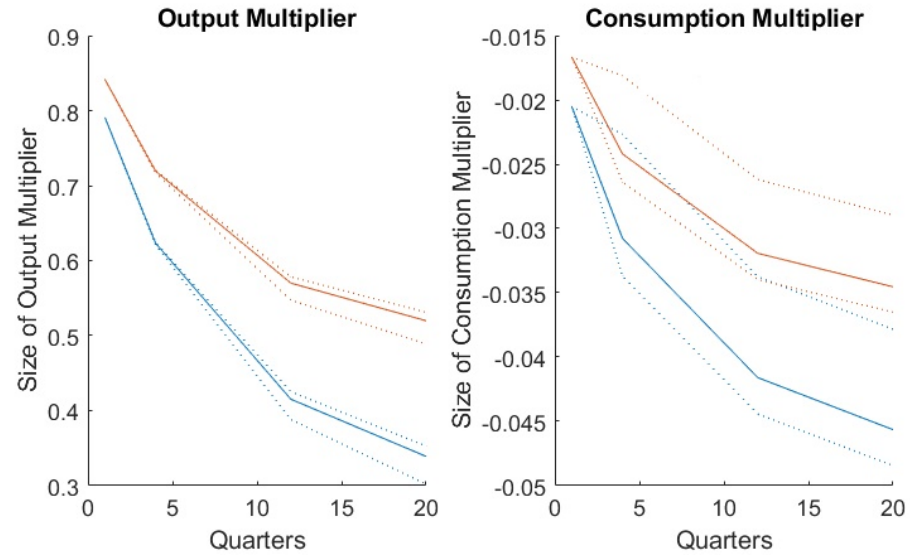


Figure B8: Output and consumption multipliers country spending shock: blue (High), red (Low)

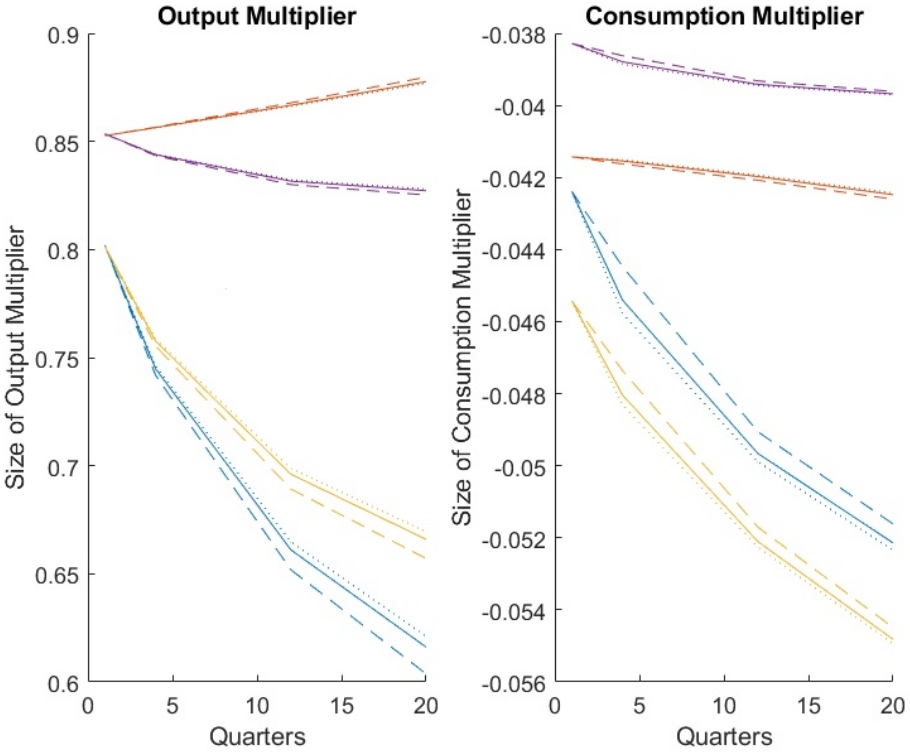


Figure B9: output and consumption multipliers union spending shock: blue (H/H), red (L/H), yellow (H/L), purple (L/L)

Domestic output is barely affected by a change in the parameter value of λ^*. However, consumption changes due to the impact of prices and the interest rate channel. The initial ranking of the regimes for the consumption multiplier is not affected, however, due to intertemporal substitution occurring after a few periods. Under a large share of exports, foreign policy becomes more important for domestic consumers, so regime combinations with

a low-intensive union are preferred. A large country with low intensity of debt reduction keeps prices relatively low, preventing interest rates from rising significantly. Households substitute consumption inter-temporally less, generating a higher multiplier.

Elasticity of substitution for goods

The greater the elasticity of substitution between domestically produced and imported goods, the lower the negative effect on consumption. However, at the same time, this causes greater harm to domestic output. Thus, the elasticity is creating a trade-off here between both multipliers.

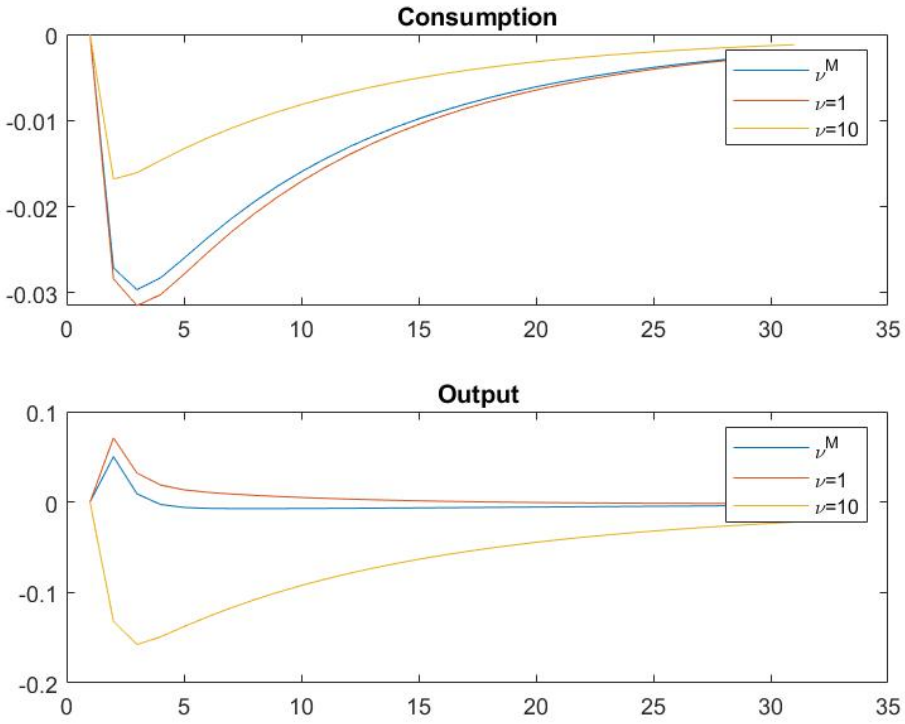


Figure B10: IRF of consumption and output at different levels of ν

With price increases due to higher demand for goods, households substitute relatively cheaper products. In the case of a domestic fiscal shock, this behavior is possible; however, when both governments increase demand, the prices of both become higher. In this case, the relative price increase between both countries determines which product is relatively cheaper and attracts higher consumption.

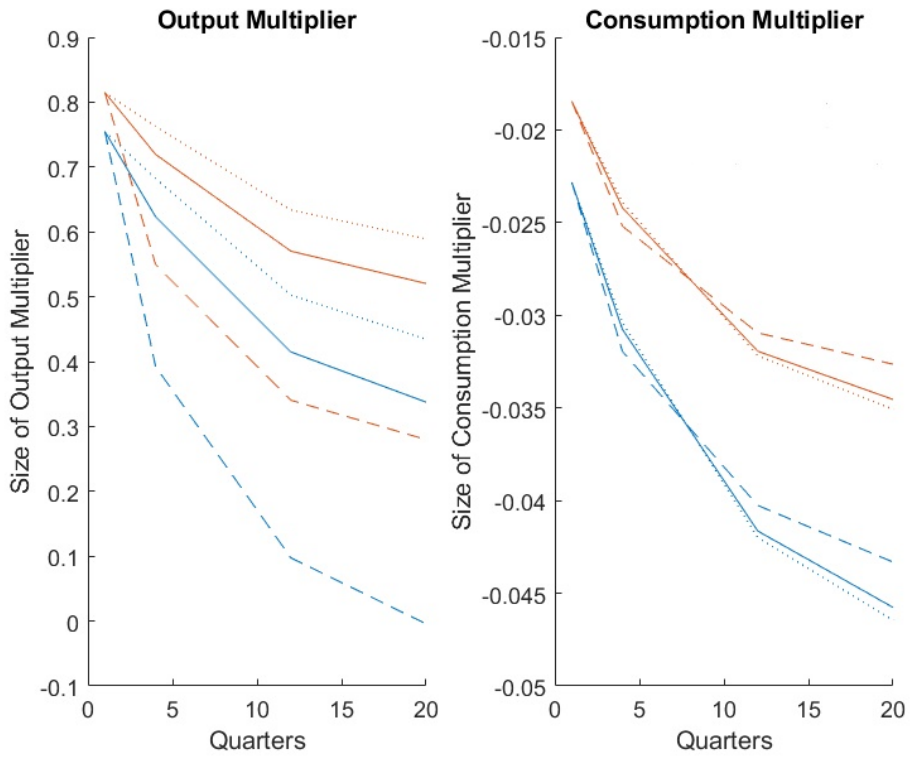


Figure B11: Output and consumption multipliers country spending shock: blue (High), red (Low)

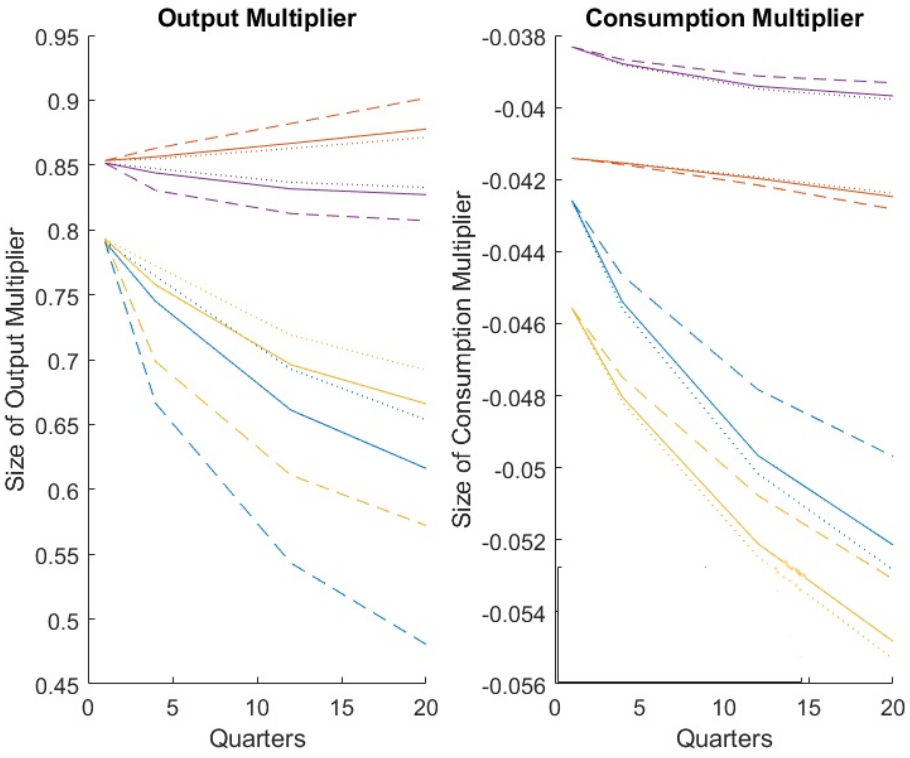


Figure B12: output and consumption multipliers union spending shock: blue (H/H), red (L/H), yellow (H/L), purple (L/L)

An increase in substitutability increases the spread between active and passive fiscal policy since the demand reacts more towards price changes. However, the ranking prevails for all four regime mixes throughout different values of ν.

C Benchmark Calibration Nakamura and Steinsson (2014)

My model follows a similar setup as Nakamura and Steinsson (2014). However, some parameter values differ from the calibration in this paper. Thus, I show that the ranking of the regimes does not differ qualitatively.

Parameter	This Paper	Nakamura and Steinsson (2014)
σ, σ^*	6.89, 7.4	1
β, β^*	0.9635, 0.9671	0.99
ν	1.327	2
s	0.1013	0.1
θ_H, θ_F	0.79, 0.849	0.75
η, η^*	0.1823, 0.2058	0.2
λ, λ^*	0.199, 0.07	0.31, 0.076

Table C1: Parameter Comparison Benchmark Model

Using the values from the benchmark model yields quantitatively different results. For one, the effects on output are dampened by the higher share of imports and elasticity of intertemporal substitution. The latter is responsible for the greater loss in current private consumption under inflation-targeting monetary policy. Nakamura and Steinsson (2014) conclude that, in this case, the multiplier takes on a value of 0.2. This paper supports that finding. While the low-intensity regime reaches a multiplier of 0.381, the high-intensity regime is only 0.1687 (Low/High). On average, this yields a multiplier of 0.275, assuming a similar duration of the regimes.

Figures in C1 and C2 show that the ranking does not change due to different calibrations since the evolution of multipliers over time is similar. Thus, results do not differ qualitatively but only quantitatively.

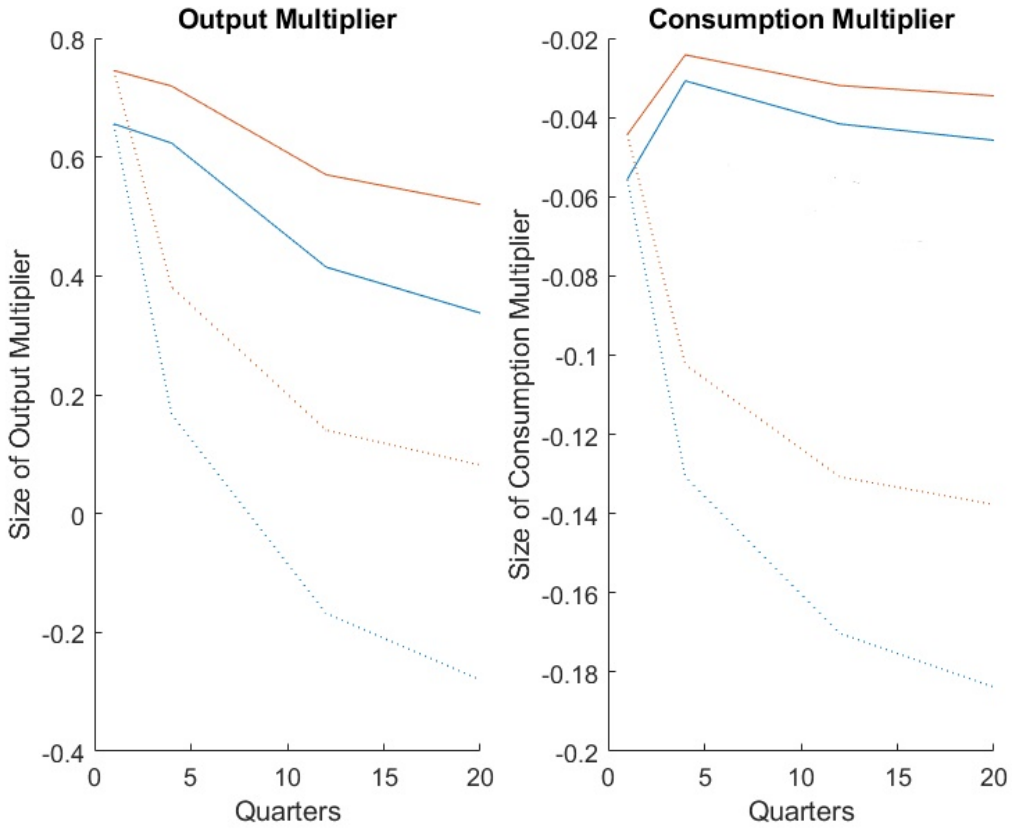


Figure C1: Domestic government spending shock, blue (H/H), red (L/H), yellow (H/L), purple (L/L) dotted: Benchmark

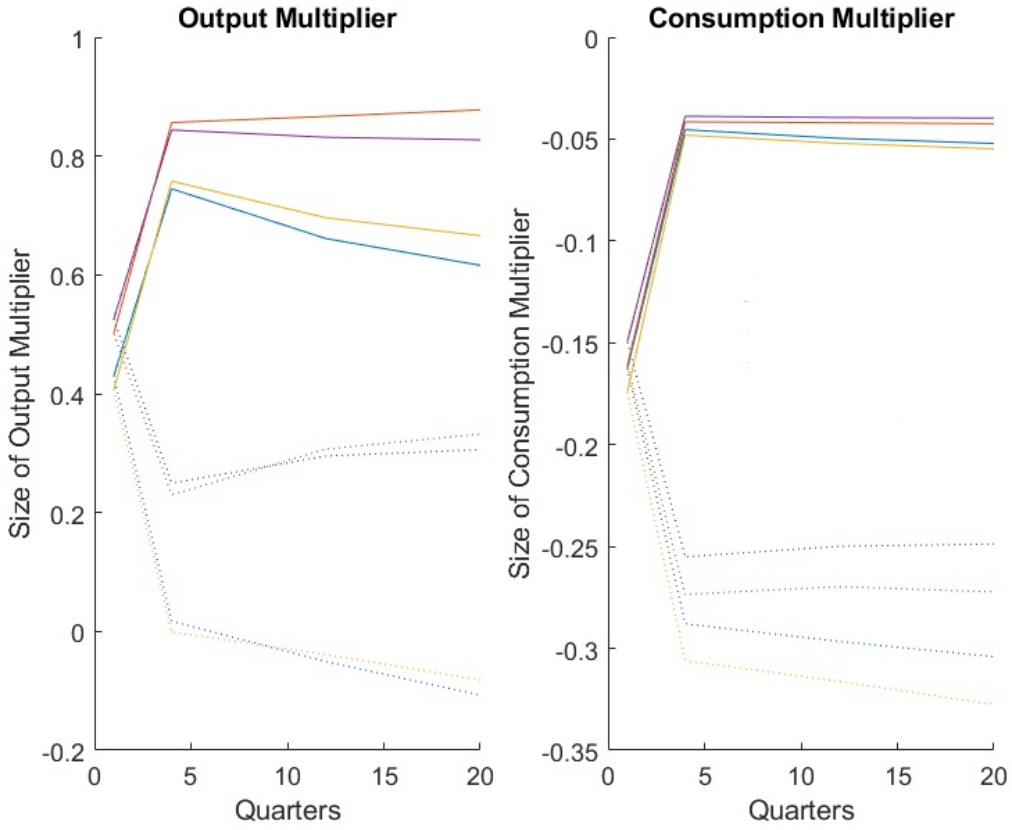


Figure C2: Union-wide government spending shock, blue (H/H), red (L/H), yellow (H/L), purple (L/L) dotted: Benchmark

D Non Switching Policy Functions

Arguing for Markov Switching regimes for fiscal policy behavior yields the opportunity to analyze the importance of the financing decision on economic stimulus. In the following, I estimate and compare the effect of non-switching fiscal policy on multipliers. I first evaluate the responses of taxes toward changes in government spending, output, and debt using a standard linear regression. Table 10 displays the resulting coefficients for the union and

	Spain	Euro Area
γ_y	0.4377***	0.1561***
	(0.0218)	(0.0218)
γ_b	0.0505***	0.0376***
	(0.0035)	(0.0035)
γ_g	0.4835***	0.4875***
	(0.0022)	(0.0022)
σ^t	0.00001***	0.00003***
	(0.0000)	(0.0000)

Table D2: Non-Switching Fiscal Policy Coefficients , Log-Likelihood 320.0473

Spain as an example of an EU member state. All are highly statistically significant and lie mostly between the defined low and high-intensity regime results. However, automatic stabilizers react stronger in this setting. The coefficient for Spain increased to 0.4377, while

it was around half that size in the highly intensive regime and nonsignificant for the other regime. The union shows a similar picture.

Thus, the resulting multipliers for both regimes in Table 11 are significantly lower, especially for output. More precisely, implying a non-switching environment leads to negative multipliers after around five quarters when there is a country individual spending shock. This, however, is not supported by the data. In fact, output multipliers are found to be positive and below one.

	1 quarter	1 year	3 years	5 years
Output Multiplier (Shock to G_t)	0.2822	0.0782	-0.0546	-0.1221
Output Multiplier (Shock to G_t^U)	0.6909	0.6830	0.6593	0.64110
Consumption Multiplier (Shock to G_t)	-0.0330	-0.0398	-0.0446	-0.0471
Consumption Multiplier (Shock to G_t^U)	-0.0876	-0.0894	-0.0939	0.0977

Table D3: Multiplier with non-switching fiscal policies

Only a union-wide fiscal stimulus leads to credible results regarding the impact on a member's GDP. With little below 0.7, shocks to G_t^U show a smaller effect than in the switching setting. However, the difference between the multipliers in both types of shocks is much greater. The need to find a union-wide solution has become even greater than before. Consumption multipliers are again negative and have a similar size as before. The union-wide shock leads to a larger crowding out of private consumption due to increased foreign goods prices. Overall the results are more realistic than the multipliers for output.

In conclusion, assuming time-varying fiscal policy behavior is supported by the data and provides more reliable results concerning the multipliers. Further robustness checks and sensitivity analysis regarding the parameter values and a comparison of the model results using the calibration of the benchmark model from Nakamura and Steinsson (2014), can be found in the appendix section B.

E Spillovers in Terms of Domestic GDP

Regime Mix	1 quarter	1 year	3 years	5 years
H/H	0	0.01	0.02	0.02
H/L	0	0.01	0.02	0.02
L/H	0	0.01	0.01	0.01
L/L	0	0.01	0.01	0.01

Table E4: Effects of a spending shock in the home country on foreign production % of foreign GDP.

Regime Mix	1 quarter	1 year	3 years	5 years
H/H	-0.07	0.91	2.18	2.67
H/L	-0.07	0.81	1.91	2.29
L/H	-0.06	0.94	2.26	2.78
L/L	-0.05	0.84	1.98	2.37

Table E5: Effects of a spending shock in the foreign country on home production in % of domestic GDP.

Chapter 5

Conclusion

This dissertation comprises three chapters. Chapter 3 and 4 cover a theoretical analysis of fiscal monetary and cross-country fiscal interactions on the efficacy of fiscal spending shocks. Both aim to identify the transmission mechanisms responsible for the results that I receive in Chapter 2. Each part analyzes the influence of interdependence between and within different monetary and fiscal regimes on fiscal multipliers, spillovers, and second-round effects. The first covers an empirical estimation using local projections, followed by a qualitative and quantitative approach using a two-country New Keynesian DSGE model with time-varying policy rules. By constructing Taylor-type fiscal policy rules, I allow governments just like the monetary authority to switch between *active* and *passive* regimes. According to Leeper (1991), an active central bank implements strong inflation targeting such that the real rate rises with inflation, not so in the passive state. On the other side, an active government is characterized by an expansive policy that does not adjust the surplus enough to hold debt in check. At the same time, a passive regime shows strong consolidation efforts. These regimes have various implications when considering the effect of fiscal spending shocks in an open economy framework. The present Chapter summarizes this dissertation's main outcomes, discusses the individual chapters' advantages and limitations, elaborates on some ideas for future research, and formulates a couple of policy implications.

Chapter 2 estimates regime-dependent spillover multipliers in 14 members of the European Monetary Union between the period of 1997 to 2020. Using a local projection method with embedded probability regimes, I show that spillovers across countries are positive and large in certain regime combinations. Overall, an *active* fiscal behavior in the receiving country and a *passive* generate the highest multipliers for all. However, regarding the influence of union-wide fiscal behavior and monetary policy, the type of country matters: Highly indebted countries require cheap refinancing costs. Hence a passive monetary authority and active union generate the lowest interest rates. For the average member, however, these two authorities are negligible as the trade channel is more important than the mechanism of interest rates. The spillovers are larger for countries with greater debt and smaller sizes. The first can be explained by the larger marginal benefits of increases in public demand due to a small fiscal space. While small countries benefit from their large import-to-spending share, increasing the effect of terms of trade.

Chapter 3 builds on the preceding Chapter 2, offering a qualitative analysis of the mechanisms responsible for the empirical results in 2. First, it identifies determinacy conditions of different fiscal and monetary regime combinations in a two-country New Keynesian DSGE

model. I find three unique and stable equilibria where monetary policy is not necessarily required to pin down the price level. Instead, the Fiscal Theory of the Price Level argues that the budget constraint of the member or the rest of the union can serve as the identifying equation. A regime phase identification for selected members of the EMU follows this. For that, I take the estimation results from Chapter 2 and conclude when phases were stable, explosive, or indeterminate. My results indicate that Greece, Portugal, and Ireland have been in a multi-explosive regime combination during the financial crisis, where all authorities behaved actively. Simultaneously they experienced a relatively strong increase in their public debt over this horizon. Lastly, the Chapter completes with an analysis of fiscal and spillover multipliers within the three stable and unique equilibria. Results show a largely negative influence of monetary dominant regimes due to high-interest rates. The same argument holds true because of its relatively great size when considering a passive union-wide fiscal policy that raises interest rates, despite a passive central bank. Hence, multipliers are largest when the member is the one to determine the price level, and spillovers are greatest when the union takes over and keeps interest rates low.

In Chapter 4, I calibrate the two-country NK-DSGE model on the Spanish economy and the rest of the union following Lubik and Schorfheide (2005) to assess the quantitative implications of regime interactions. More precisely, I investigate the implications of cross-country fiscal interaction rather than fiscal monetary combinations of multipliers and various spillovers. In contrast to the previous Chapter, however, I keep the analysis within the equilibrium of active monetary policy and passive fiscal policies. Hence, both fiscal policies are then switching according to a 2-state Markov process as in Davig and Leeper (2011) across a slightly and a very *passive* regime. Though in both regimes, the flow budget constraint guarantees a sufficient adaption of the surplus, but both states differ in their intensity of debt reduction. This combination allows me to quantitatively analyze differences in fiscal behavior within the country and across its border on the efficacy of government stimulus programs. I find that rather than the regime itself, its relative passive- or activeness matters in determining the influence on a country's competitiveness. Such that a low intensive government in the member and a high intensity-union generate the largest benefit for firms due to a gain in terms of trade; this is emphasized when the shock originates on an aggregate union level. Consumers, on the other side, prefer the union-wide price level to be kept low with a low intensive fiscal behavior such that interest rates remain low and foreign goods can serve as cheap substitutes. This trade-off between output and consumption decreases with the size of the member. Spillovers are largest when the targeted country shows a relatively low intensity for debt reduction, while the union's behavior matters more for the small members than vice versa.

Some of the findings of the preceding chapters need to be interpreted with caution, as the methods and data used in the chapters of this dissertation dispose of some shortcomings. On this account, the subsequent paragraphs discuss the limitations of this research.

Overall the literature on fiscal multipliers is still in disagreement on their size. While empirical literature finds positive results, spending shocks in theoretical models are often shown to cause significant crowing-out effects (Mahfouz et al. (2003)). The same is true for spillover multipliers, despite the disregard in the existing literature. As models only capture some partial effects, the complex nature of fiscal spending transmission channels is rather

difficult to grasp. In Chapter 2, the resulting multipliers are significantly large and positive, some indicating a multiplier of 5 for highly indebted countries. This large outcome can be due to unexplained feedback or second-round effects. For example, through the strong linkages between countries, an increase in public demand in one member might stimulate production across its border. Consequently, higher demand for intermediate goods imported from other European countries propagates further intermediate and resource production across the union. Moreover, as the OECD economic outlook is only half-annually, the observed time horizon is limited. With large state probabilities of both regimes (close to one) over most periods, only a few observations respond to either state, especially when restricting the sample further by leaving out the financial crisis. Furthermore, as 14 countries remain in the sample due to data availability, some information is left out of the analysis.

Regarding the estimation procedure, retrieving members' state probability following the setup by Davig and Leeper (2011) might yield robust results for monetary policy but not fiscal policy. As the Taylor rule is a commonly accepted definition of monetary behavior, no such status quo exists for fiscal policy. First, the choice of a fiscal instrument significantly affects the resulting coefficients. Second, even the definition of taxes from the data influences results and phases significantly. This issue can be seen in the different tax rates used for the Spanish economy in the estimation of Chapter 2 versus Chapter 4, but also by comparing Davig and Leeper (2007) and Davig and Leeper (2011). Thus, just as Bianchi (2012), the existence of switching monetary policy, in general, is a suitable approach to better fit the actual data, while regime-switching for fiscal policy cannot be identified clearly. A comparison of different fiscal policy rules to best fit the data and explain significant differences in its behavior can solve part of this problem. Additionally, the fact that regime persistence is significantly large, especially in fiscal policy, suggests that regime switches are not likely and not enough to introduce Ricardian equivalence.

The theoretical approach using a two-country New Keynesian model then tries to explain various mechanisms responsible for the results. Despite its relatively high complexity, some important features still need to be added to grasp the whole effect. As the model only represents the union and one member, it ignores any influence coming from outside the EMU border. An increase in fiscal spending in the union shows even larger multipliers for the member than a domestic shock; however, the Euro's appreciation increases with the shock's size. Hence, for extra- EU trade-intensive countries, this generates additional losses in competitiveness.

Furthermore, while in the model, all countries are weighted based upon their share of GDP for any monetary policy reactions, in the past, the ECB has focused its attention on single troublesome members (Drometer et al. (2018)). During the sovereign debt crisis, the focus was mainly on countries struggling to refinance themselves on the market. Hence, monetary policy might be perceived as even more passive for countries without high interest rates and deflationary pressure.

Another shortcoming of the model is the assumption that government spending is restricted to domestic goods only. This feature causes large price effects and prohibits direct transfer across the border, as shown in Chapter 2. Hence, the main driver for these results is the thereby created relatively strong terms of trade effect since the spillover can only work through the trade channel. Additionally, while labor mobility is possible in the union,

it is not in the model. Hence, all effect works through the quantitative labor supply of households.

Another shortcoming of the model is the homogeneity assumption of regime switches. As I assume independence across fiscal and monetary policies, each authority can switch regimes independently of the others. However, there is likely more coordination and strategy behind the scenes. When monetary policy is highly active fiscal policy will likely stay passive such that debt is kept low or a small member will orientate its upcoming switch to fit union-wide fiscal policy. There is various literature on strategic games regarding the interactions of these authorities (Van Aarle et al. (1995), Leitemo (2000), Dixit (2001)). This paper ignores the possible endogeneity of regime switches and their strategic component. Lastly, fiscal stimulus programs such as the Next Generation EU work through various mechanisms besides simple unproductive spending (Bankowski et al. (2022)). Transfers, investments, and tax reductions all cause interacting effects; hence, considering the spending multiplier, only one ignores the influence through those channels. While empirical approaches might then overestimate the true effect of spending shocks by leaving out other responsible factors, theoretical models can only capture some of this.

Despite the discussed weaknesses of the data and methodologies applied in this dissertation, the Chapters address some of the key aspects of regime-dependent fiscal multipliers and spillover effects. Nevertheless, much work remains to be done to understand the mechanisms and conditions responsible for positive and large multipliers, especially in the context of open economies.

The results of this dissertation have implications for fiscal policy on national and union-wide levels and monetary policy in currency unions. First, considering the determinacy of equilibria in open economies allows single-currency union members to behave expansively and still guarantee stability. Furthermore, by defining clear fiscal rules, as in the Stability and Growth Pact, monetary policy receives support in determining the price level. If the central bank, however, fails to meet its mandate as it did after 2009, the union can step in. Overall, being part of a monetary union hinders national governments from behaving unsustainable, yet fiscal coordination *active* regimes can be beneficial in some periods. Furthermore, especially highly indebted countries can benefit significantly from their membership. Through tight trade linkages and a single currency, stimulus programs in other countries can increase their GDP. This indicates stabilization without any expenses. However, whether these results are positive and large depends on the regimes all authorities are in. Thus, when monetary policy remains at the lower bound and other countries maintain a balanced budget, a country without large fiscal space can wait for spillovers. This approach enables new stabilization techniques as some countries can exhaust free-riding possibilities. Smaller countries can benefit, especially when core countries have significantly better economic conditions.

Lastly, this dissertation emphasizes the influence of the heterogeneity of shocks and country characteristics on the efficacy of fiscal stimulus. Trade-intensive countries benefit largely from spillovers and union-wide solutions. A rise in foreign demand will largely spill over through imports and benefit the terms of trade. Especially when a shock is demand-driven, this can stimulate domestic production immensely. However, the smaller the size of the member, the higher the effects of a domestic shock. As monetary policy will only

react to aggregate changes, real interest rates might even turn negative. Hence, it is crucial for policymakers to understand the benefit of various types of shocks and their dependence on certain behavior and characteristics. A small and highly trade-intensive country such as Luxembourg should benefit largely from spillovers but, due to its size, might also engage in domestic shocks. At the same period, countries such as Belgium should abstract from their spending measures due to its tight fiscal space, relatively large size, and share of imports. Furthermore, the EMU can amplify the influence of aggregate spending packages by coordinating fiscal policies across the union such that weaker countries receive a larger benefit. This way, core countries could finance these shocks through taxes and allow for active behavior in countries that require more assistance. This would add to a further synchronization of the union.

Overall, the dissertation outlines several economic, structural, and political factors that significantly impact the efficacy of fiscal spending shocks. By empirically analyzing regime-dependent spillovers, identifying fiscal-monetary stability conditions in a currency union, and determining the mechanisms quantitatively and qualitatively responsible for these results, this work offers a broad insight into the benefit of stimulus programs in currency unions.

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