# Effects of Macroeconomic Shocks on Unemployment Rates Across the Euro Area

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## Abstract

This thesis studies the effects of macroeconomic shocks on unemployment rates across the Euro Area (EA) over the course of a whole business cycle. It consists of three main chapters. Chapter 1 focuses on identifying whether common monetary policy shocks conducted by the European Central Bank (ECB) have effects on national unemployment rates in the member-states of the European Monetary Union (EMU), and how heterogenous the effects are.[1] Chapter 2 examines the extent to which the effects of shocks on unemployment are intermediated by various labor market institutions associated with each of the EA national economies. Chapter 3 looks at gender unemployment differences, asking whether an adverse shock leads to a larger increase in the unemployment rate for females relative to males, taking into account the role of labor market institutions.

***Heterogeneous effects of single monetary policy on unemployment rates in the largest EMU countries***

Employing the baseline New Keynesian dynamic stochastic general equilibrium model with unemployment developed by Galí-Smets-Wouters (2012), we explore the potential heterogeneous effects of the single monetary policy conducted by the ECB on unemployment rates in a monetary union. More specifically, we compare the Bayesian estimates and the implied macro-dynamics using quarterly data for the time period 1999Q1-2017Q4 in the largest EMU countries, namely, France, Germany, Italy and Spain, which also represent four different trends in European unemployment. The results uncover that ECB monetary policy shocks are likely to play an important role in driving fluctuations in national unemployment rates in our

[1] In the whole of the thesis, we use the terms European Monetary Union (EMU) and Euro Area (EA) interchangeably.

EMU sample, not only in the short run but also in the medium and long run. Moreover, the heterogeneity in the effect of ECB monetary policy on unemployment rates is evident in two aspects: first, the unemployment rate increases in all four EMU countries in response to the tightening of monetary policy but with various degrees of dynamic responses in terms of elasticity and persistence. Spain is the most affected, while the effects in France are twice lower, and Germany and Italy fall in-between. Second, the common Zero Lower Bound monetary policy of the post-crisis period manifests itself differently in countries characterized by "low debt-low risk premium" from countries characterized by "high debt-high risk premium": for instance, it results in a reduced unemployment rate in France and Germany but an increased unemployment rate in Italy and Spain.

***Unemployment across the Euro Area: the role of shocks and labor market institutions***

Heterogeneity in unemployment trends across the EA is most likely determined by the inherited diversity of national labor market institutions and mechanisms. Based on a panel data set of 11 EA countries over the period 1999-2013, this chapter empirically analyses the direct effects of shocks and labor market institutions on unemployment, on the one hand, and the indirect effects of labor market institutions on changing the transmission of shocks to unemployment, on the other hand. The shocks consist of: 1) total factor productivity shocks, 2) the real long-term interest rate, 3) labor demand shocks, 4) ECB money supply shocks and 5) ECB unsystematic monetary policy shocks. The labor market institutions cover the unemployment benefit system, active labor market policies, employment protection laws, the system of wage determination and the labor tax wedge. The results suggest that the real interest rate and labor demand shocks significantly affect the unemployment rate in the EA. As for labor market institutions, strict employment protection laws play a favorable role, correlated with a reduction in unemployment. In contrast, a higher tax wedge tends to have an adverse effect on unemployment, not only directly increasing unemployment but also indirectly amplifying the effects of shocks on unemployment.

***Macroeconomic shocks and the gender unemployment gap across the Euro Area***

This chapter aims at shedding light on whether some demographic groups are more

likely to be unemployed in response to adverse shocks. Using data from 11 EA countries over the 2000-2013 period, we first examine the impact of shocks on unemployment rates by gender. The shocks include the rate of productivity growth, the real long-term interest rate, labor demand shocks, and monetary policy shocks. Second, we further disaggregate gendered unemployment rates by age, marital status, and education, and investigate the impact of shocks on unemployment rates of various demographic groups across the EA. We find that reductions in labor demand are associated with a relatively larger increase in unemployment rates for women, particularly for young and less-educated women. Similarly and more notably, a contractionary monetary policy is significantly correlated with a rise in the female unemployment rate, while it does not show any significant impact on the male unemployment rate.

**Keywords:** Macroeconomic shocks, Unemployment, Singe monetary policy, European Monetary Union, New Keynesian DSGE models, Bayesian estimation, Labor market institutions, Interactions, Gender unemployment gap, Demographic composition of unemployment

**JEL codes:** D58, E24, E31, E32, E52, F45, J08, J16, J24

## Declaration

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

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# Introduction

In the 1960s, the theory of the optimal currency area, pioneered by economist Robert Mundell, studied the characteristics by which a geographical region could maximize economic efficiency while sharing a single currency (Mundell 1961). The identification of an optimal currency area is based on a series of criteria, for example: labor mobility across the region, openness with capital mobility and price and wage flexibility across the region, a currency risk-sharing or fiscal mechanism to share risk across the region, and production diversification (Frankel and Rose 1998; Kenen 1969; McKinnon 1963; Mundell 1961). The optimal currency area theory has had its primary test with the introduction of the euro as a common currency across European countries. But since its inception, it has been known that the Euro Area (EA) does not meet all the classic requirements of an optimal currency area. Some critics attribute the EA economic difficulties in part to the heterogeneity among member states, which may ultimately lead to the collapse of the single currency (see, Jonung and Drea, 2010). An important aspect of the heterogeneity of the EA is reflected in the different national labor markets. Compared with the United States (US), the EA has lower labor mobility than the US, possibly due to language and cultural differences. For instance, in 2012, more than 40% of US residents were born outside the state in which they live, while in the EA, only 14% people were born in a different country than the one in which they live (O'Rourke and Taylor 2013). In fact, the US economy was approaching a single labor market in the nineteenth century. However, for most parts of the EA, such levels of labor mobility and labor market integration remain a distant prospect.

The European Central Bank (ECB) has been looking for ways to accommodate heterogeneity, especially when it risks undermining the uniform transmission of monetary policy. Managing heterogeneity between countries has always been a challenge for the ECB. In this environment, monetary policy is more difficult to calibrate. Different transmission mechanisms spread the same shock to different degrees, and the lag may vary from country to country. Therefore, it is important to nurture a better institutional framework that can contribute to increase the effectiveness of a single monetary policy, and to minimize episodes of decreasing output and of employment losses, as experienced during the financial and EA debt sustainability crises.

It is largely within this context that this thesis explores the effects of macroeconomic shocks on unemployment rates across the EA, in the time period beginning from the inception of the EA and covering the 2007 financial crisis as well as its aftermath. In Chapter 1, we identify the potential heterogeneous effects of the single monetary policy conducted by the ECB on unemployment rates in the largest EA countries, namely, France, Germany, Italy and Spain. These four countries have broadly comparable size but display significant heterogeneity in unemployment rate dynamics. There has been a strand of the literature on the effects of monetary policy shocks on unemployment, but it is still an area that needs to be explored to compare the heterogenous responses of unemployment rates to common monetary policy shocks in the EA countries (Karanassou et al., 2005; Ravn and Simonelli, 2007; Alexius and Holmlund, 2008). Our study is based on setting up a medium-scale New Keynesian dynamic stochastic general equilibrium (DSGE) model, which has been widely used for monetary policy analysis (e.g., Christiano et al., 2005; Smets and Wouters, 2007). The canonical medium-scale New Keynesian DSGE models, represented by Smets and Wouters (2007), are critiqued due to the lack of labor market variables, such as unemployment (Chari et al., 2009). A rapidly growing body of research has sought to rectify the limitations of the canonical DSGE models by incorporating labor market imperfections that might result in increases in unemployment (see Gertler et al., 2008; Christiano et al., 2010, 2020). We employ the medium-scale New Keynesian DSGE model with unemployment developed by Galí et al. (2012), which has various advantages in uncovering the heterogeneous effects of ECB monetary policy on national unemployment rates and other labor market features, such as the labor force and the real wage.

According to the evidence provided in Chapter 1, even among countries of broadly comparable size, there are significant differences in unemployment rates in response to a common area-wide shock. In other words, country-specific factors remain considerable, which are related to national labor markets institutions. Chapter 2, therefore, studies the role that labor market institutions play in the context of a single monetary policy across the EA. More specifically, by using a panel data set of 11 EA countries over the period 1999-2013, we empirically examine the direct effects of shocks and labor market institutions on unemployment, on the one hand, and the indirect effects of labor market institutions on changing the transmission of shocks to unemployment, on the other hand. A substantial literature has attempted to explain European unemployment patterns from the perspective of the role of macroeconomic shocks and labor market institutions (see Nickell, 1997; Nickell et al., 2005 for the direct effects of shocks and labor market institutions on unemployment; Blanchard and Wolfers, 2000; Bertola, 2017 for the interactions between shocks and labor market institutions to influence unemployment). However, how labor market institutions intermediate the effects of shocks in a single monetary policy regime is perhaps an open question, which matters to policymakers concerned about the effectiveness of a single monetary policy. We extend the literature by including two common monetary policy shocks, namely the ECB money supply shocks and the ECB unsystematic monetary policy shocks, along with the other three country-specific shocks emphasized in many existing studies: total factor productivity shocks, the real long-term interest rate, and labor demand shocks. Besides, we update and extend the time-varying measures for labor market institutions for the more recent period, covering the unemployment benefit system, active labor market policies, employment protection laws, the system of wage determination and the labor tax wedge. The robust estimation results reveal that generous unemployment benefits, pervasive unionization and high tax wedges play a significant role in determining the severity of shocks on the unemployment rate.

Considering that the labor market position of different demographic groups has always been an important issue in light of widespread concerns about the integration of women into the labor market, youth employment problems, and the employment of the less-educated (See Blau and Kahn, 1997 and Ruhm, 1998 on women's employment; Blanchflower and Freeman, 2007 on youth employment; and OECD, 2011 on the employment of the less-educated), it is interesting to break down the overall unemployment rate and pay attention to how the unemployment rate of different demographic groups is affected by shocks and labor market institutions. Various analyses have assessed gender unemployment differences, but typically focusing on labor market flows, industry composition and human capital characteristics (see Niemi, 1974; Johnson, 1983; Baussola et al., 2015; Razzu and Singleton, 2016; Albanesi and Şahin, 2018). Some multi-country studies have added important insights into the effect of labor market institutions (see Azmat et al., 2006; Bertola et al., 2007; Dieckhoff et al., 2015). However, a very limited literature studies how unemployment rates of various demographic groups respond to macroeconomic shocks. This is the focus of Chapter 3: are women much more likely to be unemployed than men under adverse shocks, and does an adverse shock lead to larger increases in unemployment rates for some demographic groups relative to others? We empirically compare the impact of shocks on the unemployment rates of different demographic groups by considering the intersection between gender, age, marital status and education, and also assess the extent to which the effects of the initial shocks on unemployment are intermediated by labor market institutions. We find that ECB monetary policy has, even if unintentional, gender-biased real effects on economic activity, in this case captured by its significant effect on the female unemployment rate only, and not on the male unemployment rate.

These three main chapters are standalone, but are logically ordered and linked. I also offer overall concluding remarks following the main chapters. The findings of this thesis aim to shed light on the importance of institutional harmonization in a single monetary policy regime, and provide some evidence on the debate among economists and policymakers about the need to move forward with a more common fiscal policy in the EA.

# Chapter 1: Heterogeneous Effects of Single Monetary Policy on Unemployment Rates in the Largest EMU Countries

*Note: A version of this essay has been published as Reading Department of Economics Discussion Paper Series No. 2019-07. This article was co-authored with* Dr Alexander Mihailov *and Prof. Giovanni Razzu; e-mails: a.mihailov@reading.ac.uk and g.razzu@reading.ac.uk. Alexander and Giovanni have agreed that the essay can appear within this thesis, and that it represents a majority contribution on my part. This work was presented at the MMF PhD Conference, City, University of London, 2019; the Centre for International Macroeconomic Studies Easter School and Conference on DSGE Modelling for Emerging Open Economies, University of Surrey, 2019; and the Royal Economic Society PhD Meeting and Job Market, University of Westminster, 2018.*

## 1.1 Introduction

Even before the adoption of the euro in 1999, but definitely thereafter, much has been debated among economists, policymakers and politicians on the various potential heterogeneous effects of single monetary policy conducted by the ECB in the European Monetary Union (EMU) member-states.[2] This chapter sets as its task to focus on a particular dimension of such national heterogeneity in a monetary union, namely, in unemployment rates. Specifically, this study aims to shed light on the effects of single monetary policy on unemployment rates of four major EMU countries: Germany, France, Italy and Spain, which together account for above 75% of the gross domestic product (GDP) in the EMU.[3]

A stylized fact about the labor markets in the EMU is that there are large cross-country differences in unemployment rates across the member-states. As shown in Figure 1.1, the four largest EMU countries during the period of single monetary policy display significant heterogeneity in unemployment rate dynamics.[4] Particu-

[2] See, among others, Guiso et al. (1999), Rafiq and Mallick (2008) and Ciccarelli et al. (2013).
[3] Authors' calculation for 2017 based on the online Eurostat database.
[4] This is why we choose these four highly representative countries as our research samples. They cover, to the greatest extent, different labor market conditions within the EMU, and are comparable, since they all entered the EA right from its inception on January 1, 1999.

larly, the evolution of the unemployment rate in Spain is characterized by a sharp rise since the global financial crisis (GFC), while Germany displays the opposite evolution, revealing a gradual and sustained decline since 2005, no matter the negative consequences of the GFC on output and employment in many other countries. The unemployment rate evolution in Italy features a significant cyclical fluctuation with two peaks in 1999 and 2014 and a single trough in the heat of the GFC in 2007. However, the dynamic of the unemployment rate in France remains relatively stable compared to the other three countries that is captured by the end points of our time period, close to 10% but somewhat below most of the time before the GFC and rising just above 10% after it.

Heterogeneity in unemployment trends within the EMU is most likely determined by the different socio-historical traditions in the design and evolution of labor market institutions across Europe, what we would refer to as "institutional heterogeneity".[5] The notable aspect of this institutional heterogeneity is that it appears to persist even under the common monetary policy, as conducted by the ECB in the EMU since 1999, no matter the harmonization of legislation and the policymaking efforts that attempt to mitigate the inherited diversity of national labor market institutions and mechanisms across the EMU member-states. An exploration into the differences of labor market institutions in EMU member-states is left to Chapter 2. Before moving to such an analysis, we first have to identify any facts about the degree and the dimensions of any potential heterogeneous effects of single monetary policy on unemployment rates in a monetary union.

A strand of the literature has focused on discussing the effects of monetary policy shocks on unemployment. For example, Ravn and Simonelli (2007) study the effects of monetary policy shocks on labor market indicators in the US. They estimate a twelve-variable VAR on US data and find that 15-20% of the variance in unemployment is caused by monetary policy shocks and the maximum effect of a shock occurs after 4-5 quarters. Christiano et al. (2010), by using medium-scale DSGE model versions incorporating unemployment, obtain results consistent with Ravn and Simonelli (2007), namely, unemployment in the US responds to an expansionary monetary policy shock with high persistence and the maximum effect occurs after 4-5 quarters. The effects of monetary policy shocks on European

[5] See, e.g., Baker et al. (2005).

unemployment have also been explored. Amisano and Serati (2003) compare Sweden, Italy, the UK and the US using VAR models estimated by the Bayesian approach. They find that demand shocks play a dominant role in explaining unemployment fluctuations not only in the short run, but also in the medium/long run. In addition, the effects of demand shocks are highly persistent in Sweden, Italy and the UK, and less long-lasting in the US. Their paper does not identify shocks to monetary policy separately but the total results for demand shocks can be interpreted as an upper bound on the influence of monetary policy. More European countries are studied by Karanassou et al. (2005). They test 11 European Union (EU) countries by dynamic multi-equation models using GMM estimation and observe there are long drawn-out responses of unemployment to monetary policy changes. Alexius and Holmlund (2008) focus on measuring the volatility and persistence of unemployment. By applying a VAR model, they examine the Swedish experience of unemployment and monetary policy and compare it with the US study of Ravn and Simonelli (2007). They find that around 30% of the fluctuations in unemployment are caused by monetary policy shocks and the maximum effect occurs after 7-17 quarters in Sweden. Hence, monetary policy tends to have larger and more persistent effects on unemployment in Sweden than in the US. Notice that none of the previous studies has compared the volatility and persistence of unemployment rates in response to common monetary policy shocks across countries in the EMU. Our study fills in this gap in the literature.

This chapter analyzes the heterogeneous effects of single monetary policy on the unemployment rate by using quarterly data from 1999 to 2017 in the largest EMU countries, France, Germany, Italy and Spain. We employ the baseline New Keynesian DSGE model featuring unemployment developed by Galí et al. (2012), GSW hereafter. GSW reformulate the medium-scale New Keynesian DSGE model proposed by Smets and Wouters (2007, SW, henceforth) by embedding the theory of unemployment based on Galí (2011a, 2011b). While there are other papers modeling unemployment in DSGE setups differently, the GSW framework has the advantage of preserving the convenience of the representative household paradigm and allowing to determine the equilibrium levels of employment, the labor force and the unemployment rate (as well as other macroeconomic variables of interest) conditional on the monetary policy rule in place.[6] Unemployment in the model results from the presence of market power in differentiated labor markets and the presence of nominal wage rigidities.

Using a square model version of GSW, we aim to assess: 1) how important are monetary policy shocks relative to other shocks in driving unemployment fluctuations in the four countries? 2) what are the estimated dynamic effects of a monetary policy shock on the unemployment rate in the four countries? We also look at the comparative estimates of a range of structural parameters that are essential in labor market decisions, including the Frisch elasticity of labor supply, wage markup as indication of market power in wage determination, wage indexation, wealth effects on labor supply as well as Calvo wage and price stickiness parameters.

The rest of the chapter is structured as follows. In the next section, we summarize the GSW theoretical model; in Section 1.3 we present its log-linearized version that we then use for the analysis. Section 1.4 describes the data and the estimation methodology. Section 1.5 reports and interprets our estimation results, mostly in terms of key labor market parameter values, forecast error variance decompositions, historical shock decompositions and impulse responses. Section 1.6 concludes.

## 1.2 Micro-foundations of the Non-linear DSGE model

To assess the dynamic effects of a monetary policy shock on unemployment rates, the model used in this paper closely follows GSW (2012). A visual representation of the GSW model appears in Figure 1.2. Specifically, the final goods producers buy the intermediate goods $Y_t(i)$ on the market, package them into output $Y_t$ and resell it to households. Households consist of many identical large households. Each household has all differentiated labor types within it. We assume a (large) representative household with a continuum of members and one member from this household is indexed by $(l, j)$. $l$ represents the type of differentiated labor in which this member is specialized; $j$ determines his disutility from work. On one hand, all members specialized in labor type $l$ from each household gather into a union representing the workers with type of labor $l$ and setting the corresponding

[6] For other papers embedding unemployment into DSGE setups, see, e.g., Blanchard and Galí (2007), Christiano et al. (2020, 2011, 2008), and Gertler et al. (2008).

wages for their workers. The unions have market power over setting wages which allows for the introduction of sticky nominal wages (following Calvo, 1983) and results in a split aggregate wage equation. Then, there are labor packers who buy the differentiated labor types $N_t(l)$ from each union, package them into aggregate labor $N_t$ and sell it to the intermediate goods producers. On the other hand, households rent capital services $K_t$ to the intermediate goods producers and decide how much capital to accumulate given certain capital adjustment costs. Finally, the intermediate goods producers produce differentiated goods, decided on labor and capital inputs, and set prices with market power, again according to the Calvo model, resulting in a split aggregate price equation. In this section, we sketch out the main building blocks.

### 1.2.1 Final Goods Producers

The final good $Y_t$ is a composite product of a continuum of differentiated intermediate goods $Y_t(i)$ aggregated via a Dixit-Stiglitz (1977) index that does not feature a constant elasticity of substitutions across the differentiated inputs:

$$Y_t = \left[ \int_0^1 Y_t(i)^{\frac{1}{1+\lambda_{p,t}}} di \right]^{1+\lambda_{p,t}} \tag{1.1}$$

$\lambda_{p,t}$ is a stochastic parameter which determines the time-varying mark-up in the goods market.

The profit maximization conditions in the final goods sector yield the demand function for the intermediate good type:

$$Y_t(i) = Y_t \left[ \frac{P_t(i)}{P_t} \right]^{-\frac{1+\lambda_{p,t}}{\lambda_{p,t}}} \tag{1.2}$$

where $P_t(i)$ is the price of the intermediate good $i$ and $P_t$ is the price of the final good. Perfect competition in the final goods market implies that the latter can be written as:

$$P_t = \left[ \int_0^1 P_t(i)^{-\frac{1}{\lambda_{p,t}}} di \right]^{-\lambda_{p,t}} \tag{1.3}$$

### 1.2.2 Intermediate Goods Producers

Each intermediate good *i* is produced using the following production function:

$$Y_t(i) = \varepsilon_{a,t}\left[K_t(i)\right]^{\alpha}\left[N_t(i)e^{\tau t}\right]^{1-\alpha} - \Phi e^{\tau t} \tag{1.4}$$

where $\varepsilon_{a,t}$ is an exogenous stochastic process capturing total factor productivity (TFP), $K_t(i)$ and $N_t(i)$ are, respectively, capital services and labor used in production for the intermediate good *i*, and $\Phi$ is a fixed cost of production. $e^{\tau t}$ represents the labor-augmenting deterministic growth rate in the economy. The parameter $\alpha$ captures the share of capital in income.

Cost minimization implies:

$$\frac{K_t}{N_t} = \frac{\alpha}{1-\alpha}\frac{W_t}{R_t^K} \tag{1.5}$$

The capital-labor ratio will be identical across intermediate goods producers and equal to the aggregate capital-labor ratio. $W_t$ denotes the aggregate nominal wage rate and $R_t^K$ denotes the nominal rental rate of capital. The marginal cost of production in the intermediate goods sector is given by:

$$MC_t = \frac{W_t^{1-\alpha}\left(R_t^K\right)^{\alpha}}{\alpha^{\alpha}\left(1-\alpha\right)^{1-\alpha}\varepsilon_{a,t}\left(e^{\tau t}\right)^{1-\alpha}} \tag{1.6}$$

Then, nominal profits of the intermediate goods producer *i* can be expressed as:

$$\left[P_t(i) - MC_t(i)\right]Y_t(i) \tag{1.7}$$

Next, nominal price stickiness is introduced following the Calvo (1983) mechanism. Specifically, the intermediate goods producers have market power in the market for their own goods, assuming that each producer can readjust its price with probability $1-\xi_p$ in each period. For those producers that cannot readjust prices, $P_t(i)$ will increase at the geometric weighted average, with weights $1-\iota_p$ and $\iota_p$ of the steady state inflation rate $\pi_*$ and of last period's observed inflation $\pi_{t-1}$, respectively, where $\iota_p$ measures the degree of price indexation. For those producers that can adjust prices, the problem is to choose a price level $\tilde{P}_t(i)$ that maximizes the expected present discounted value of profits in all states of nature where this producer is stuck with that price in the future. Profit optimization by producers who can adjust prices at time $t$ results in the following first-order condition:

$$E_t \sum_{s=0}^{\infty} \xi_p^s \beta^s \Xi_{t+s}^p \left[ \frac{\tilde{P}_t(i)\chi_{t,s}}{P_{t+s}} \right]^{-\frac{1+\lambda_{p,t+s}}{\lambda_{p,t+s}}-1} \frac{\chi_{t,s}}{\lambda_{p,t+s} P_{t+s}} Y_{t+s} \left[ MC_{t+s}(i)\left(1+\lambda_{p,t+s}\right) - \tilde{P}_t(i)\chi_{t,s} \right] = 0 \tag{1.8}$$

where $$\chi_{t,s} = \begin{cases} 1 & s=0 \\ \prod_{l=1}^{s} \pi_{t+l-1}^{\iota_p} \pi_*^{1-\iota_p} & s=1,2,\ldots,\infty \end{cases}.$$

The parameter $\xi_p$ measures the degree of price stickiness, $\beta$ denotes the discount factor, $\Xi_t^p$ is the Lagrange multiplier associated with the consumer's budget constraint in the household optimization problem. Equation (1.8) shows that the price set by the intermediate goods producer *i*, at time *t*, is a function of expected future marginal costs. The price will be a mark-up over these weighted marginal costs. If prices are perfectly flexible $\left(\xi_p = 0\right)$, the mark-up in period *t* is equal to $1+\lambda_{p,t}$. With sticky prices the mark-up becomes variable over time when the economy is hit by exogenous shocks.

The definition of the price index in Equation (1.3) implies that its law of motion is given by:

$$P_t = \left[ \left(1-\xi_p\right) \tilde{P}_t^{-\frac{1}{\lambda_{p,t}}} + \xi_p \left( P_{t-1} \pi_{t-1}^{\iota_p} \pi_*^{1-\iota_p} \right)^{-\frac{1}{\lambda_{p,t}}} \right]^{-\lambda_{p,t}} \tag{1.9}$$

### 1.2.3 Households

Each household maximizes its utility, which consists of the utility from consumption and disutility from work:

$$E_t \sum_{s=0}^{\infty} \beta^s \left[ \log\left(C_{t+s} - hC_{t+s-1}\right) - \mathrm{X}_{t+s} \Theta_{t+s} \int_0^1 \int_0^{N_{t+s}(l)} j^{\varphi} dj dl \right] \tag{1.10}$$

Equation (1.10) allows for (external) habits in consumption, indexed by $h$. The term $\int_0^1 \int_0^{N_{t+s}(l)} j^{\varphi} dj dl$ represents the disutility from work in period *t+s* for workers in all labor types, where $N_{t+s}(l)$ is employment in period *t+s* among workers specialized in type $l$ labor, $\varphi$ is a parameter determining the shape of the distribution of work disutilities across individuals.

$\mathrm{X}_t$ is an exogenous preference shifter that affects the marginal disutility from work, referred to below as a "labor supply shock". $\Theta_t$ is an endogenous preference shifter that affects the marginal disutility from work, taken as given by each household and defined as:

$$\Theta_t = \frac{Z_t}{C_t - hC_{t-1}} \tag{1.11}$$

$$Z_t = Z_{t-1}^{1-\upsilon}\left(C_t - hC_{t-1}\right)^{\upsilon} \tag{1.12}$$

$Z_t$ can be interpreted as a "smooth" trend for (quasi-differenced) aggregate consumption. Equation (1.11) implies a "consumption externality" on labor supply: during aggregate consumption booms (when $C_t - hC_{t-1}$ is above its trend value $Z_t$), the household's marginal disutility from work goes down and the labor supply in turn increases. The degree of the "consumption externality" is determined by the value of the parameter $\upsilon$, which will be discussed in more detail in Section 1.5.

Households maximize their objective function (1.10) subject to a budget constraint which is given by:

$$\frac{B_{t+s}}{\varepsilon_{b,t} R_{t+s}} = B_{t+s-1} + \mathrm{Y}_{t+s} - P_{t+s}C_{t+s} - P_{t+s}I_{t+s} - T_{t+s} \tag{1.13}$$

Households hold their financial wealth in the form of bonds $B_t$. $R_t$ is the gross nominal interest rate paid on bonds, $\varepsilon_{b,t}$ is an exogenous premium in the return to bonds which might reflect inefficiencies in the financial sector. Current income and financial wealth can be used for consumption, investment in physical capital and payment of lump-sum taxes.

The household's total income is given by:

$$\mathrm{Y}_{t+s} = W_{t+s}N_{t+s} + \Pi_{t+s} + \left(R_{t+s}^{K}\mu_{t+s}\bar{K}_{t+s-1} - P_{t+s}a\left(\mu_{t+s}\right)\bar{K}_{t+s-1}\right) \tag{1.14}$$

Total income consists of three components: labor income $\left(W_{t+s}N_{t+s}\right)$, the per-capita profit the household gets from owning firms $\left(\Pi_{t+s}\right)$ and the return on the real capital stock minus the cost associated with variations in the degree of capital utilization $\left(R^K_{t+s}\mu_{t+s}\bar{K}_{t+s-1} - P_{t+s}a\left(\mu_{t+s}\right)\bar{K}_{t+s-1}\right)$.

***Consumption and Savings Behavior***

The maximization of the objective function (1.10) subject to the budget constraint (1.13) with respect to holdings of bonds and consumption, yields the following first-order conditions:

$$\beta\varepsilon_{b,t}R_tE_t\left(\Xi_{t+1}\pi^{-1}_{t+1}\right) = \Xi_t \tag{1.15}$$

where $\Xi_t$ is the marginal utility of consumption, which is given by:

$$\Xi_t = \left(C_t - hC_{t-1}\right)^{-1} \tag{1.16}$$

***Investment and Capital Accumulation***

Households own the capital stock, which they rent out to the intermediate goods producers at a given rental rate of $R^K_t$. They can increase the supply of rental services from capital either by investing in additional capital $\left(I_t\right)$ that takes one period to be installed, or by changing the utilization rate of already installed capital $\left(\mu_t\right)$. Both actions are costly in terms of foregone consumption (see Equation (1.14)).

The household's capital accumulation equation is given by:

$$\bar{K}_t = \left(1-\delta\right)\bar{K}_{t-1} + \varepsilon_{i,t}\left(1 - S\left(\frac{I_t}{I_{t-1}}\right)\right)I_t \tag{1.17}$$

where $\bar{K}_t$ is the capital stock owned by households, $I_t$ is gross investment, $\delta$ is the depreciation rate and the adjustment cost function $S\left(.\right)$ is a positive function of changes in investment. Given that our investment data are deflated by the overall price index of GDP, $\varepsilon_{i,t}$ is a stochastic shock in the relative price of investment versus consumption goods, representing the relative efficiency of investment goods (or investment-specific technological shocks).

Households choose the capital stock $\left(\bar{K}_t\right)$, investment $\left(I_t\right)$ and the utilization rate $\left(\mu_t\right)$ in order to maximize their objective function (1.10) subject to the budget constraint (1.13) and (1.14) and the capital accumulation Equation (1.17). The first-order conditions result in the following equations:

$$Q_t = \beta E_t\left[\frac{\Xi_{t+1}}{\Xi_t}\left(\frac{R_{t+1}^K}{P_{t+1}}\mu_{t+1} - a\left(\mu_{t+1}\right) + Q_{t+1}\left(1-\delta\right)\right)\right] \tag{1.18}$$

$$Q_t\varepsilon_{i,t}\left[1 - S\left(\frac{I_t}{I_{t-1}}\right) - S'\left(\frac{I_t}{I_{t-1}}\right)\frac{I_t}{I_{t-1}}\right] + \beta E_t\left[Q_{t+1}\frac{\Xi_{t+1}}{\Xi_t}\varepsilon_{i,t+1}S'\left(\frac{I_{t+1}}{I_t}\right)\left(\frac{I_{t+1}}{I_t}\right)^2\right] = 1 \tag{1.19}$$

$$a'\left(\mu_t\right) = \frac{R_t^K}{P_t} \tag{1.20}$$

where $Q_t$ is Tobin's Q. Equation (1.18) says that if one buys a unit of capital today he/she has to pay its price in real terms, but tomorrow he/she will get the proceeds from renting capital, plus he/she can sell back the capital that has not depreciated. Equation (1.19) is the law of motion for the shadow value of capital. Note that if adjustment costs were absent, Equation (1.19) would simply say that Tobin's Q is equal to one. In other words, in the absence of adjustment costs the shadow costs of taking resources away from consumption equal the shadow benefits of putting these resources into investment. Equation (1.20) shows that the marginal cost of changing capital utilization equals the real rental rate of capital.

### 1.2.4 Labor Market

For the workers specialized in type $l$ labor, the labor supply is expressed by employment $N_t(l)$. These employed workers receive wage $W_t(l)$, which is set by the corresponding union $l$. Labor packers then buy the labor from the unions, package it into $N_t$ and resell it to the intermediate goods producers. The aggregate employment $N_t$ is a composite defined by a Dixit-Stiglitz aggregator analogous to that for differentiated goods:

$$N_t = \left[\int_0^1 N_t(l)^{\frac{1}{1+\lambda_{w,t}}} dl\right]^{1+\lambda_{w,t}} \tag{1.21}$$

$\lambda_{w,t}$ is a stochastic parameter that determines the time-varying wage mark-up in the labor market.

Labor packers maximize profits in a perfectly competitive environment. The first-order condition of the labor packers is:

$$N_t(l) = N_t\left[\frac{W_t(l)}{W_t}\right]^{-\frac{1+\lambda_{w,t}}{\lambda_{w,t}}} \tag{1.22}$$

Perfect competition implies that the aggregate nominal wage $W_t$ can be written as:

$$W_t = \left[\int_0^1 W_t(l)^{-\frac{1}{\lambda_{w,t}}} dl\right]^{-\lambda_{w,t}} \tag{1.23}$$

Next, nominal wage stickiness is similarly introduced following Calvo (1983). Specifically, the union $l$ has market power: it can readjust wage $W_t(l)$ with probability $1-\xi_w$ in each period. Now the union $l$ readjusts the wage to $\tilde{W}_t(l)$ in period *t* and will keep with this wage in the future with probability $\xi_w$. Assume the union will keep the wage $\tilde{W}_t(l)$ in the future period *t+s*. $\tilde{W}_t(l)$ will increase at the deterministic growth rate $e^{\tau}$ and a weighted average of the steady state inflation $\pi_*$ and of last period's inflation $\pi_{t-1}$:

$$W_{t+s}(l) = \tilde{W}_t(l)\left(\prod_{l=1}^{s} e^{\tau}\pi_{t+l-1}^{\iota_w}\pi_*^{1-\iota_w}\right) \quad s = 1,2,\ldots,\infty \tag{1.24}$$

where $\iota_w$ measures the degree of wage indexation. The problem is to choose $\tilde{W}_t(l)$ that maximizes household's utility (Equation (1.10)) in all states of nature where the workers specialized in the type $l$ labor are stuck with that wage in the future. This maximization problem results in the following first-order condition:

$$E_t\sum_{s=0}^{\infty}\xi_w^s\beta^s\Xi_{t+s}\frac{1}{\lambda_{w,t+s}}N_{t+s}(l)\left[\left(1+\lambda_{w,t+s}\right)\frac{N_{t+s}(l)^{\varphi}\,\mathrm{X}_{t+s}\Theta_{t+s}}{\Xi_{t+s}} - \frac{\tilde{W}_t(l)\chi_{t,s}}{P_{t+s}}\right] = 0 \tag{1.25}$$

where $\chi_{t,s} = \begin{cases} 1 & s = 0 \\ \prod_{l=1}^{s} e^{\tau}\pi_{t+l-1}^{\iota_w}\pi_*^{1-\iota_w} & s = 1,2,\ldots,\infty \end{cases}$.

Equation (1.25) shows that the wage set by the union $l$ will be a mark-up over the marginal rate of substitution between employment and consumption for type $l$ workers.

The definition of the wage index in Equation (1.23) implies that the law of the aggregate nominal wage motion is given by:

$$W_t = \left[ \left(1-\xi_w\right)\tilde{W}_t^{-\frac{1}{\lambda_{w,t}}} + \xi_w \left(W_{t-1} e^{\tau} \pi_{t-1}^{\iota_w} \pi_*^{1-\iota_w}\right)^{-\frac{1}{\lambda_{w,t}}} \right]^{-\lambda_{w,t}} \tag{1.26}$$

In addition, labor force participation is introduced in the following way. A worker specialized in type $l$ labor and with disutility of work $X_t \Theta_t j^{\varphi}$ will find it optimal to participate in the labor market in period $t$ if and only if:

$$\Xi_t \frac{W_t(l)}{P_t} \geq X_t \Theta_t j^{\varphi} \tag{1.27}$$

That is, she will stay in or enter the labor force only if the benefit for her, captured by the product of the marginal utility of consumption and the real wage for her type of labor $l$ in Equation (1.27), outweighs the utility cost. The above condition is, then, evaluated at the symmetric equilibrium as:

$$\frac{W_t(l)}{P_t} = X_t Z_t L_t(l)^{\varphi} \tag{1.28}$$

with the marginal supplier of type $l$ labor denoted as $L_t(l)$.

### 1.2.5 Government Policies

The central bank follows a nominal interest rate rule by adjusting its instrument in response to deviations of inflation and output from their respective target levels:

$$\frac{R_t}{R^*} = \left(\frac{R_{t-1}}{R^*}\right)^{\rho_R} \left[ \left(\frac{\pi_t}{\pi_*}\right)^{\psi_1} \left(\frac{Y_t}{Y_t^{'}}\right)^{\psi_2} \right]^{1-\rho_R} \left( \frac{Y_t}{Y_t^{'}} \Big/ \frac{Y_{t-1}}{Y_{t-1}^{'}} \right)^{\psi_3} r_t \tag{1.29}$$

where $R^*$ is the steady state (gross) nominal interest rate and $Y_t^{'}$ is the natural level of output. The parameter $\rho_R$ determines the degree of interest rate smoothing. The monetary policy shock is introduced by the stochastic process for $r_t$.

The government budget constraint is given by:

$$B_{t-1} + \mathrm{P_t G}_t = \frac{B_t}{\varepsilon_{b,t} R_t} + T_t \tag{1.30}$$

where $\mathrm{G}_t$ is government spending. Hence, the market clearing condition for the final goods market can be obtained as:

$$Y_t = C_t + I_t + G_t + a(\mu_t)\bar{K}_{t-1} \tag{1.31}$$

## 1.3 The Linearized DSGE Model

In this section, we outline the log-linearized version of the model.[7] We first describe the aggregate demand side of the model and then turn to aggregate supply. The aggregate resource constraint is given by:

$$\hat{y}_t = \frac{c_*}{y_*}\hat{c}_t + \frac{i_*}{y_*}\hat{i}_t + \frac{r_*^k k_*}{y_*}\hat{\mu}_t + \hat{\varepsilon}_t^g \tag{1.32}$$

where $\hat{c}_t$ stands for consumption, $\hat{i}_t$ for investment and $\hat{\varepsilon}_t^g$ for exogenous public spending. The terms $\frac{c_*}{y_*}$ and $\frac{i_*}{y_*}$ represent, respectively, the steady-state values of the consumption-to-output ratio and the investment-to-output ratio, defined as: $\frac{c_*}{y_*} = 1 - g_* - \frac{i_*}{y_*}$, $\frac{i_*}{y_*} = \left(e^\tau - 1 + \delta\right)\frac{k_*}{y_*}$, where $e^\tau$ is the steady-state growth rate, $g_*$ is the steady-state value of the ratio of public spending to output and $\frac{k_*}{y_*}$ is the steady-state capital-to-output ratio. The term $\frac{r_*^k k_*}{y_*}\hat{\mu}_t$ measures the cost associated with variable capital utilization, where $r_*^k$ is the steady-state rental rate of capital and $\hat{\mu}_t$ is the capital utilization rate. Following GSW, we assume that the public spending shock follows an AR(1) process with an IID-Normal error term and is also affected by the productivity shock as follows: $\hat{\varepsilon}_t^g = \rho_g \hat{\varepsilon}_{t-1}^g + \eta_t^g + \rho_{ga}\eta_t^a$, with $\eta_t^g \sim N\left(0, \sigma_g\right)$. As GSW note, the latter is empirically motivated by the fact that, in estimation, exogenous spending also

[7] All variables denoted by a "hat" are log-linearized around their respective steady-state values, denoted by a star subscript.

includes net exports, which may be affected by domestic productivity developments. As for households, the dynamics of consumption are given by:

$$\hat{c}_t = \frac{\frac{h}{e^{\tau}}}{1+\frac{h}{e^{\tau}}}\hat{c}_{t-1} + \frac{1}{1+\frac{h}{e^{\tau}}}E_t\left(\hat{c}_{t+1}\right) - \frac{1-\frac{h}{e^{\tau}}}{1+\frac{h}{e^{\tau}}}\left(\hat{R}_t - E_t\left(\hat{\pi}_{t+1}\right) + \hat{\varepsilon}_t^b\right) \tag{1.33}$$

Current consumption $\hat{c}_t$ depends on a weighted average of past and expected future consumption and on the ex-ante real interest rate $\left(\hat{R}_t - E_t\left(\hat{\pi}_{t+1}\right)\right)$, as well as on a disturbance term $\hat{\varepsilon}_t^b$. As is common in the DSGE literature, the parameter $h$ captures external habits in consumption that improve model fit. The disturbance term $\hat{\varepsilon}_t^b$ represents a wedge between the interest rate controlled by the central bank and the return on assets held by the households, and is commonly referred to as the risk premium shock. A positive shock to this wedge increases the required return on assets and reduces current consumption. At the same time, it also increases the cost of capital and reduces the value of capital and investment. As is standard, this risk premium shock is assumed to follow an AR(1) process with an IID-Normal error term: $\hat{\varepsilon}_t^b = \rho_b \hat{\varepsilon}_{t-1}^b + \eta_t^b$, with $\eta_t^b \sim N\left(0, \sigma_b\right)$.

The dynamics of investment are given by:

$$\hat{i}_t = \frac{1}{1+\beta}\hat{i}_{t-1} + \frac{\beta}{1+\beta}E_t\hat{i}_{t+1} + \frac{1}{1+\beta}\frac{1}{e^{2\tau}S^{"}}\hat{Q}_t + \hat{\varepsilon}_t^i \tag{1.34}$$

where $S^{"}$ is the steady-state elasticity of the capital adjustment cost function. As demonstrated by Christiano et al. (2005), a higher elasticity of the cost of adjusting capital reduces the sensitivity of investment ($\hat{i}_t$) to the real value of the existing capital stock ($\hat{Q}_t$). Again, the disturbance to the investment-specific technology process is assumed to follow an AR(1) process with an IID-Normal error term: $\hat{\varepsilon}_t^i = \rho_i \hat{\varepsilon}_{t-1}^i + \eta_t^i$, with $\eta_t^i \sim N\left(0, \sigma_i\right)$.

The corresponding arbitrage equation for the value of capital is given by:

$$\hat{Q}_t = \frac{\beta(1-\delta)}{e^{\tau}}E_t\left(\hat{Q}_{t+1}\right) + \left[1 - \frac{\beta(1-\delta)}{e^{\tau}}\right]E_t\left(\hat{r}_{t+1}^k\right) - \left[\hat{R}_t - E_t\left(\hat{\pi}_{t+1}\right) + \hat{\varepsilon}_t^b\right] \tag{1.35}$$

The current value of the capital stock ($\hat{Q}_t$) depends positively on its expected future value and the expected real rental rate of capital and negatively on the ex-ante real interest rate and the risk premium disturbance.

Turning to the supply side, the aggregate production function is given by:

$$\hat{y}_t = \mathrm{M}_p \left( \alpha \hat{k}_t + (1-\alpha)\hat{n}_t + \hat{\varepsilon}_t^a \right) \tag{1.36}$$

Output is produced using capital services ($\hat{k}_t$) and labor services (or employment, $\hat{n}_t$). $\mathrm{M}_p$ represents the steady-state (gross) price markup. Disturbances in TFP are captured by the term $\hat{\varepsilon}_t^a = \rho_a \hat{\varepsilon}_{t-1}^a + \eta_t^a$, which follows an AR(1) process with an IID-Normal error term ($\eta_t^a \sim N(0, \sigma_a)$).

The current capital services depend on capital installed in the previous period ($\hat{\bar{k}}_{t-1}$) and the degree of capital utilization ($\hat{\mu}_t$):

$$\hat{k}_t = \hat{\bar{k}}_{t-1} + \hat{\mu}_t \tag{1.37}$$

where the accumulation of installed capital ($\hat{\bar{k}}_t$) is a function of the flow of investment and of the relative efficiency of these investment expenditures, as captured by the investment-specific technology disturbance,

$$\hat{\bar{k}}_t = \frac{1-\delta}{e^{\tau}} \hat{\bar{k}}_{t-1} + \left(1 - \frac{1-\delta}{e^{\tau}}\right) \hat{i}_t + \left(1 - \frac{1-\delta}{e^{\tau}}\right)(1+\beta) e^{2\tau} S'' \hat{\varepsilon}_t^i \tag{1.38}$$

and the degree of capital utilization is a positive function of the rental rate of capital,

$$\hat{\mu}_t = \frac{1-\psi}{\psi} \hat{r}_t^k \tag{1.39}$$

where $\psi$ determines the elasticity of capital utilization costs with respect to capital inputs. The rental rate of capital is derived by cost minimization:

$$\hat{r}_t^k = \hat{w}_t + \hat{n}_t - \hat{k}_t \tag{1.40}$$

As was discussed in Section 1.2, price- and wage-setting follow a Calvo adjustment mechanism with partial indexation. Due to price stickiness and partial indexation, prices and wages adjust sluggishly to their desired markup. The price markup ( $\hat{\mu}_t^p$ ) is determined, under monopolistic competition, as the difference between the real wage ( $\hat{w}_t$ ) and the marginal product of labor ( $mpl_t$ ):

$$\hat{\mu}_t^p = \hat{w}_t - mpl_t = -\left[ \left(1-\alpha\right)\hat{w}_t + \alpha\hat{r}_t^k \right] + \hat{\varepsilon}_t^a \tag{1.41}$$

Similarly, the wage markup ( $\hat{\mu}_t^w$ ) is determined as the difference between the real wage and the marginal rate of substitution between working and consuming ( $mrs_t$ ):

$$\hat{\mu}_t^w = \hat{w}_t - mrs_t = \hat{w}_t - \left[ \hat{z}_t + \varphi\hat{n}_t + \hat{\varepsilon}_t^\chi \right] \tag{1.42}$$

where $\hat{z}_t = \left(1-\upsilon\right)\hat{z}_{t-1} + \frac{\upsilon}{1-\frac{h}{e^\tau}}\left(\hat{c}_t - \frac{h}{e^\tau}\hat{c}_{t-1}\right)$. The parameter $\varphi$ is the inverse of the Frisch elasticity of intertemporal substitution in labor supply, which measures the substitution effect of a change in the wage rate on labor supply. As mentioned, $\hat{n}_t$ denotes employment. $\hat{\varepsilon}_t^\chi$ captures the exogenous labor supply shock, which follows an AR(1) process with an IID-Normal error term $\hat{\varepsilon}_t^\chi = \rho_\chi\hat{\varepsilon}_{t-1}^\chi + \eta_t^\chi$, with $\eta_t^\chi \sim N\left(0,\sigma_\chi\right)$.

Profit maximization by price-setting firms gives rise to the following New-Keynesian Phillips curve:

$$\hat{\pi}_t = \frac{1}{1+\iota_p\beta}\left[ \iota_p\hat{\pi}_{t-1} + \beta E_t\left(\hat{\pi}_{t+1}\right) - \frac{\left(1-\xi_p\beta\right)\left(1-\xi_p\right)}{\xi_p\left(1+\left(\mathrm{M}_p-1\right)\varsigma_p\right)}\hat{\mu}_t^p \right] + \hat{\varepsilon}_t^p \tag{1.43}$$

Inflation ( $\hat{\pi}_t$ ) depends positively on past and expected future inflation, negatively on the current price markup, and positively on a price markup disturbance ( $\hat{\varepsilon}_t^p$ ). The price markup disturbance is assumed to follow an ARMA(1,1) process with an IID-Normal error term: $\hat{\varepsilon}_t^p = \rho_p\hat{\varepsilon}_{t-1}^p + \eta_t^p - \mu_p\eta_{t-1}^p$ with $\eta_t^p \sim N\left(0,\sigma_p\right)$, where the inclusion of the MA term is designed to capture the high-frequency fluctuations in inflation. The term $\frac{\left(1-\xi_p\beta\right)\left(1-\xi_p\right)}{\xi_p\left(1+\left(\mathrm{M}_p-1\right)\varsigma_p\right)}$ measures the speed of adjustment to the desired markup and it depends on the degree of price stickiness ( $\xi_p$ ), the discount factor ( $\beta$ ), the curvature of the Kimball goods market aggregator ( $\varsigma_p$ ), and the steady-state markup, which in equilibrium is itself related to the share of fixed costs ( $\Phi$ ) in production through a zero-profit condition ( $\mathrm{M}_p = 1 + \frac{\Phi}{y_*}$ ).

Similarly, Calvo-style wage-setting implies:

$$\hat{w}_t = \frac{1}{1+\beta}\left\{\left[\hat{w}_{t-1} - \iota_w \hat{\pi}_{t-1}\right] + \beta\left[E_t\left(\hat{w}_{t+1}\right) + E_t\left(\hat{\pi}_{t+1}\right)\right] - \left(1+\beta\iota_w\right)\hat{\pi}_t - \frac{(1-\xi_w\beta)(1-\xi_w)}{\xi_w\left(1+\left(\mathrm{M}_w-1\right)\varsigma_w\right)}\hat{\mu}_t^w\right\} + \hat{\varepsilon}_t^w \quad (1.44)$$

The real wage rate is a function of expected and past real wage rates, expected, current, and past inflation rates, the wage markup, and a wage markup disturbance ( $\hat{\varepsilon}_t^w$ ). The wage markup disturbance is assumed to follow an ARMA(1,1) process with an IID-Normal error term: $\hat{\varepsilon}_t^w = \rho_w \hat{\varepsilon}_{t-1}^w + \eta_t^w - \mu_w \eta_{t-1}^w$ with $\eta_t^w \sim N\left(0, \sigma_w\right)$. As in the case of the price markup shock, the inclusion of a MA term allows to pick up some of the high-frequency fluctuations in wages. Similarly, the term $\frac{\left(1-\xi_w\beta\right)\left(1-\xi_w\right)}{\xi_w\left(1+\left(\mathrm{M}_w-1\right)\varsigma_w\right)}$ measures the speed of adjustment to the desired wage markup, and it depends on the degree of wage stickiness ( $\xi_w$ ), the discount factor $\beta$ and the demand elasticity for labor, which itself is a function of the steady-state (gross) wage markup $\mathrm{M}_w$ and the curvature of the Kimball labor market aggregator ( $\varsigma_w$ ).

Following GSW, two additional log-linearized equations are added to determine the unemployment rate:

$$\hat{\mu}_t^w = \varphi \hat{u}_t \quad (1.45)$$

$$\hat{u}_t = \hat{l}_t - \hat{n}_t \quad (1.46)$$

In (1.45), the unemployment rate ( $\hat{u}_t$ ) varies in proportion to the average wage markup, where $\varphi$ is the inverse of the Frisch elasticity of labor supply. In addition, the unemployment rate ( $\hat{u}_t$ ) is defined in a standard way as shown in (1.46).

Finally, the monetary authority follows a generalized Taylor rule in setting the short-term (gross) interest rate ( $\hat{R}_t$ ) in response to the lagged interest rate, current inflation, the current level and the current change in the output gap and an exogenous disturbance term that is assumed to follow an AR(1) process with an IID-Normal error term $\hat{\varepsilon}_t^r = \rho_r \hat{\varepsilon}_{t-1}^r + \eta_t^r$, with $\eta_t^r \sim N(0, \sigma_r)$. The parameters $\Psi_1$, $\Psi_2$ and $\Psi_3$ represent the degree of policy feedback to inflation, output gap and change in output gap respectively.

$$\hat{R}_t = \rho_R \hat{R}_{t-1} + (1-\rho_R)\left[\Psi_1 \hat{\pi}_t + \Psi_2\left(\hat{y}_t - \hat{y}_t^{'}\right)\right] + \Psi_3\left[\left(\hat{y}_t - \hat{y}_t^{'}\right) - \left(\hat{y}_{t-1} - \hat{y}_{t-1}^{'}\right)\right] + \hat{\varepsilon}_t^r \quad (1.47)$$

## 1.4 Data and Estimation Methodology

The log-linearized model presented in Section 1.3 is estimated with Bayesian techniques, based on the data for four major EMU countries, namely, France, Germany, Italy and Spain. For each country, the data set consists of eight key macroeconomic quarterly time series: the log difference of real GDP, the log difference of real consumption, the log difference of real investment, the log difference of the GDP deflator (i.e., a measure for price inflation), the ECB interest rates on marginal lending facilities (i.e., a measure for the central bank policy rate), log employment (relative to a base quarter), the unemployment rate, and the log difference of the real wage rate (i.e., a measure for wage inflation).[8] The sample period covers 1999Q1-2017Q4 (76 quarterly observations) for all variables.[9] The corresponding measurement equations are:

$$Y_t = \begin{bmatrix} dy \\ dc \\ dinve \\ p\inf obs \\ robs \\ empobs \\ unempobs \\ dw \end{bmatrix} = \begin{bmatrix} e^{\overline{\tau}} \\ e^{\overline{\tau}} \\ e^{\overline{\tau}} \\ \overline{\pi} \\ \overline{r} \\ \overline{n} \\ \overline{u} \\ e^{\overline{\tau}} \end{bmatrix} + \begin{bmatrix} \hat{y}_t - \hat{y}_{t-1} \\ \hat{c}_t - \hat{c}_{t-1} \\ \hat{i}_t - \hat{i}_{t-1} \\ \hat{\pi}_t \\ \hat{R}_t \\ \hat{n}_t \\ \hat{u}_t \\ \hat{w}_t - \hat{w}_{t-1} \end{bmatrix} \quad (1.48)$$

[8] The aggregate real variables (real GDP, real consumption, real investment and employment) are expressed per capita by dividing with the population over 15. We use only one of the two measures of the real wage rate in GSW, namely the total compensation of employees that is available for the EMU countries on a comparable basis (as GSW note, their results using two real wage measures do not differ much if they use just the measure we use too). All series are seasonally adjusted at source and are downloaded from the Eurostat and the ECB. A more detailed description of the data, with definitions and transformations, is given in Appendix 1.A.1.

[9] Our estimation period begins from the first quarter of 1999, when the ECB started to assume responsibility for monetary policy decision-making in the EMU, and the data for the key ECB interest rates are only available since then.

where $\bar{e^{\tau}} = 100\left(e^{\tau} - 1\right)$ is the common quarterly trend growth rate for real GDP, consumption, investment and wages; $\bar{\pi} = 100 \times \left(\pi_{*} - 1\right)$ is the quarterly steady-state inflation rate; and $\bar{r} = 100 \times \left(\frac{\pi_{*} e^{\tau}}{\beta} - 1\right)$ is the steady-state nominal interest rate. Given the estimates of the trend growth rate and the steady-state inflation rate, the latter will be determined by the estimated discount rate. $\bar{n}$ and $\bar{u}$ are, respectively, the steady-state employment and the steady-state unemployment rate.

Since most of these prior shapes and values are common or similar in Bayesian estimation of DSGE models, we use the same priors for all estimated parameters as GSW do, summarized in Table 1.1. Note that, differently from SW, GSW replace the Inverse Gamma prior for the standard deviations of the innovations to the shock processes by a Uniform prior, which is in fact an agnostic prior allowing more influence of the data in determining the posterior. As is standard, we first estimate the mode of the posterior distribution by maximizing the log posterior function, which applies Bayes rule in combining the prior information on the parameters with the likelihood of the data. Second, the Random Walk Metropolis-Hastings Markov Chain Monte Carlo (RWMH-MCMC) algorithm is used to sample from the posterior distribution and to evaluate the marginal likelihood of the model.[10] Based on the estimated parameters, the model is simulated and impulse responses to shocks, variance decompositions and historical shock decompositions are reported and discussed.

## 1.5 Estimation and Simulation Results

### 1.5.1 Estimated Parameter Posteriors

Table 1.2 reports the mean and standard deviation (SD) of the posterior distribution of the estimated parameters over the sample period 1999Q1-2017Q4, or 76 observations in the measurement equations (1.48). Overall, the estimated values for the structural parameters are broadly consistent with their respective typical value ranges known from related work, e.g., most closely to GSW, SW and Merola (2015). In our analysis and interpretation hereafter, we mainly focus on the estimates of the

[10] All estimations are done with Dynare. A RWMH-MCMC sample of 1,000,000 draws was simulated, with the first 20% of it discarded, to minimize the influence of initial values.

parameters and shock processes that are of direct importance for the labor market and monetary policy.

1.5.1.1 Structural Parameters

Starting with the structural parameters in the top panel of Table 1.2, our estimates show some heterogeneity in the intertemporal substitution in the supply of labor across the EMU. The estimates of the inverse of the Frisch elasticity of labor supply $\varphi$ range from 2.78 in Italy, through 2.98 in Germany and 3.94 in France, to 4.31 in Spain. Our results, further, uncover substantial heterogeneity in the degree of market power in wage determination for differentiated labor. The steady-state (gross) wage markup $\mathrm{M}_w$ is estimated to be the lowest, 18% (in net terms) in Germany, whereas in Spain it is the highest, 54%, with those for Italy, 22%, and France, 35%, falling in-between. This heterogeneity further implies, by the theory embodied in Equation (1.45), a corresponding heterogeneity in average unemployment rates, as also documented by the data. It is reassuring that the model-implied average unemployment rates, calculated using our estimates of $\varphi$ and $\mathrm{M}_w$ in Equation (1.45), predict pretty closely the corresponding mean values from the full sample. The highest estimate of the inverse of the Frisch elasticity in intertemporal labor supply and the highest estimate of the steady-state wage markup correspond to the highest average unemployment rate, in Spain, about 13% according to Equation (1.45) and about 16% in our sample. The average unemployment rate in Germany is the lowest in our sample, about 6% by the model prediction in (1.45) and about 7% according to the sample mean of our data. The model does best along this aspect in predicting the average unemployment rate in France, 9% according to both model and data. For Italy, the model implied average rate of unemployment is about 8% while in the sample it is about 9%.[11]

Turning attention to the parameters related to the wage Phillips curve, Equation (1.44), the estimated degree of wage indexation $\iota_w$ ranges from 19% in Germany, 22% in France, 23% in Italy, and 26% in Spain. The estimated degree of (Calvo)

[11] Interestingly, compared to an analogous measure of market power in differentiated product markets, labor markets, on this account, are more competitive and more diverse nationally, with the exception of Spain. Our estimates for the steady-state (gross) price markup $\mathrm{M}_p$ in three of these four countries cluster tightly from 42% (net) in Germany, through 44% in Italy, to 52% in France. Spain is, again estimated as an extreme case from our four EMU economies, now being at the opposite end of having the most competitive goods markets, with the lowest steady-state (net) price markup of 13%.

wage rigidity $\xi_w$ ranges from 0.65 in Germany, through 0.74 in Italy and 0.76 in France, to 0.84 in Spain. Again, Spain exhibits a relatively higher wage stickiness in the labor market, corresponding to an average duration of wage contracts of about six quarters, whereas in Italy and France this duration is of about four quarters and in Germany of almost three quarters. Along this dimension, we clearly see again the likely effect in the estimated parameters reflecting the considerable heterogeneity across the four largest EMU economies in our sample.

Then, the parameter that governs the short-term wealth effects on labor supply, $\upsilon$, displays much high values, with some heterogeneity, in the four EMU countries in our sample. To be more specific, Germany reveals the largest value of estimated $\upsilon$, 0.83, followed by Spain, Italy and France with values of 0.76, 0.78 and 0.64, respectively, revealing a relatively strong short-term wealth effect on labor supply, consistent with standard King-Plosser-Rebelo (1988, KPR) preferences. In this case, the strong short-term wealth effects imply that the labor force moves countercyclically in response to most shocks (as we will see in the analysis of the impulse response functions).[12] This is an important characteristic on the labor-market preferences we uncover for the major EMU economies.

As for the monetary policy reaction function parameters, as might be expected for a single monetary policy in a monetary union, the estimated feedback coefficients are pretty much clustered for all four EMU member-states we examine. The long-run feedback coefficient to inflation $\Psi_1$ is estimated to be slightly higher in France (1.31) and Spain (1.38) while relatively lower in Italy (1.14) and Germany (1.20). Moreover, monetary policy reacts moderately to the output gap $\Psi_2$ (0.11--0.20) and minimally to changes in the output gap $\Psi_3$ (0.02--0.05) in all four EMU countries. In addition, notice that the estimates for steady-state inflation ranges from 2.5% per annum (pa) in Spain to 1.8% pa in Germany, with France, 2.0% pa, and Italy, 2.2% pa, falling in-between. These measures are not that far from the inflation target of 2.0% pa, on average, the ECB has announced and

[12] KPR (1988) preferences are characterized by strong short-term wealth effects on labor supply, that is, assuming $\upsilon = 1$. This helps ensure that the labor force moves countercyclically in response to most shocks. This can be illustrated by combining Equations (1.42), (1.45) and (1.46), we obtain $\hat{l}_t = \frac{1}{\varphi}\hat{w}_t - \frac{1}{\varphi}[(1-\upsilon)\hat{z}_{t-1} + \upsilon\hat{c}_t] - \frac{1}{\varphi}\hat{\varepsilon}_t^{\chi}$, where habit formation is omitted to simplify the argument. Under KPR (1988) preferences ($\upsilon = 1$), strong wealth effects are featured by the negative comovement between consumption and labor force.

pursues in the conduct of its monetary policy.

#### 1.5.1.2 Shock Process Parameters

The bottom panel in Table 1.2 reports the estimates of the parameters that enter the exogenous shock processes, that is, their persistence and volatility, respectively. For all four EMU countries, the monetary policy shock and the wage markup shock processes are estimated to be the least persistent, with AR (1) coefficients of 0.30 (Italy), 0.36 (Spain), 0.42 (France) and 0.43 (Germany) for the monetary policy shock and 0.21 (Italy), 0.48 (Germany and Spain), and 0.52 (France) for the wage markup shock. Furthermore, in the case of our EMU countries, the shocks with the highest persistence are the TFP, risk premium and spending shocks, above 0.90 for all EMU sample countries (with two minimal exceptions).

It is also worth noting that the estimated means of the SD of the shock to the wage markup process and the labor supply process in Italy and Spain are impressively higher in relative terms, 2.57% and 2.68% in Italy and 3.55% and 3.15% in Spain, respectively. These two shocks are the most volatile in the mentioned two countries. Similarly, in France (1.58%) and Germany (2.26%) the labor supply shock comes out as the most volatile overall, followed by the price markup shock, 1.01% in France and 1.76% in Germany. Moreover, the monetary policy shock exhibits the lowest estimated mean SD in all four EMU countries, tightly clustered in the 0.07-0.09% range, which is combined with a low persistence of this shock too, as was mentioned.

#### 1.5.1.3 Summary of the RWMH-MCMC Bayesian Estimation

Finally, Table 1.3 provides summary statistics for the RWMH-MCMC Bayesian estimation. In particular, it reports the acceptance rate of the two chains used in the posterior simulation and the log data density, also known as the marginal likelihood for the estimated model given the observed sample. There is not any narrow-range recommendation regarding the acceptance rate, but it is consensual in the Bayesian estimation literature that it should be between 20% and 50%.[13] On this account, the acceptance rates in Table 1.3 are reliable. The log data density, in its turn, indicates that the data for France ensure the best fit of the GSW model in our implementation of the estimations, whereas the data for Italy exhibit the worst fit. We have also

[13] See, e.g., Koop (2006) or Herbst and Schorfheide (2016).

checked carefully the univariate and multivariate MCMC convergence criteria as well as the shapes of the posteriors for each estimated parameter, and have concluded that all estimation results per country are of a good quality overall.[14]

### 1.5.2 What Drives Unemployment Fluctuations in the EMU Countries?

To address this question of our study, and assess how influential monetary policy shocks might be when compared to other types of shocks in determining unemployment variability in the four EMU member-states, we first look into the forecast error variance decomposition (FEVD) in the short, medium and long run, and then into the historical shock decomposition of the unemployment rate.

#### 1.5.2.1 Variance Decomposition in the Short, Medium and Long Run

Table 1.4 presents the contribution of each shock to the forecast error variance of the unemployment rate in each country. This decomposition provides insights into the main forces driving unemployment fluctuations. The contribution of each of the structural shocks to the conditional forecast error variance of the national unemployment rate in each sample country is reported in the "short run" (1-quarter horizon), "medium run" (10-quarter horizon) and "long run" (10-year horizon).

For all four EMU countries, the biggest fraction of the variations in the unemployment rate is explained by risk premium shocks at any horizon. The contribution of risk premium shocks ranges from about one-third to almost a half in the short run, to about 45-60% in both the medium and long run. Especially at the two longer horizons, these risk premium shocks are more important, accounting for about 10 percentage points (pp) more, in the "high debt - high risk premium" EMU countries in our sample, Italy and Spain, relative to the "low debt - low risk premium" EMU economies, France and Germany.

In all four sample countries too, monetary policy shocks come next in importance, accounting for about one-fifth to one-third of the fluctuations in the unemployment rate at 10 and 40 quarters ahead, although in the short run of 1 quarter their importance is somewhat reduced, to between 8% and 22%. This result highlights

[14] The only exception, which arises commonly in such Bayesian estimation of medium-scale DSGE models attempting to estimate around 30-50 parameters, is that on a couple of occasions a posterior is not unimodal or nicely shaped. This relates to estimated means of SDs of the shock processes (whose prior is agnostic, assumed Uniform), and does not impair in general estimates for the more important, and better identified, structural parameters or shock persistence parameters.

monetary policy in the EMU countries turns out to be relevant when influencing unemployment in the medium and even long run, and this has strong policy implications, especially bearing in mind as well the features across the four EMU countries revealed by the structural parameter estimates we have been describing in the present study.

Two labor market shocks identified separately are the labor supply shock and the wage markup shock, which do not really matter in the medium and long run for unemployment variability in all four EMU countries. The labor supply shock does not account for more than 1% to 4% of the fluctuations in the unemployment rate. It matters more in the short run, however, ranging between 5% and 17% across these countries, and especially in Italy, where it comes third in relevance at that horizon, and Spain, where it comes fourth. Similarly, the wage markup shock has only a negligible influence (below 6%) on the variability of the unemployment rate at all horizons.

#### 1.5.2.2 Historical Shock Decomposition

Figures 1.3-1.6 present the historical decomposition of the rate of unemployment in terms of estimated contributions to its evolution by the underlying latent shock processes the GSW model considers in each of the EMU countries over the full sample.

Taking France first, we clearly see in Figure 1.3 that the dominant shocks affecting the rate of unemployment have been risk premium shocks and monetary policy shocks, which is consistent with the FEVD analysis we summarized. In particular, what is worth noting is that before the GFC, low risk premium shocks have generally depressed the unemployment rate, whereas the relatively expansionary monetary policy has contributed to its increase, especially in the early 2000s. After the GFC, however, these roles have reversed, with the Zero Lower Bound policy depressing unemployment, but higher risk premium shocks increasing it.

Looking next at Germany, Figure 1.4 convincingly illustrates again the dominance of risk premium and monetary policy shock contributions to the fluctuations in the unemployment rate. As in the case of France, the role of monetary policy is reversed pre- vs post-GFC, for the same reasons. Analogous interpretation would apply to the risk premium, but its reversal from a brake on unemployment to a driver of unemployment seems to have occurred somewhat earlier, before the GFC. It is worth noting that, as in France, the contribution of risk premium shocks has been negative during the GFC followed by the Greek crisis (these are the observations between 2006Q2 and 2008Q4 on the x-axis).

Taking now Italy, the same two dominant types of shocks are evident in Figure 1.5, but now the contribution of risk premium shocks post-GFC is twice more pronounced in pushing unemployment up. This coincides with the repercussions of the Greek crisis and the spillovers of perceived sovereign risk on other EMU "high-debt" countries, such as Italy and Spain in our sample. By contrast, the Zero Lower Bound policy at the ECB has contributed to the lower unemployment rate in Italy during most of the post-GFC subperiod, although reversing this influence in the final three years.

Checking the historical decomposition for Spain in Figure 1.6, we see again the dominance of risk premium and monetary policy shocks, but now both these types of shocks are very important in pushing the unemployment rate up after the GFC. This highlights the Spanish high-debt crisis and the associated higher risk premium prevailing in the post-GFC subsample, as well as the heterogeneity of the effects of the ECB's policy on national unemployment rates across the four countries in our sample.

To summarize, monetary policy shocks are the second most important driving force, after risk premium shocks, behind unemployment fluctuations for all countries in our EMU sample. This is confirmed in a quite unambiguous and robust way by both the FEVDs and the historical decompositions we analyzed.

### 1.5.3 Dynamic Effects of the Key Driving Shocks on the Unemployment Rate

To study the dynamic responses of the unemployment rate (and the related labor market variables) in the four EMU countries of our sample, we now look at the impulse response functions (IRFs) of the key driving shocks that are simulated after estimation. We begin with the monetary policy shock because our main interest is in its heterogeneous effects on unemployment rates in the EMU, and also because our FEVD and historical shock decomposition analyses highlight this type of shock as the second largest source of variability in the unemployment rate. We then look at the IRFs to the type of shock with the strongest influence on EMU unemployment rates that we identified, namely the risk premium shock. These two types of shocks represent demand shocks more generally in the classification of GSW. Finally, we also consider the effects of the two types of labor market shocks, the wage markup shock and the labor supply shock, that the GSW framework allows to separately identify, no matter that these turn out to be much less important in driving unemployment fluctuations in the largest EMU economies relative to other shocks.

#### 1.5.3.1 Monetary Policy Shocks

Figure 1.7 illustrates the estimated impulse responses of output, output growth, inflation, the real wage, the interest rate, employment, the labor force, the unemployment rate and the output gap to a positive monetary policy shock in the four sample countries. This is, therefore, a contractionary monetary policy shock, as it increases unexpectedly the nominal interest rate and corresponds to a rise in the innovation to the interest rate process by one SD above its steady-state value (of zero), leading to a temporary decline in output (via a corresponding decline in consumption and investment, not shown in Figure 1.7). GSW refer to this monetary policy shock, together with the risk premium, investment-specific and exogenous spending shocks, as demand shocks because all four of them imply a positive comovement of output, inflation and the real wage. We confirm these positive comovements in Figure 1.7 (and Figure 1.8) for our four EMU economies. With regard to inflation, we confirm another well-known stylized fact but for three of our sample countries, except France: namely, the presence of "inflation persistence", that is, a long-lived subsequent drop in inflation after a surprise contraction in monetary policy (e.g., Ravn and Simonelli, 2007), the highest in Italy.[15]

Concerning the labor market variables, employment drops in response to the tightening of monetary policy, due to the contraction in output. The depth and persistence of the drop in employment is strongest and most persistent in Spain, close to 0.7 pp below steady state at its trough (for an interest rate shock of about 0.05 pp above steady state on impact, so in highly elastic way), and is more than two times weaker and less persistent in France (but still implying an elastic response). The labor force rises, because of the strong wealth effect. The negative

[15] Interestingly, our IRFs do not capture any visible effect of monetary policy shocks to inflation in France.

correlation between employment and the labor force following a monetary policy shock leads to unemployment fluctuations, by construction, mostly driven by employment fluctuations and not labor force fluctuations, since the magnitudes along the vertical axis of the IRFs are, roughly, two times higher for the former relative to the latter. As a result, the unemployment rate increases in all four EMU economies after an unexpected rise in the interest rate, displaying IRFs that mirror those for employment, but with the opposite sign. Again, heterogeneity in the effect of the ECB's monetary policy on national unemployment rates in the EMU is clearly seen in Figure 1.7. Spain is the most affected within our sample countries, as the unemployment rate rises on impact to 0.48 pp above steady state, and further to a maximum effect of 0.74 pp above steady state in quarter 3, and with lag-length in persistence until return to steady state exceeding 20 quarters. By contrast, in France the impact, maximum and persistence effects are, roughly, twice lower, and Germany and Italy fall in-between, but still exhibiting distinguishable profiles of response. Note also that price inflation and the real wage both move procyclically conditional on the monetary policy shock, that is, the real wage declines in all our four EMU countries following a contractionary monetary policy surprise by the ECB, as a result of the downward pressure of rising unemployment on nominal wages. However, the heterogeneity in the real wage IRFs is the largest among all depicted ones in the nine respective panels of Figure 1.7. The real wage in France is affected relatively more weakly, down to about 0.1 pp below steady state after about 6 quarters (but elastically, given the magnitude of the interest rate change on impact) and then recovers fast; Spain's response of the real wage is very similar, but more persistent; the real wage in Italy bottoms out after about two years and a half and after a drop three times stronger than that in France or Spain, also displaying the highest persistence (or slowest recovery); finally, on this account Germany experiences the strongest effect of monetary policy on real wages, down nearly by 0.4 pp below steady state around two years after the shock.

#### 1.5.3.2 Risk Premium Shocks

We, next, consider briefly the role of risk premium shocks, as these come out in the FEVDs and the historical shock decompositions as the most influential determinant of the variability of the unemployment rate in all four EMU countries at all horizons. The IRFs in Figure 1.8 qualitatively depict that output (and the output gap, which coincide when the natural output is not affected by shocks), inflation, the real wage, the interest rate and employment all comove positively, while the unemployment rate comoves negatively, conditional on the risk premium shock. However, under KPR references, the labor force drops on impact (by about 0.2 pp below steady state in all four EMU economies except Italy, where it falls twice deeper) and does not recover for about a year in France and Germany and for about 2 years in Italy and Spain. The positive risk premium shock thus seems to be associated with a likely wealth effect that makes households perceive themselves as richer and want to work less, exiting the labor force. Hence, the reduction in the labor force leads to a stronger fluctuation in the rate of unemployment relative to employment for all our four sample countries.

#### 1.5.3.3 Labor Market Shocks

We, finally, turn to the impulse responses of the unemployment rate and the key related variables to shocks originating in the labor market: the wage markup shock depicted in Figure 1.9 and the labor supply shock illustrated in Figure 1.10.

The dynamics after wage markup shocks in Figure 1.9 are more complicated and more varied across countries. A negative comovement of inflation and the real wage with output is only presented for Spain: A positive wage markup shock generates high inflation, with a magnitude of about 0.1 pp above steady state. For the other three countries in our EMU sample the effect of wage markup shocks on inflation is negligible. As far as the unemployment rate is concerned, a wage markup shock increases it: considerably and persistently in Spain, much less so in France and Germany, and in the strongest way on impact in Italy, about 0.3 pp above steady state, but with a fast return to it after 3-4 quarters.

By contrast, an adverse labor supply shock, as in Figure 1.10, has negative effects on output and employment but positive effects on the output gap and the unemployment rate. Among the four key driving forces behind fluctuations in the rate of unemployment in the sample EMU member-states, only the labor supply shock affects the natural level of output, thereby driving a wedge between the dynamic responses of output and the output gap. More precisely, a positive labor supply shock (a sudden rise of $X_t$ in the utility function (1.10)) increases the disutility to work, so people move out of the labor force, and as can be seen in the

IRFs, employment and the labor force drop with very high persistence (the unemployment rate drops on impact and only temporarily). This results in a drop in actual output, but even more so in natural output, i.e., output that would have prevailed under the counterfactual scenario of fully flexible prices and wages and a constant desired wage markup, thereby generating a positive output gap on impact that exhausts itself in about a year.

## 1.6 Conclusion

This chapter estimated and simulated a canonical medium-scale New Keynesian DSGE model that incorporates unemployment with indivisible labor as in GSW (2012) using observable quarterly data from the four largest EMU countries - France, Germany, Italy and Spain - to assess, primarily, the differences in the effects of monetary policy shocks on the national rates of unemployment since the introduction of the euro in January 1999. We also compared the relative importance of other types of structural shocks in driving the variability of national unemployment rates and analyzed the behavior of a few other central labor market variables, such as employment, the labor force and the real wage.

Some novel results emerged from our analysis.

First, we uncovered a clear common ranking of the sources of national unemployment rate fluctuations in the largest four EMU economies. At any horizon examined, the biggest fraction of the variability in the unemployment rate was explained by risk premium shocks, whose contribution ranged from about one-third to almost a half in the short run, to about 45-65% in both the medium and long run. It is worth noting that at the two longer horizons, these risk premium shocks were more important, accounting for about 10 pp more, in the "high debt -- high risk premium" EMU countries (Italy and Spain) relative to the "low debt -- low risk premium" EMU countries (France and Germany). Monetary policy shocks were the second largest exogenous force, after risk premium shocks, driving fluctuations in national unemployment rates in our EMU sample. In the short run of 1 quarter, their contribution was quantified to account for 8%-22% of unemployment fluctuations, and their importance was increased in the medium and long run, to between one-fifth and one-third at 10 and 40 quarters ahead. Monetary policy in the EMU countries thus turned out to be important when influencing unemployment at all horizons. These conclusions were supported by robust evidence in all four examined countries by both the FEVDs and the historical decompositions we analyzed.

Second, in our historical decomposition analysis, focusing on the post-GFC subperiod, we found that there was an interesting difference in the roles of the two dominant shocks (the risk premium and monetary policy shocks) in contributing to unemployment fluctuations between the "low debt - low risk premium" EMU countries (France and Germany) and the "high debt - high risk premium" EMU countries (Italy and Spain). In France and Germany, the Zero Lower Bound policy depressed the unemployment rate, and higher risk premium shocks, as repercussions from the Greek crisis, increased it. Somewhat differently, in Italy and Spain, both these types of shocks came out as very important in pushing the unemployment rate up after the GFC.

Third, turning to the dynamic responses of the key labor market variables to the single monetary policy conducted by the ECB, we documented that employment fell in response to the tightening of monetary policy, due to the contraction in output, but labor force participation increased, because of the strong wealth effect on labor supply. The negative correlation between employment and the labor force following a monetary policy shock led to unemployment fluctuations, mostly driven by employment fluctuations and not labor force fluctuations. As a result, the unemployment rate increased in all four EMU economies after a monetary policy shock, exhibiting time profiles that mirrored those for employment, but with the opposite sign. The heterogeneity in the effect of the ECB's monetary policy on national unemployment rates in the EMU was evident in the dynamic responses: Spain was the most affected, in terms of both elasticity and persistence; in France the impact, in terms of the maximum and persistence of effects, was roughly twice lower, and Germany and Italy fell in-between.

Fourth, our structural parameter estimates revealed substantial heterogeneity across the four largest EMU economies in the degree of market power in wage determination for differentiated labor. This heterogeneity further implied, by the theory embodied in the GSW model, a corresponding heterogeneity in average unemployment rates, as also documented by the data. Notably, the model-implied average unemployment rates, calculated using our estimates of the elasticity of labor supply and of the steady state wage markup, predicted quite precisely the corresponding mean values from the full sample. Moreover, the estimated parameters governing the wealth effects on labor supply revealed relatively high values, with some heterogeneity, in the four EMU countries in our sample, in agreement with the specification of the utility function in KPR (1988). Our impulse response analysis conditional on a monetary policy shock also confirmed that these strong wealth effects led to a negative comovement between employment and the labor force in all our four sample countries, as implied by the KPR preferences.

Essentially, this chapter found that the same ECB monetary policy has quite heterogeneous effects on the unemployment rate and the key labor market variables in the four major EMU countries. The reasons for such a heterogeneity in the effect of the single monetary policy on the unemployment rate are most likely related to the differences in the functioning of the labor market institutions each of these countries has inherited before joining the euro. Therefore, Chapter 2 will bring in the specific labor market institutions that characterize each of the different EA national economies, specifically, examining the effects of labor market institutions on changing the transmission of shocks to unemployment.

## Appendix to Chapter 1

### 1.A.1 Data Description

**Definitions and Sources of the Original Data:**

1. GDPC05: Real Gross Domestic Product - Millions of Chained 2005 Euro, Seasonally Adjusted.

   Source: Eurostat, Database, Database by Themes, Economy and Finance, National Accounts, Quarterly National Accounts, Main GDP Aggregates.

2. GDPDEF: Gross Domestic Product - Implicit Price Deflator - 2005=100, Seasonally Adjusted.

   Source: Eurostat, Database, Database by Themes, Economy and Finance, National Accounts, Quarterly National Accounts, Main GDP Aggregates.

3. CONS: Actual Individual Consumption – Millions of Chained 2005 Euro, Seasonally Adjusted.

   Source: Eurostat, Database, Database by Themes, Economy and Finance, National Accounts, Quarterly National Accounts, Main GDP Aggregates.

4. GFCF: Gross Fixed Capital Formation - Millions of Chained 2005 Euro, Seasonally Adjusted.

   Source: Eurostat, Database, Database by Themes, Economy and Finance, National Accounts, Quarterly National Accounts, Main GDP Aggregates.

5. WAGE: Compensation Per Employee – Compensation of All Employees divided by the Number of Employees, Seasonally Adjusted.

   Source: Eurostat, Database, Database by Themes, Economy and Finance, National Accounts, Quarterly National Accounts, Main GDP Aggregates and Auxiliary Indicators.

6. ECBr: The Interest Rates on Marginal Lending Facilities – Averages of Daily Figures –% per annum.

   Source: European Central Bank, Statistic, ECB/Eurosystem policy and exchange rates, Official interest rates.

7. POPULATION: Total Population – Age: 15 years and over– Number in Millions,

Seasonally Adjusted.

Source: Eurostat, Database, Database by Themes, Population and Social Conditions, Labor Market (labor), Employment and Unemployment (Labor Force Survey), LFS Series-Detailed Quarterly Survey Results.

8. POPUindex: POPULATION (2005:1)=1

9. EMP: Employment – Age: 15 years and over – Number in Millions, Seasonally Adjusted.

   Source: Eurostat, Database, Database by Themes, Population and Social Conditions, Labor Market (labor), Employment and Unemployment (Labor Force Survey), LFS Series-Detailed Quarterly Survey Results.

10. UNEMP: Unemployment Rate –Age: from 15 to 64 years – Pre-2005 is estimated data and Post-2005 is observed data[16], Seasonally Adjusted.

    Source: Eurostat, Database, Database by Themes, Population and Social Conditions, Labor Market (labor), Employment and Unemployment (Labor Force Survey), LFS Series-Detailed Quarterly Survey Results.

**Definitions of the Transformed Data:**

1. consumption = ln(CONS/POPUindex)*100
2. investment = ln(GFCF/POPUindex)*100
3. output = ln(GDPC05/POPUindex)*100
4. real wage = ln(WAGE/GDPDEF)*100
5. inflation = ln(GDPDEF/GDPDEF(-1))*100
6. employment = ln(EMP/POPUindex)*100
7. unemployment rate = UNEMP
8. interest rate = ECBr/4

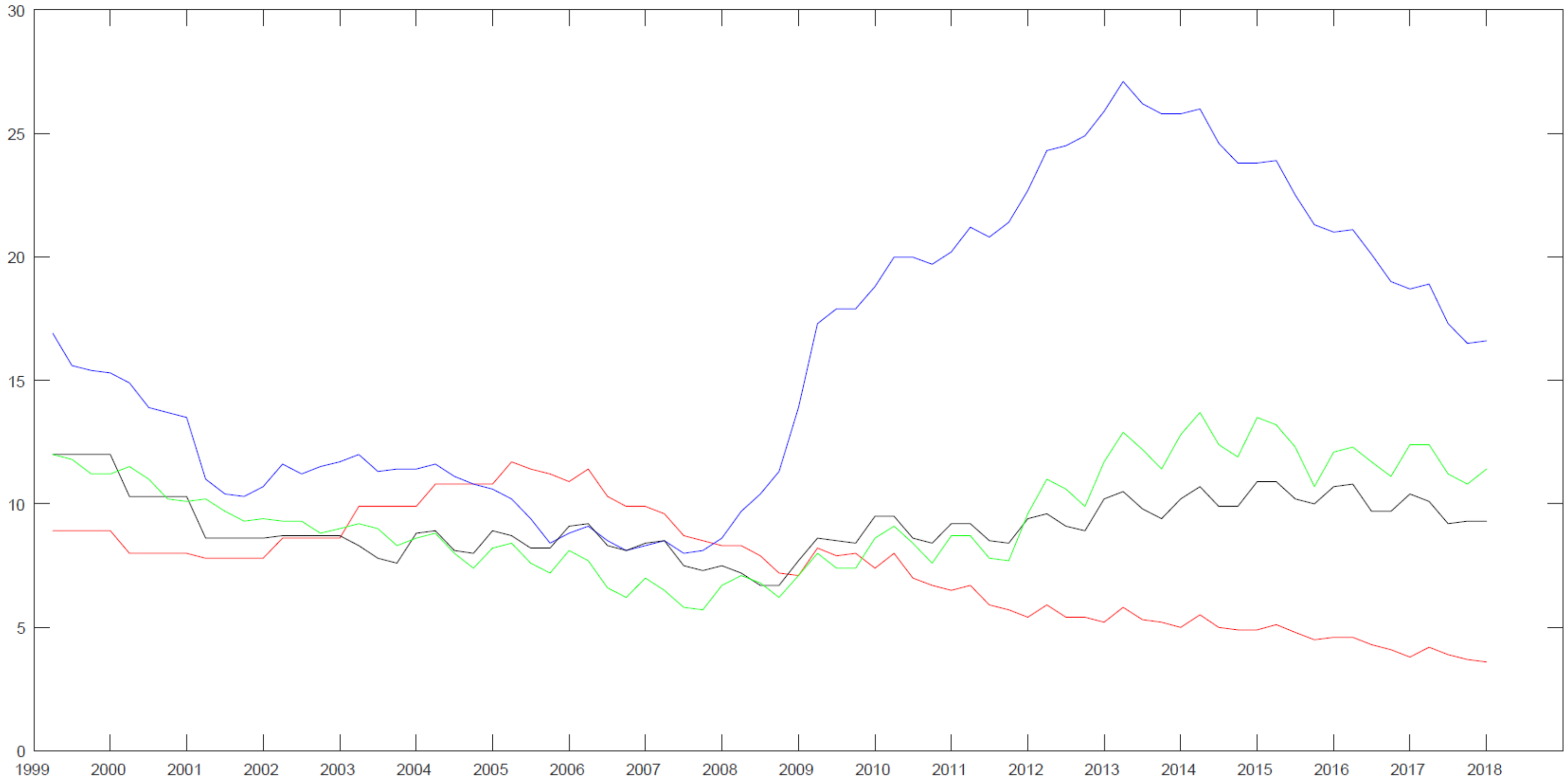
**Definitions of the Data Variables Used in the Measurement Equations:**

[16] The unemployment rate data used in this chapter is from Eurostat, which is mainly based on the results of the European Labor Force Survey (EU-LFS). The EU-LFS initially conducts an annual spring survey from 1998 to 2004. Since 2005, a transition from an annual spring survey to a quarterly continuous survey provides quarterly data on the labor market. Thus, our data for the pre-2005 period is the estimated quarterly unemployment rate and thereafter is the observed data.

1. dc = consumption-consumption(-1)
2. dinve = investment-investment(-1)
3. dy = output-output(-1)
4. empobs = employment-base quarter (close to sample average employment)
5. unempobs = unemployment rate
6. dw = real wage- real wage(-1)
7. pinfobs = inflation
8. robs = interest rate

### 1.B.1 Figures

Figure 1.1 Evolution of the Unemployment Rate in the EMU Largest Countries (1999Q1-2017Q4)




Note: y-axis: % of the economically active population; France black; Germany red; Italy green; Spain blue. Source: Eurostat, Database, Employment and Unemployment (Labor Force Survey), LFS Series-Detailed Quarterly Survey Results, seasonally adjusted.

Figure 1.2 Goods Production and Labor Market in the GSW Model

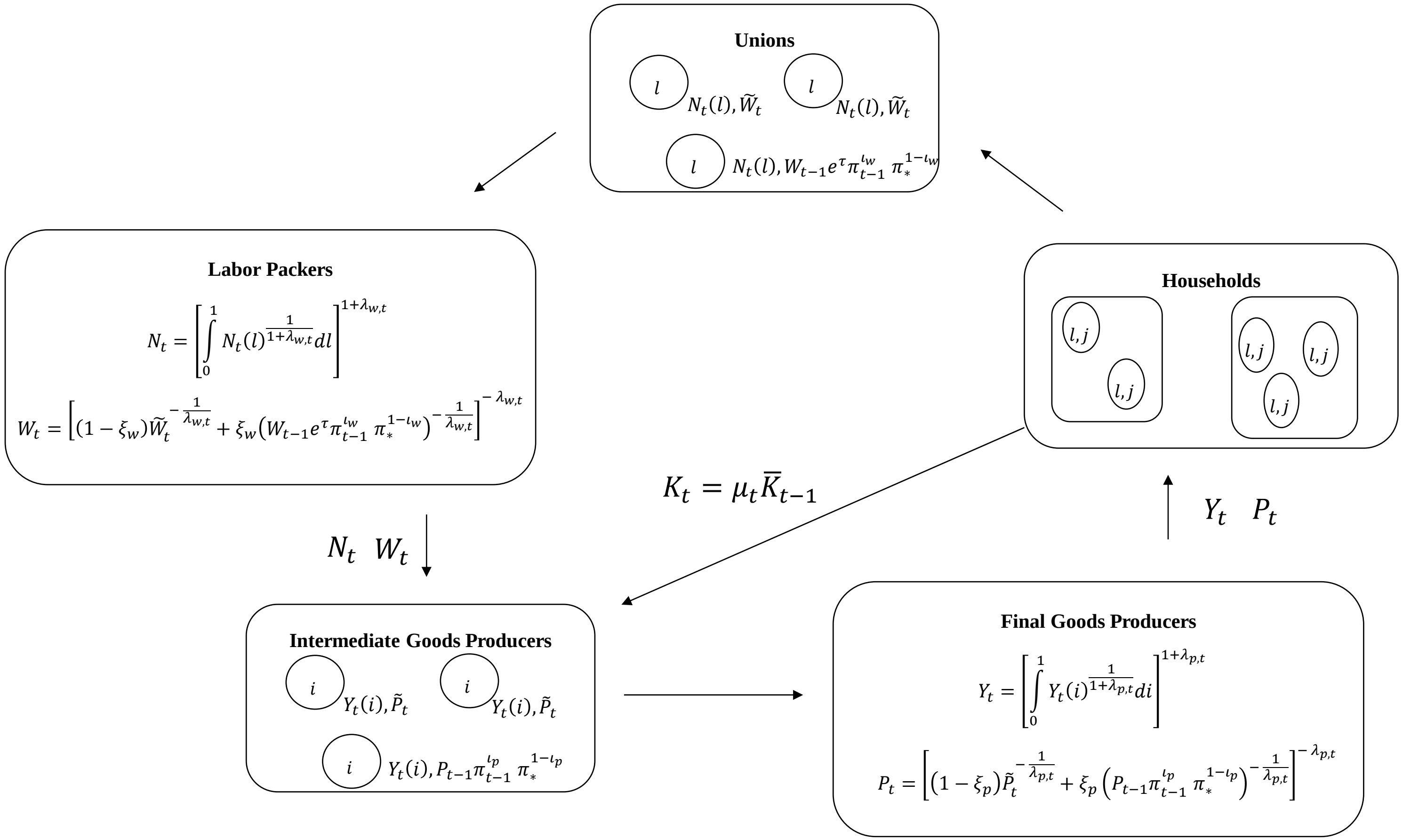
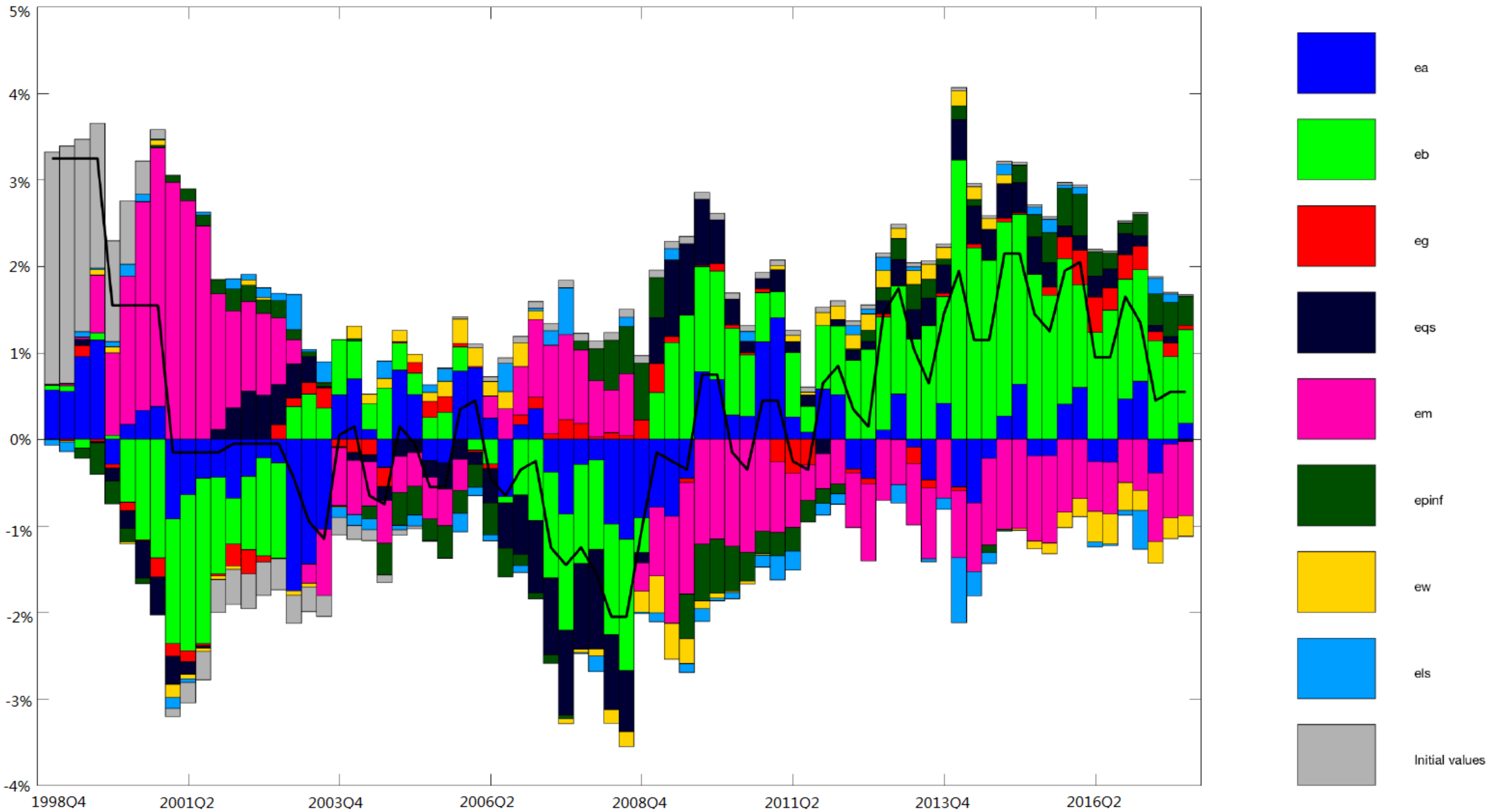
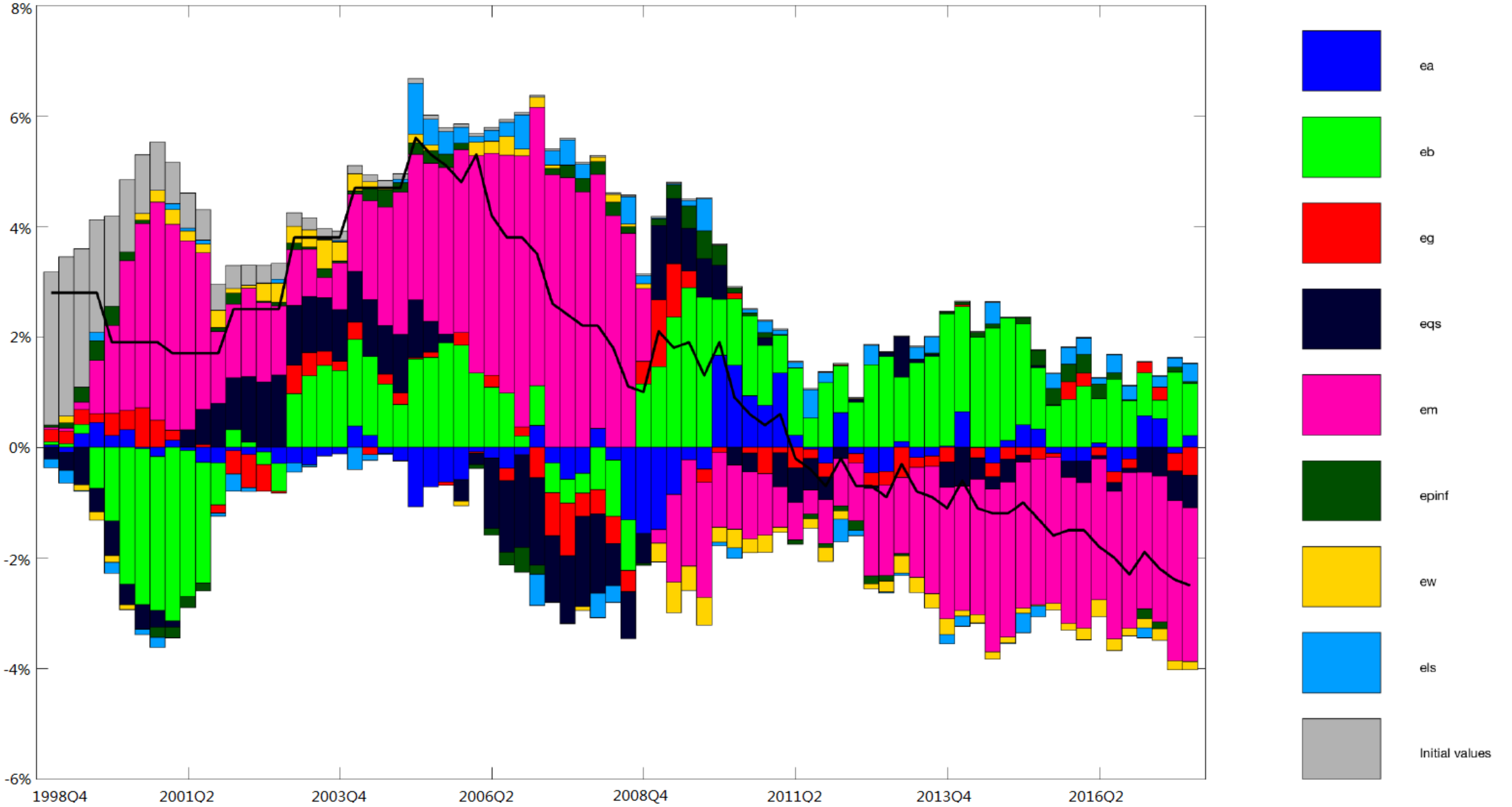


Figure 1.3 France – Historical Shock Decomposition



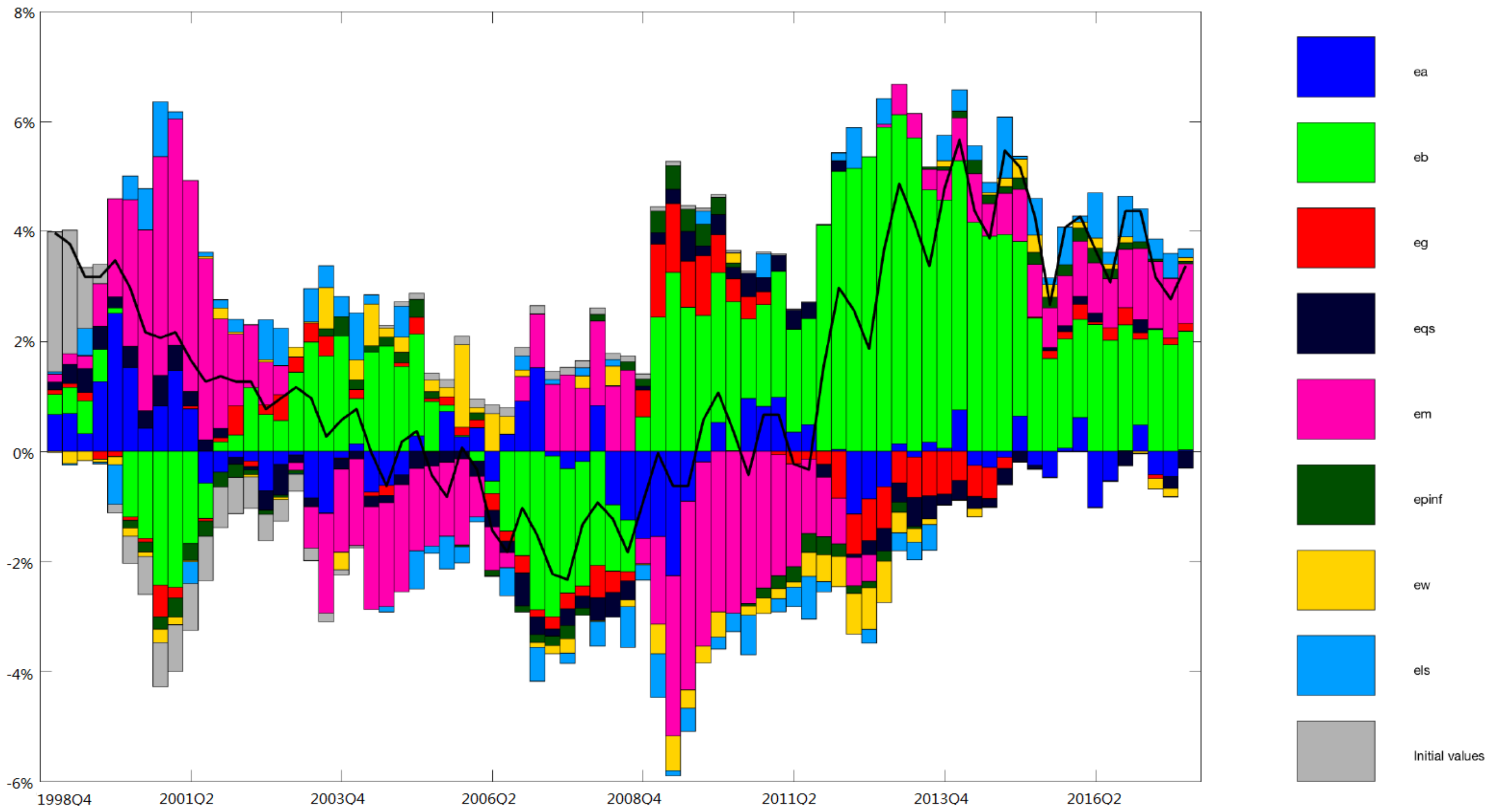

Note: ea: the neutral technology (TFP) shock; eb: the risk premium shock; eg: the public spending shock; eqs: the investment-specific technology shock; em: the monetary policy shock; epinf: the price markup shock; ew: the wage markup shock; els: the labor supply shock.

Figure 1.4 Germany - Historical Shock Decomposition



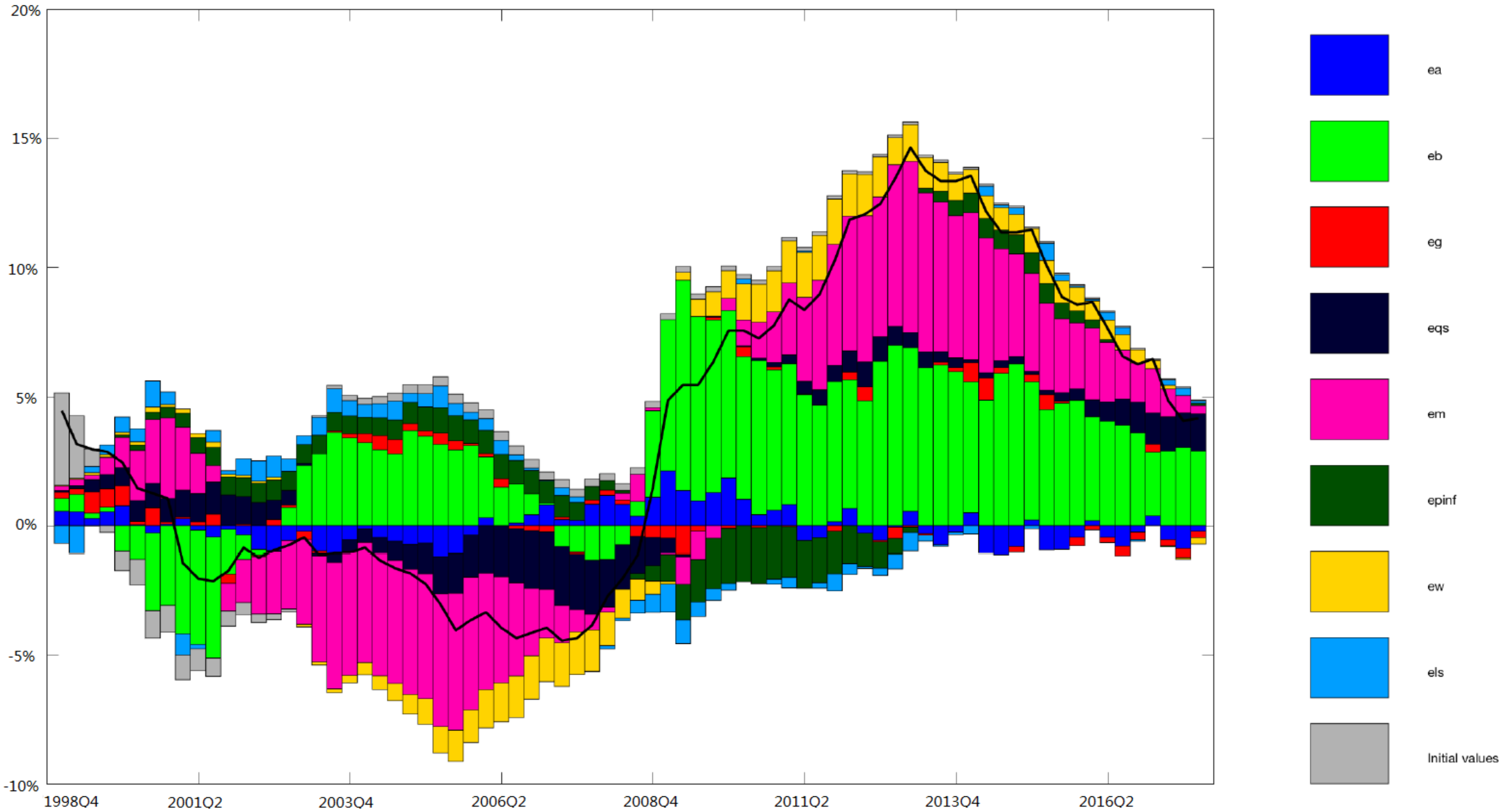

Note: ea: the neutral technology (TFP) shock; eb: the risk premium shock; eg: the public spending shock; eqs: the investment-specific technology shock; em: the monetary policy shock; epinf: the price markup shock; ew: the wage markup shock; els: the labor supply shock.

Figure 1.5 Italy - Historical Shock Decomposition



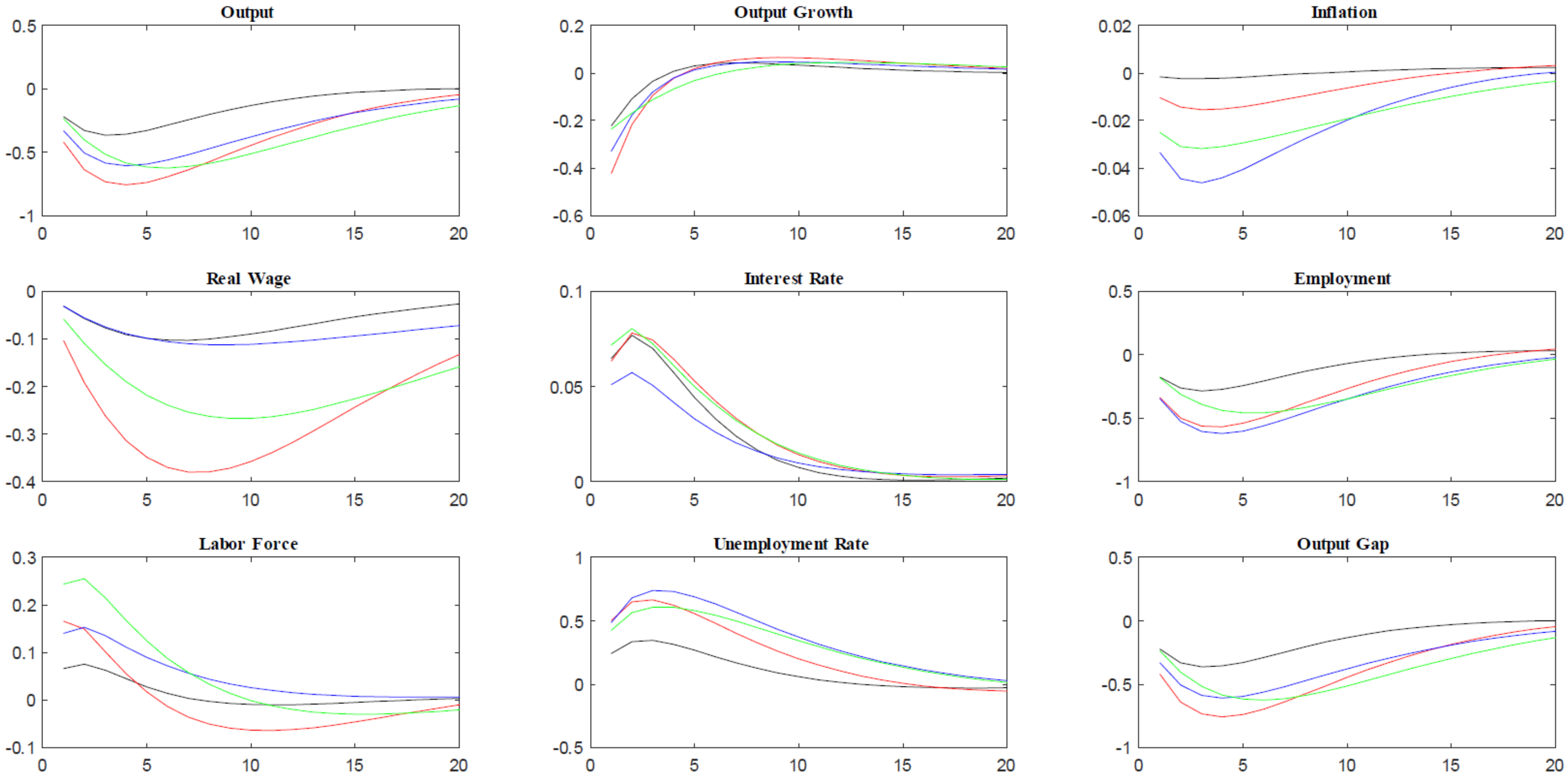

Note: ea: the neutral technology (TFP) shock; eb: the risk premium shock; eg: the public spending shock; eqs: the investment-specific technology shock; em: the monetary policy shock; epinf: the price markup shock; ew: the wage markup shock; els: the labor supply shock.

Figure 1.6 Spain - Historical Shock Decomposition



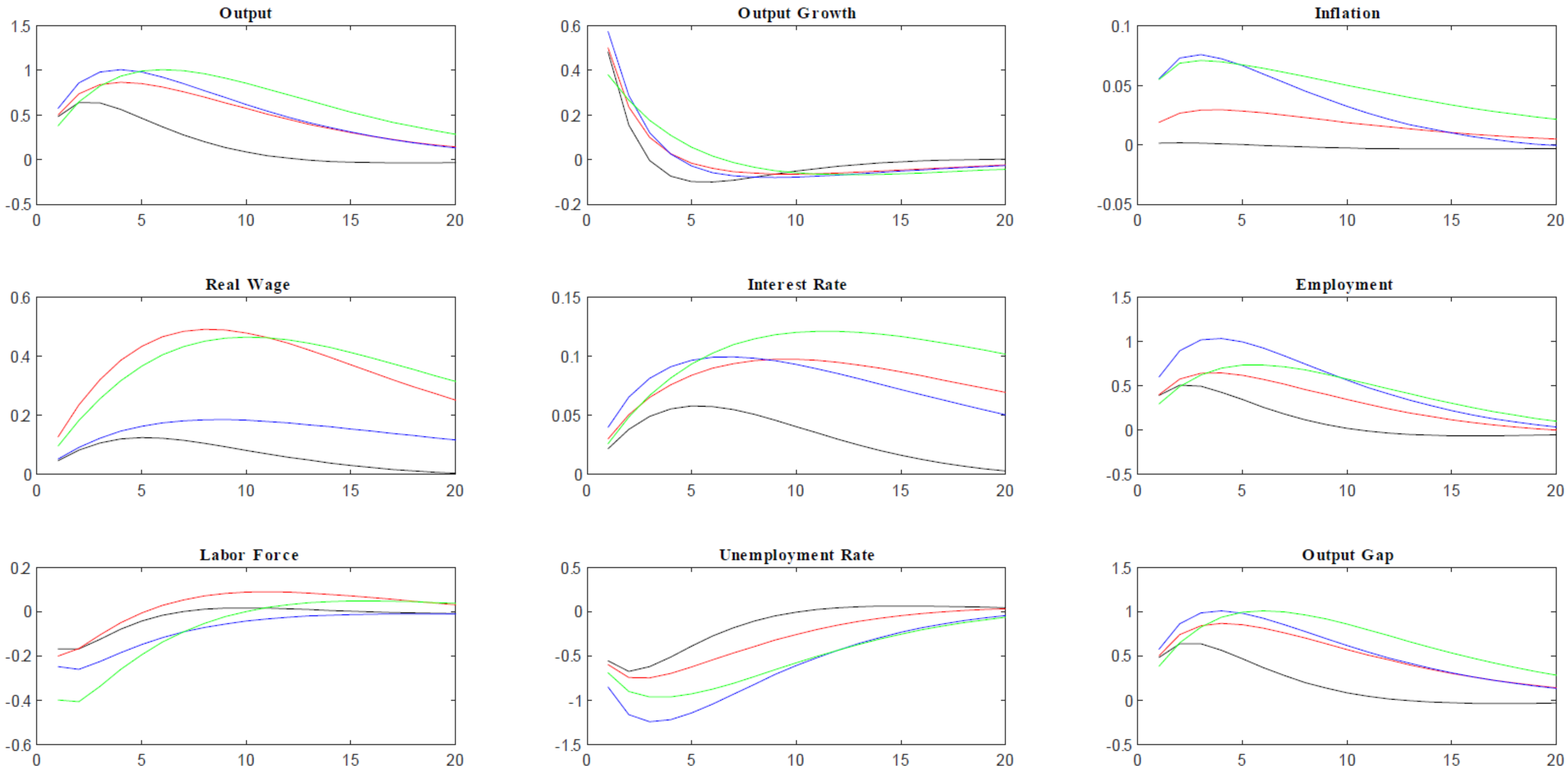

Note: ea: the neutral technology (TFP) shock; eb: the risk premium shock; eg: the public spending shock; eqs: the investment-specific technology shock; em: the monetary policy shock; epinf: the price markup shock; ew: the wage markup shock; els: the labor supply shock.

Figure 1.7 Dynamic Responses to a Positive Monetary Policy Shock of 1 SD



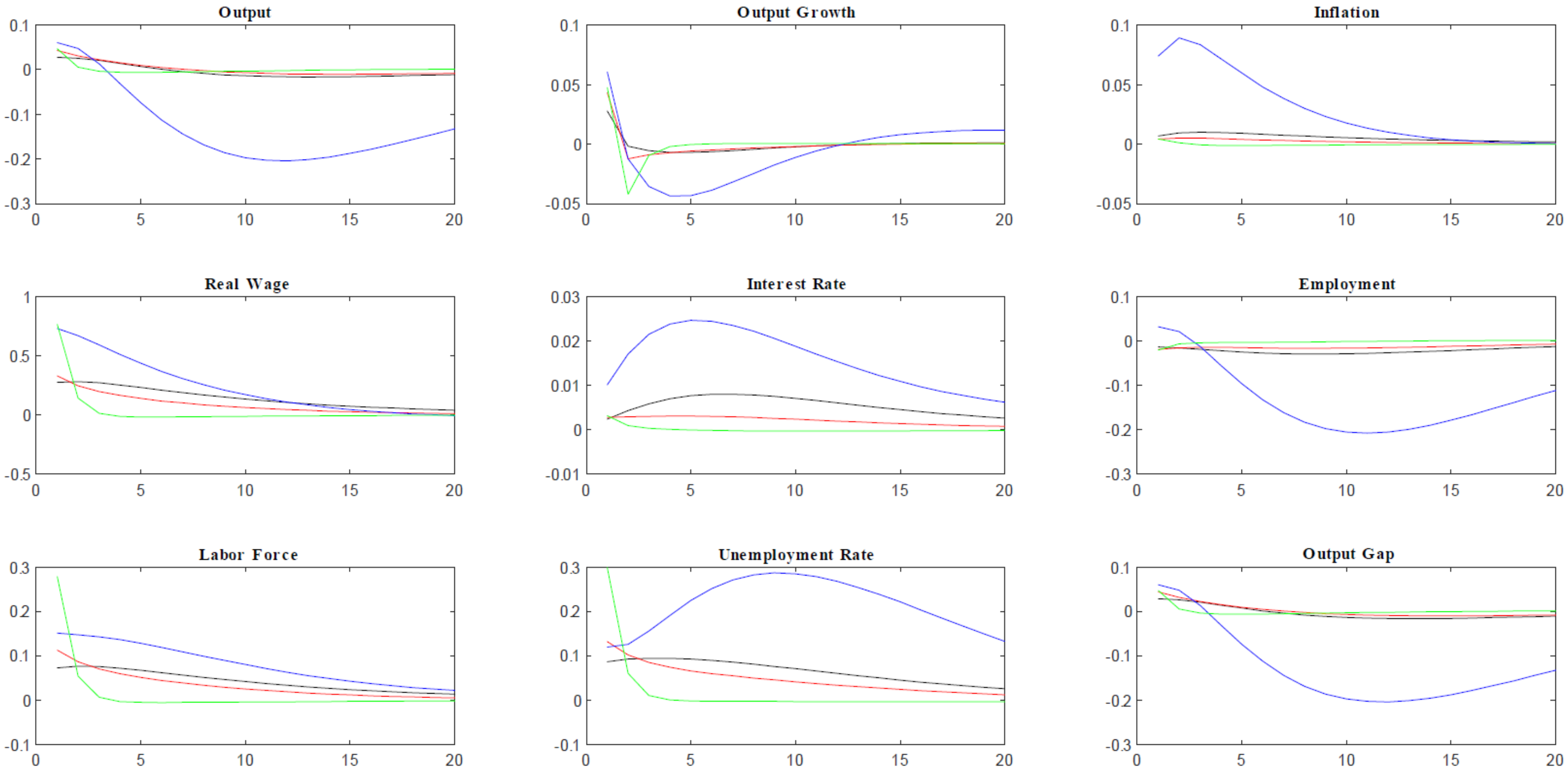

Note: y-axis: quarterly % deviations from steady-state value; x-axis: number of quarters after shock (impact in quarter 1); France black; Germany red; Italy green; Spain blue.

Figure 1.8 Dynamic Responses to a Positive Risk Premium Shock of 1 SD



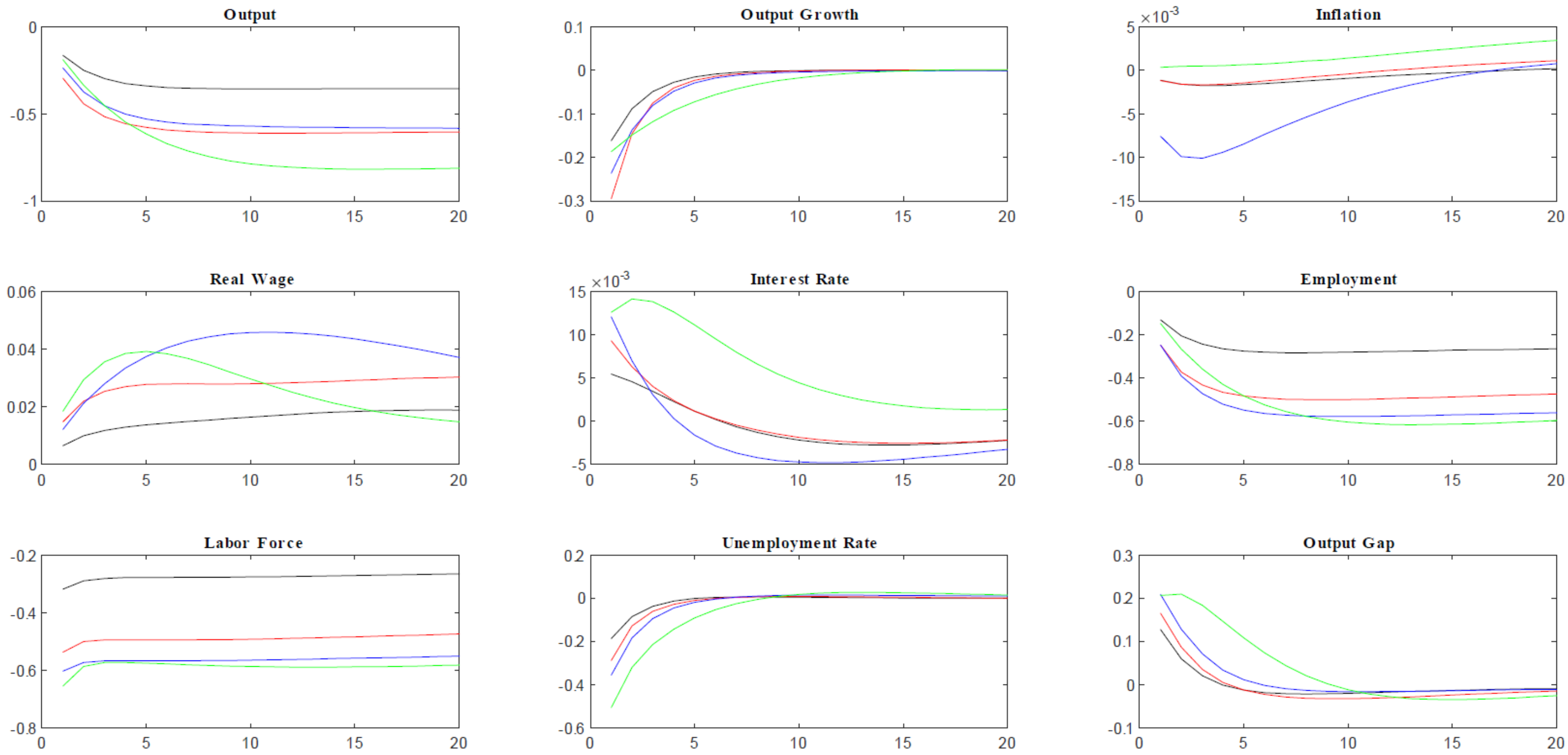

Note: y-axis: quarterly % deviations from steady-state value; x-axis: number of quarters after shock (impact in quarter 1); France black; Germany red; Italy green; Spain blue.

Figure 1.9 Dynamic Responses to a Positive Wage Markup Shock of 1 SD




Note: y-axis: quarterly % deviations from steady-state value; x-axis: number of quarters after shock (impact in quarter 1); France black; Germany red; Italy green; Spain blue.

Figure 1.10 Dynamic Responses to a Positive Labor Supply Shock of 1 SD




Note: y-axis: quarterly % deviations from steady-state value; x-axis: number of quarters after shock (impact in quarter 1); France black; Germany red; Italy green; Spain blue.

### 1.B.2 Tables

Table 1.1 Prior Distribution Assumed for Model Parameters

| No | Notation | Economic Interpretation | Prior Distribution | | |
|---|---|---|---|---|---|
| | | | pdf | mean | SD |
| Structural Parameters | | | | | |
| 1 | $S''$ | elasticity of capital adjustment cost | N | 4.00 | 1.00 |
| 2 | h | external habit | B | 0.70 | 0.10 |
| 3 | $\varphi$ | inverse Frisch elasticity of labor supply | N | 2.00 | 1.00 |
| 4 | $\upsilon$ | short-term wealth effect on labor supply | B | 0.50 | 0.20 |
| 5 | $\xi_p$ | Calvo price stickiness | B | 0.50 | 0.15 |
| 6 | $\xi_w$ | Calvo wage stickiness | B | 0.50 | 0.15 |
| 7 | $\iota_p$ | price indexation | B | 0.50 | 0.15 |
| 8 | $\iota_w$ | wage indexation | B | 0.50 | 0.15 |
| 9 | $\psi$ | elasticity of capital utilization cost | B | 0.50 | 0.15 |
| 10 | $\mathrm{M}_p$ | (gross) price markup | N | 1.25 | 0.25 |
| 11 | $\mathrm{M}_w$ | (gross) wage markup | N | 1.25 | 0.25 |
| 12 | $\rho_R$ | interest-rate smoothing | N | 0.75 | 0.10 |
| 13 | $\Psi_1$ | policy feedback to inflation | N | 1.50 | 0.25 |
| 14 | $\Psi_2$ | policy feedback to output gap | N | 0.12 | 0.05 |
| 15 | $\Psi_3$ | policy feedback to change in output gap | N | 0.12 | 0.05 |
| 16 | $\bar{\pi}$ | steady-state inflation | Γ | 0.62 | 0.10 |
| 17 | $\tilde{\beta}$ | steady-state time discount factor | Γ | 0.25 | 0.10 |
| 18 | $\bar{n}$ | steady-state employment | N | 0.00 | 2.01 |
| 19 | $e^{\bar{\tau}}$ | trend growth rate | N | 0.40 | 0.10 |
| 20 | $\alpha$ | contribution of capital in production function | N | 0.30 | 0.05 |
| Persistence of the Exogeneous Shock Processes and SD of the Innovations to the Exogenous Shock Processes | | | | | |
| 21 | $\rho_a$ | neutral technology (TFP) | B | 0.50 | 0.20 |
| 22 | $\rho_b$ | risk premium | B | 0.50 | 0.20 |
| 23 | $\rho_g$ | public spending | B | 0.50 | 0.20 |
| 24 | $\rho_i$ | investment-specific technology | B | 0.50 | 0.20 |
| 25 | $\rho_r$ | monetary policy | B | 0.50 | 0.20 |
| 26 | $\rho_p$ | price markup | B | 0.50 | 0.20 |
| 27 | $\rho_w$ | wage markup | B | 0.50 | 0.20 |
| 28 | $\mu_p$ | price markup | B | 0.50 | 0.20 |
| 29 | $\mu_w$ | wage markup | B | 0.50 | 0.20 |
| 30 | $\rho_{ga}$ | spillover of TFP shocks on public spending | N | 0.50 | 0.25 |
| 31 | $\sigma_a$ | neutral technology (TFP) | U | 2.50 | 1.44 |
| 32 | $\sigma_b$ | risk premium | U | 2.50 | 1.44 |
| 33 | $\sigma_g$ | public spending | U | 2.50 | 1.44 |
| 34 | $\sigma_i$ | investment-specific technology | U | 2.50 | 1.44 |
| 35 | $\sigma_r$ | monetary policy | U | 2.50 | 1.44 |
| 36 | $\sigma_p$ | price markup | U | 2.50 | 1.44 |
| 37 | $\sigma_w$ | wage markup | U | 2.50 | 1.44 |
| 38 | $\sigma_\chi$ | labor supply | U | 2.50 | 1.44 |

Note: The following parameters are not identified by the estimation procedure, and are therefore calibrated as in GSW: capital depreciation $\delta$= 0.025; curvature of price aggregator $\varsigma_p$= 10; persistence of labor supply shock $\rho_\chi$= 0.999.

## Table 1.2 Posterior Distribution Estimates for Model Parameters

| No | Notation | France mean | France SD | Germany mean | Germany SD | Italy mean | Italy SD | Spain mean | Spain SD |
|---|---|---|---|---|---|---|---|---|---|
| Structural Parameters | | | | | | | | | |
| 1 | $S''$ | 3.99 | 0.87 | 4.04 | 0.88 | 5.82 | 0.76 | 5.41 | 0.81 |
| 2 | h | 0.52 | 0.09 | 0.47 | 0.07 | 0.80 | 0.03 | 0.58 | 0.05 |
| 3 | φ | 3.94 | 0.63 | 2.98 | 0.57 | 2.78 | 0.50 | 4.31 | 0.59 |
| 4 | υ | 0.64 | 0.19 | 0.83 | 0.11 | 0.78 | 0.10 | 0.76 | 0.16 |
| 5 | $\xi_p$ | 0.89 | 0.02 | 0.89 | 0.03 | 0.84 | 0.05 | 0.82 | 0.05 |
| 6 | $\xi_w$ | 0.76 | 0.05 | 0.65 | 0.05 | 0.74 | 0.04 | 0.84 | 0.02 |
| 7 | $\iota_p$ | 0.47 | 0.13 | 0.43 | 0.14 | 0.26 | 0.10 | 0.36 | 0.16 |
| 8 | $\iota_w$ | 0.22 | 0.08 | 0.19 | 0.07 | 0.23 | 0.09 | 0.26 | 0.10 |
| 9 | ψ | 0.66 | 0.12 | 0.53 | 0.12 | 0.63 | 0.11 | 0.81 | 0.09 |
| 10 | $\mathrm{M}_p$ | 1.52 | 0.10 | 1.42 | 0.10 | 1.44 | 0.10 | 1.13 | 0.08 |
| 11 | $\mathrm{M}_w$ | 1.35 | 0.06 | 1.18 | 0.04 | 1.22 | 0.05 | 1.54 | 0.09 |
| 12 | $\rho_R$ | 0.87 | 0.03 | 0.93 | 0.01 | 0.95 | 0.01 | 0.94 | 0.01 |
| 13 | $\Psi_1$ | 1.31 | 0.19 | 1.20 | 0.16 | 1.14 | 0.12 | 1.38 | 0.20 |
| 14 | $\Psi_2$ | 0.19 | 0.04 | 0.20 | 0.04 | 0.20 | 0.04 | 0.11 | 0.04 |
| 15 | $\Psi_3$ | 0.02 | 0.01 | 0.04 | 0.02 | 0.05 | 0.02 | 0.05 | 0.02 |
| 16 | $\bar{\pi}$ | 0.51 | 0.08 | 0.44 | 0.07 | 0.55 | 0.07 | 0.63 | 0.09 |
| 17 | $\tilde{\beta}$ | 0.20 | 0.08 | 0.25 | 0.10 | 0.27 | 0.10 | 0.21 | 0.08 |
| 18 | $\bar{n}$ | 0.74 | 0.91 | 0.48 | 1.09 | 0.86 | 1.10 | -3.12 | 1.30 |
| 19 | $e^{\bar{\tau}}$ | 0.20 | 0.05 | 0.12 | 0.04 | 0.05 | 0.03 | 0.17 | 0.04 |
| 20 | α | 0.30 | 0.02 | 0.30 | 0.03 | 0.18 | 0.02 | 0.19 | 0.03 |
| Persistence of the Exogeneous Shock Processes and SD of the Innovations to the Exogenous Shock Processes | | | | | | | | | |
| 21 | $\rho_a$ | 0.93 | 0.02 | 0.92 | 0.06 | 0.88 | 0.04 | 0.93 | 0.02 |
| 22 | $\rho_b$ | 0.80 | 0.16 | 0.96 | 0.02 | 0.97 | 0.01 | 0.94 | 0.02 |
| 23 | $\rho_g$ | 0.95 | 0.01 | 0.91 | 0.03 | 0.91 | 0.04 | 0.96 | 0.03 |
| 24 | $\rho_i$ | 0.66 | 0.10 | 0.46 | 0.14 | 0.15 | 0.08 | 0.85 | 0.06 |
| 25 | $\rho_r$ | 0.42 | 0.10 | 0.43 | 0.08 | 0.30 | 0.08 | 0.36 | 0.08 |
| 26 | $\rho_p$ | 0.78 | 0.14 | 0.42 | 0.18 | 0.19 | 0.11 | 0.68 | 0.18 |
| 27 | $\rho_w$ | 0.52 | 0.16 | 0.48 | 0.16 | 0.21 | 0.11 | 0.48 | 0.16 |
| 28 | $\mu_p$ | 0.90 | 0.05 | 0.72 | 0.07 | 0.61 | 0.16 | 0.59 | 0.21 |
| 29 | $\mu_w$ | 0.45 | 0.18 | 0.54 | 0.19 | 0.60 | 0.12 | 0.45 | 0.15 |
| 30 | $\rho_{ga}$ | 0.19 | 0.04 | 0.36 | 0.07 | 0.24 | 0.05 | 0.23 | 0.07 |
| 31 | $\sigma_a$ | 0.75 | 0.07 | 0.84 | 0.08 | 0.89 | 0.08 | 0.75 | 0.07 |
| 32 | $\sigma_b$ | 0.36 | 0.26 | 0.15 | 0.04 | 0.16 | 0.04 | 0.20 | 0.06 |
| 33 | $\sigma_g$ | 0.21 | 0.02 | 0.47 | 0.04 | 0.41 | 0.04 | 0.43 | 0.04 |
| 34 | $\sigma_i$ | 0.23 | 0.04 | 0.77 | 0.13 | 0.77 | 0.08 | 0.24 | 0.04 |
| 35 | $\sigma_r$ | 0.08 | 0.01 | 0.09 | 0.01 | 0.09 | 0.01 | 0.07 | 0.01 |
| 36 | $\sigma_p$ | 1.01 | 0.24 | 1.76 | 0.99 | 1.52 | 0.90 | 0.20 | 0.16 |
| 37 | $\sigma_w$ | 0.58 | 0.29 | 0.45 | 0.18 | 2.57 | 1.03 | 3.55 | 0.90 |
| 38 | $\sigma_\chi$ | 1.58 | 0.28 | 2.26 | 0.43 | 2.68 | 0.48 | 3.15 | 0.44 |

Table 1.3 Key Characteristics of the RWMH-MCMC Bayesian Estimation

| | France | Germany | Italy | Spain |
|---|---|---|---|---|
| Acceptance Rate: Chain 1 | 20.0% | 38.2% | 31.3% | 39.8% |
| Acceptance Rate: Chain 2 | 22.0% | 39.4% | 32.5% | 35.7% |
| Log Data Density | -252.8 | -485.7 | -548.1 | -501.6 |

Table 1.4 Variance Decomposition of the Unemployment Rate

| Type of exogenous shock | France | Germany | Italy | Spain |
|---|---|---|---|---|
| Horizon = 1 quarter ("short run"), contribution in % | | | | |
| Demand shocks | | | | |
| Risk premium | 42.6 | 31.6 | 31.3 | 47.7 |
| Public spending | 1.9 | 7.5 | 4.4 | 7.2 |
| Investment-specific technology | 2.9 | 14.1 | 2.5 | 1.3 |
| Monetary policy | 8.1 | 22.1 | 11.9 | 15.5 |
| Supply shocks | | | | |
| Neutral technology (TFP) | 37.2 | 14.4 | 27.7 | 18.8 |
| Price markup | 1.5 | 1.4 | 0.1 | 0.2 |
| Labor market shocks | | | | |
| Wage markup | 1.0 | 1.5 | 5.4 | 1.0 |
| Labor supply | 4.8 | 7.3 | 16.9 | 8.4 |
| Horizon = 10 quarters ("medium run"), contribution in % | | | | |
| Demand shocks | | | | |
| Risk premium | 54.1 | 45.2 | 61.8 | 60.5 |
| Public spending | 0.7 | 2.2 | 1.4 | 1.6 |
| Investment-specific technology | 6.0 | 10.7 | 0.9 | 5.6 |
| Monetary policy | 18.2 | 34.4 | 23.9 | 21.8 |
| Supply shocks | | | | |
| Neutral technology (TFP) | 14.5 | 4.3 | 6.9 | 3.3 |
| Price markup | 2.8 | 1.0 | 0.3 | 3.0 |
| Labor market shocks | | | | |
| Wage markup | 2.4 | 0.8 | 0.8 | 3.2 |
| Labor supply | 1.4 | 1.5 | 4.0 | 1.1 |
| Horizon = 40 quarters ("long run"), contribution in % | | | | |
| Demand shocks | | | | |
| Risk premium | 51.7 | 44.8 | 62.6 | 58.3 |
| Public spending | 0.7 | 2.1 | 1.3 | 1.4 |
| Investment-specific technology | 5.8 | 10.6 | 0.8 | 5.8 |
| Monetary policy | 17.3 | 34.0 | 23.8 | 21.1 |
| Supply shocks | | | | |
| Neutral technology (TFP) | 15.8 | 5.2 | 6.9 | 3.7 |
| Price markup | 4.5 | 1.0 | 0.2 | 3.1 |
| Labor market shocks | | | | |
| Wage markup | 3.0 | 0.9 | 0.8 | 5.6 |
| Labor supply | 1.3 | 1.4 | 3.7 | 1.0 |

# Chapter 2: Unemployment Across the Euro Area: The Role of Shocks and Labor Market Institutions

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## 2.1 Introduction

The 2007 GFC was associated with job losses for a substantial number of persons, and a strong and persistent increase in unemployment in many European countries. Figure 2.1 displays unemployment rate paths in the EA since 1999, both as a whole (the red line) and for 11 individual EA countries. The average unemployment rate across the EA rose from 6.5% in 2007 to 10.8% in 2013.[17] These figures, however, mask large divergences in unemployment rates across countries, from 5.2% in Germany to 26.1% in Spain in 2013. These cross-country differences are not only likely to be strongly influenced by cross-country differences in the magnitude of economic shocks, but also by the institutional framework of national labor markets.

There is a substantial literature which attempts to explain the time series patterns of European unemployment, from the perspective of the role of external shocks and labor market institutions. There is a division between studies which focus on the direct effects of labor market institutions on unemployment and those which consider interactions between shocks and labor market institutions to influence unemployment. A good example studying the direct effects of institutions on unemployment in Europe is Nickell (1997), which considers the relationship between unemployment rates and a set of measures of labor market institutions, based on two cross-sections dated 1983-88 and 1989-1994. This study is further extended by Nickell et al. (2005), who investigate the effects of both institutions changing equilibrium unemployment in the long run, and shocks driving the short-run deviations of unemployment from its equilibrium level. They find that changes in labor market institutions explain around 55% of the rise in

[17] Here the average unemployment rate is defined as the unweighted average of the unemployment rates for the 11 individual EA countries.

European unemployment from the 1960s to the first half of the 1990s. On the other hand, Blanchard and Wolfers (2000) (henceforth referred to as BW) use panel data methods to explore the explanatory power of the interactions of shocks and labor market institutions for unemployment in the Organization for Economic Co-operation and Development (OECD) between 1960 and 1995. The shocks consist of the level of TFP growth, the real interest rate and labor demand shifts. They show that interacting these observed shocks with time invariant institutional variables fits the data well. Subsequently, the basic BW model has been extended and updated by a large body of studies. A good summary of these studies is provided by Bassanini and Duval (2007). The most recent study by Bertola (2017) revisits the BW model and updates the sample period to 2014, to explain the more recent patterns of European unemployment.

In this chapter, I aim at investigating the patterns of unemployment across the EA between 1999 and 2013. To control for the effect of the introduction of the single currency, I select my sample countries as the first group of countries joining the EA since the official launch of the Euro on 1 January 1999.[18] The corresponding sample period hence begins from 1999. The sample stops with 2013, as later observations would belong to a currently incomplete period for which institutional information is not yet fully available. This sample period covers the GFC and the preceding economic expansion period, featuring a series of dramatic external shocks and important changes in labor market institutions that had taken place in many Southern European countries, such as Italy and Spain, and Central European countries such as Germany.[19]

More specifically, I explore the role of shocks and labor market institutions in influencing unemployment from two aspects. First, in the spirit of Nickell et al. (2005), I examine the direct effects of shocks and labor market institutions: how much of the evolution of unemployment across the EA can be simply explained by changes in institutions and shocks? Second, I follow the method of BW and investigate the indirect effects of labor market institutions: how do labor market institutions change the transmission of shocks to unemployment?

My contributions to the literature are as follows. First, in contrast to many existing studies, I focus on the EA countries, which have a single monetary policy regime,

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[18] The countries are Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain.

[19] The evolution of unemployment covering the period of the GFC is also analyzed by Bertola (2017) and Bachmann and Felder (2020).

conducted by the ECB, and heterogenous labor market conditions. A single monetary policy could help countries to develop more integrated economies and labor markets. However, the underlying differences in labor market institutions are considered to be detrimental to the effectiveness of a single monetary policy framework (McKinnon 1963; Mundell 1961). To attempt to explain the unemployment patterns across the EA, I control for the effect of the single monetary policy by the ECB, considering two common monetary policy shocks, namely ECB money supply shocks and ECB unsystematic monetary policy shocks. Second, I enhance the models in the literature by allowing for time-varying data on all institutional variables over time. In BW, the measures of labor market institutions are time-invariant. After that, a group of subsequent studies have updated the sample of BW into time-varying measures for some of the institutions, but focusing on the period between the 1960s and the 1990s. With respect to the measures of institutions for the more recent period, Bertola (2017) constructs the time-varying data for unemployment benefit replacement rates, employment protection laws, union density and the labor tax wedge from the 1960s to 2014. In this study, I extend the time-varying measures for more labor market institutions for the sample period between 1999 and 2013, covering the unemployment benefit system, active labor market policies, employment protection laws, the system of wage determination and the labor tax wedge.[20]

The main results of my analysis reveal that the real interest rate and the labor demand shock significantly affect the unemployment rate in the EA. As for labor market institutions, generous unemployment benefits and pervasive unionization tend to be correlated with increases in the unemployment rate, but could indirectly reduce the impact of shocks on unemployment. Employment protection laws decrease unemployment but have no significant interaction with the shocks. Active labor market policies and the coordination in wage bargaining also play a favorable role in affecting unemployment. In contrast, a higher tax wedge tends to have an adverse effect on unemployment, leading to not only higher unemployment but also a larger effect of shocks on unemployment.

The remainder of this chapter is organized as follows: Section 2.2 looks at shocks, both across countries and over time; Section 2.3 does the same for labor market institutions;

[20] The details are given in Appendix 2.A.1.

Section 2.4 lays out my empirical methodology; Section 2.5 reports the main results; Section 2.6 conducts a set of robustness tests; and Section 2.7 concludes.

## 2.2 Shocks

Following the literature (BW, 2000; Nickell et al., 2005; Rumler and Scharler, 2011) and the evidence in Chapter 1, I consider the role of three country-specific shocks and two common monetary policy shocks which might drive the deviations of unemployment from its equilibrium level. Specifically, they include: 1) TFP shocks, 2) the real long-term interest rate, 3) labor demand shocks, 4) ECB money supply shocks and 5) ECB unsystematic monetary policy shocks (see Appendix 2.A.1 for details).

### 2.2.1 Country-specific Shocks

Three country-specific shocks, defined by BW, seem to play a role in affecting unemployment in the recent period (see Bertola, 2017), namely TFP shocks, the real long-term interest rate and labor demand shocks.[21] Particularly, TFP shocks can affect the unemployment rate because it takes time for workers and firms to adjust their expectations to the new productivity growth rate, leading to wage growth mismatching TFP growth for some time. However, once expectations have adjusted, this effect on unemployment should be eliminated in the short run (BW, 2000). Figure 2.2 plots the evolution of the TFP shocks for each of the EA11 countries.[22] After 1999, TFP growth fluctuates frequently in the runup to the GFC, and then suffers a large decrease during the GFC, followed by a subsequent upswing. These fluctuations have affected countries in a roughly similar fashion. The slowdown in TFP growth during the GFC can lead to a higher unemployment rate, because of wage growth temporarily being in excess of productivity growth, if real wages fail to adjust to it. Theoretically the TFP shock is expected to be negatively associated with the unemployment rate.

The real long-term interest rate, as an influencing factor behind the demand for labor, affects unemployment through changing capital accumulation and in a variety of other ways (Phelps and Zoega 1998). For example, at a given wage, that is a given ratio of employment to capital, changes in capital accumulation can shift labor demand, which in turn affects unemployment (BW, 2000). There is some evidence that high real interest

[21] The data for constructing the country-specific shocks are variable from the OECD database and the AMECO database. The related webs are http://stats.oecd.org and https://ec.europa.eu/economy_finance/ameco/user/serie/SelectSerie.cfm.

[22] Following Bertola (2017), I use the rate of TFP growth to measure the TFP shock. See Appendix 2.A.1 for more details.

rates are associated with high unemployment, notably in Fitoussi et al. (2000) and BW. Some researchers, however, find very weak effects (e.g., Nickell, 1998; Nickell et al., 2003; Phelps, 1994, Table 17.2). Figure 2.2 gives the evolution of the real long-term interest rate for each of the sample countries.[23] The red line plots the unweighted average across the EA11. On average, the real interest rate remains relatively stable over time, fluctuating around 2%. For some countries, the real interest rate sharply increases after the GFC. It shows that the real rate in Ireland and Portugal goes up from 3% in 2007 to 11% in 2011. The higher real interest rate may help to explain the increase in the unemployment rate in Ireland and Portugal since the GFC. In the subsequent empirical analysis, I expect that the real long-term interest rate will be positively related to the unemployment rate.

The measure of the labor demand shock follows BW, which is the sum of the adjusted log wage indicator and the adjusted log employment indicator (less the log of real GDP).[24] Under conditions discussed in Blanchard (1997), this measure can capture the unemployment implications of temporarily misaligned real wages. For example, as shown in Figure 2.2, between 2007 and 2009, the increase in the adjusted labor share, averaged across the EA11, reflects the effect of the increase in the real wage relative to TFP growth ($log(w/a)$), given a dramatic drop in the TFP growth rate in the same period. Generally speaking, the labor demand shocks display heterogenous trends across countries, such as the continuous upward trend in Italy and downward trend in Portugal. Other countries show varying degrees of increases in labor demand after the GFC. On average, labor demand across the EA gradually declines by the eve of the GFC and increases after, as the economy recovers. Overall, I expect that the labor demand shock will be negatively related to the unemployment rate.

### 2.2.2 Common Monetary Policy Shocks

Chapter 1 provides the robust evidence that monetary policy shocks are the second largest exogenous force driving fluctuations in national unemployment rates in the four

[23] The real long-term interest rate is measured by the long-term nominal interest rate less the yearly growth rate of the GDP deflator.

[24] Following BW, I assume that technology is characterized by a Cobb-Douglas production function $Y = (aN)^{\alpha}(K)^{1-\alpha}$, with technological progress assumed to be labor augmenting. Under perfect competition in both goods and labor markets, the marginal product of labor is equal to the real wage (MPL = w), that is $\alpha \cdot a \cdot (Y/aN) = w$. Taking logs on both sides, this yields $log(\alpha) = log(w/a) + log(aN) - log(Y)$, so that a decrease in the log of the labor share, $log(\alpha)$, leads to an equal decrease in the log of the adjusted employment, $log(aN)$, given output and the real wage. Thus, labor demand shocks could be measured by the log of the adjusted labor share, that is, the sum of the adjusted log wage indicator and the adjusted log employment indicator, less the log of real GDP. See Appendix 2.A.1 for more details.

EMU countries (France, Germany, Italy and Spain). In this chapter, I also consider the effect of the single monetary policy across the EA, by including two common monetary policy shocks from the ECB: ECB money supply shocks and ECB unsystematic monetary policy shocks. These two monetary policy shocks can be treated as proxies for aggregate demand shocks. The ECB controls either the money supply or the short-term interest rate, targeting inflation to ensure price stability. Because of inflation inertia, this leads not only to a change in inflation but also to a change in output and unemployment. The mainstream macroeconomic theory, like monetarism, believes that monetary policy only affects unemployment in the short run. However, some researchers propose that monetary policy could be non-neutral in the long run under the case of price and wage rigidity (e.g., Karanassou et al., 2005).
Following Nickell et al. (2005), ECB money supply shocks are measured by changes in money supply growth.[25] Figure 2.3 plots the time path of the money supply shock from the ECB. Roughly speaking, the ECB has twice sharply restricted the rate of money growth, once in the early years of the euro's launch and again before the GFC. This conduct is aimed at reducing inflation. The slowdown of the growth rate of the money supply may depress short-term economic growth and increase unemployment. The relationship between money supply shocks and the unemployment rate seems to be negative. Some researchers, however, find very weak effects (e.g., Nickell et al., 2005; Nunziata, 2002).

For ECB unsystematic monetary policy shocks, I follow the measure of Rumler and Scharler (2011), by estimating an interest rate rule (see Equation (2.1)) and employing its residuals ($\mu_t^M$). More specifically, I estimate a regression with the short-term nominal interest rate as the dependent variable and the current inflation rate and the current output gap as independent variables. In addition, I allow for an inertial response of monetary policy by including one-period lagged values of the dependent variable. Notice that Equation (2.1) is in line with Equation (1.47) in Chapter 1, but removes the current change in the output gap on the right-hand side, considering the negligible monetary policy reaction to it as estimated. Equation (2.1) is estimated by the generalized method of moments, which is standard in the literature (e.g., Clarida et al., 2000; Gerlach and Schnabel, 2000), and passes the weak instrument tests and over-

[25] The yearly ECB money supply shock is calculated by taking the average of monthly changes in the growth rate of the nominal money stock, that is, the second difference of the log money supply. Data on the nominal money stock are available on the ECB Statistical Data Warehouse, which are monthly monetary aggregates, M2.

identifying restriction tests. As instruments, I use the lags of all right-hand-side variables up to lag four.

$$r_t = \alpha + \beta\pi_t + \gamma y_t^{gap} + \delta r_{t-1} + \mu_t^M \tag{2.1}$$

Data for all variables are quarterly time series covering 1999Q1-2013Q4 and the yearly ECB unsystematic monetary policy shock is measured as the average of the quarterly residuals.[26] Figure 2.3 gives the evolution of the ECB nominal short-term interest rate and the measure of its unsystematic monetary policy shock. The change of the unsystematic policy shock approximately maps the trend of the ECB interest rate change. Furthermore, apart from the peak between 1999 and 2001, the pattern of the ECB unsystematic policy shock is roughly positively associated with the averaged unemployment rate across the EA. By initial observation, my measure seems to reveal that an expansionary monetary policy combats unemployment and a contractionary monetary policy leads to higher unemployment. The effect of the unsystematic monetary policy shock on unemployment is expected to be positive.

## 2.3 Labor Market Institutions

Labor market institutions influence unemployment in two ways. First, some of them affect the ease with which unemployed individuals can be matched to available job vacancies; Second, some institutions tend to raise wages in a direct fashion despite excess supply in the labor market. There may be institutions common to both ways. In line with the literature (e.g., BW, 2000; Nickell, 1997; Nickell et al., 2005), I capture the institutional setting of national labor markets by using eight indicators.[27] They cover the unemployment benefit system, active labor market policies (ALMPs), employment protection laws (EPLs), the system of wage determination and the labor tax wedge for each country. I next describe these labor market institutions in more detail.

### 2.3.1 Unemployment Benefit System

The unemployment benefit system influences unemployment either because of its impact on the effectiveness with which the unemployed are matched to available jobs

[26] Data on short-term nominal interest rates are obtained from the ECB Statistical Data Warehouse, which are nominal interest rates on ECB marginal lending facilities. Data on inflation rates and output gaps are taken from the OECD Economic Outlook No 105 (version May 2019), expressed by the percentage change of CPI on the same period of the previous year and the ratio of the output gap to potential GDP, respectively.

[27] The institutional measures are: 1) the replacement rate of unemployment benefits; 2) unemployment benefit duration; 3) a measure of active labor market policies; 4) employment protection index; 5) union contract coverage; 6) union density; 7) a measure of employer and union coordination in wage bargaining and 8) the tax wedge.

or because of its effect on wages. On the one hand, unemployment benefits directly affect the readiness of the unemployed to fill vacancies. The likelihood of taking up a job decreases when unemployment benefits are more generous. Hence, it tends to result in a longer unemployment duration and make for a more stagnant labor market with a higher proportion of the long-term unemployed. On the other hand, due to lower opportunity costs of unemployment, generous unemployment benefits push up the reservation wage. Indeed, empirical evidence suggests that unemployment benefits have a significant adverse effect on unemployment (e.g., Nickell et al., 2005). There is fairly clear micro evidence on the positive impact of benefit levels and entitlement durations on the duration of individual unemployment spells (Carling et al. 1996; Katz and Meyer 1990; Meyer 1990). Considering the important aspects of the unemployment benefit system are the level of benefits and the length of time for which they are available, I select the benefit replacement rate and the benefit duration as the measures of the unemployment benefit system.[28]

Figure 2.4 presents the time paths of two measures of the benefit replacement rate, namely the replacement rate during the 1st year of unemployment and the average replacement rate during years 2 to 5 of an unemployment spell, and Figure 2.5 plots the time path of an index of benefit duration for each sample country. The benefit replacement rates in nearly all countries are at a comparable level expect for Ireland and Italy, in which countries the benefit levels are relatively low. It is remarkable that there is a sharp rise in the replacement rate in Portugal in 2010, but which almost returns to the previous level after 2012. As for benefit duration, most countries are committed to reducing the duration of entitlement. However, Austria and Spain tend to keep the duration very stable and Ireland and Luxembourg even slightly increase their benefit duration. To make a comparison among countries, Austria and Belgium provide relatively generous unemployment benefits, especially characterized by the longest benefit durations. While the unemployment benefits in Ireland feature by a long duration but a low replacement rate. In contrast, the benefit system in Italy is different, having both the shortest benefit duration and the lowest benefit level.

[28] The OECD reports data on the net unemployment benefit replacement rate at two earnings levels for three different family types in 14 different duration categories. I derive two measures of the benefit replacement rate to express the level of benefit: the average net replacement rate during the 1st year of unemployment and the average net replacement rate during years 2 to 5 of an unemployment spell. I also derive an index of benefit duration, which is equal to [0.6 * (2nd and 3rd year replacement rate) + 0.4 * (4th and 5th year replacement rate)] / (1st year replacement rate). See Appendix 2.A.1 for the details.

### 2.3.2 Active Labor Market Policies (ALMPs)

ALMP programmes aim at reducing unemployment by improving the job matching process and by enhancing opportunities for the unemployed to accumulate skills and work experience, affecting their job search behavior. Thus, unemployed individuals become more employable. The literature indicates that ALMPs do have a negative correlation with unemployment, based on both multi-country studies (e.g., Elmeskov et al., 1998; Nickell, 1997; Scarpetta, 1996) and single-country studies (e.g., Calmfors et al., 2002).

Figure 2.6 shows the evolutions of two measures for public expenditures on ALMPs in each of the EA11, which are public expenditures on ALMPs as a share of GDP and public expenditures on ALMPs per unemployed worker as a share of GDP per member of the labor force, respectively. For the gross expenditures on ALMPs (as a share of GDP), the evolutions are heterogenous across countries. Roughly speaking, Belgium, France, Germany, Italy, Netherlands and Spain have experienced a reduction in their expenditures on ALMPs. The notable country is Germany, in which there is a sharp fall in the spending on ALMPs, reducing from above 1% to around 0.3% of GDP. In contrast, Austria and Luxembourg increase their ALMPs spends to 0.6% of GDP. However, the evolution of public expenditures on ALMPs per unemployed worker as a share of GDP per member of the labor force is stable in most countries, roughly remaining around 10%. Italy and Spain spend relatively less on ALMPs, below 10% and further reducing to about 2%. Netherlands devotes most resources to ALMPs to offset their generous unemployment benefits (see benefit duration in Figure 2.5) and to push the unemployed into work, but nonetheless has been reducing the spend on ALMPs.

### 2.3.3 Employment Protection Laws (EPLs)

EPLs are the proxies for the costs firms face when they dismiss an employee and are therefore indicators of the flexibility of a labor market. The stricter EPLs are, the more costly it is for employers to lay off workers. EPLs have an impact on the effectiveness with which the unemployed are matched to available jobs, but the specific impact is not clear-cut. In terms of outflows from unemployment, the impact of EPLs can go two ways. EPLs may tend to make firms more cautious about filling vacancies, which slows the speed at which the unemployed move into work. However, the introduction of EPLs may also lead to an increased professionalization of the personnel function within firms, which can increase the efficiency of job matching (e.g., the case in Britain in the 1970s; see Daniel and Stilgoe, 1978). By contrast, such laws will reduce involuntary separations and hence lower inflows into unemployment. Overall, the impact of EPLs on unemployment is ambiguous. The results presented by Addison and Grosso (1996), Elmeskov et al. (1998), Lazear (1990) and Nickell and Layard (1999) do not add up to anything decisive, neither do more recent studies (e.g., Bachmann and Felder, 2020).

The OECD reports indicators measuring the strictness of the regulation covering the individual dismissal of employees on regular contracts and temporary contracts. The indicators range from one to six, with higher values representing stricter regulation. Figure 2.7 plots the evolutions of the indicators on both regular and temporary contracts. In addition, it also shows a summary indicator of overall employment protection, which is the average of indicators for regular contracts and temporary contracts. On average, France and Luxembourg tend to have comparatively strict and stable regulation relative to other countries. In contrast, the employment protection in Ireland is the weakest. Notable changes include the relaxation of the laws on temporary contracts in Germany and Italy before 2004. Spain has also relaxed the laws on temporary contracts several times since 2006 and the laws on regular contracts since 2010. Portugal has experienced a staged and greater reduction on the strictness of EPLs on both regular contracts and temporary contracts than Spain over the whole sample period.

### 2.3.4 System of Wage Determination

Turning to those factors which have a direct impact on wages, the obvious place to start with is the institutional structure of wage determination. In my sample of countries, the majority of workers have their wages set by collective bargaining between employers and trade unions at the plant, firm, industry or aggregate level. The overall effect on unemployment depends on the percentage of employees who are union members (union density), the proportion of employees covered by collective agreements (union contract coverage) and the degree of coordination of wage bargaining. Generally, greater union density and coverage can be expected to exert upward pressure on wages, hence raising equilibrium unemployment. In particular, on the one hand, with higher wage resistance initially, more job matches are destroyed as a reaction to an adverse shock, leading to higher inflows into unemployment (Bertola and Rogerson 1997). On the other hand, because trade unions aim to protect the jobs of their members, this motive fosters the segregation of labor markets, making it harder for outsiders, the unemployed, to enter employment, hence reducing outflows from unemployment (Bachmann and Felder 2020). But these adverse effects can be somewhat offset if wage bargaining across the economy is highly coordinated (Nickell and Layard 1999).

Figures 2.8 and 2.9 present the evolutions of the measures for union density and union contract coverage for each country.[29] In most of the EA11, union density tends to be less than 50% and is gradually declining. Union membership in Belgium and Finland tends to be high (around 55% and 70% of employees, respectively). For some countries in which there is a wide gap between density and coverage, it is because union agreements are extended by law to cover non-members in the same sector. This situation is most noticeable in France, which has the lowest union density at around 10% but one of the highest levels of union coverage at above 90%.

In Figure 2.10, I plot the time paths of the indicator measuring the coordination in wage bargaining. Notable changes are the reductions in wage-setting coordination in Ireland and Portugal, and the increases in coordination in Luxembourg and Spain. Comparing among countries, wage bargaining tends to be coordinated to the highest degree in Belgium and to the lowest degree in France.

### 2.3.5 Labor Tax Wedge

The labor tax wedge measures the difference between the labor cost to the employer and the corresponding net take-home pay of the employee, which includes income taxes and payroll taxes.[30] The impact of the labor tax wedge on unemployment remains a subject of some debate. Layard et al. (2005) argue that the tax wedge directly impacts wages and in turn affects unemployment through real wage resistance. For example, if labor tax rates go up, the real post-tax consumption wage must fall if the real labor costs per employee facing firms are not to rise. Any resistance to this fall will lead to a rise in unemployment. This argument suggests that increases in the labor tax rate may lead to a temporary rise in unemployment. However, BW believe that the labor tax wedge affects mainly the wage, not unemployment. Because taxes, such as income taxes, are likely to be roughly neutral, which by their nature apply equally on the unemployed and the employed. And payroll taxes also may not matter very much if the unemployment

[29] The data on union density, union coverage and coordination in wage bargaining are available on the ICTWSS Database. version 6.0. Amsterdam: Amsterdam Institute for Advanced Labor Studies (AIAS), University of Amsterdam. June 2019.

[30] My measure of the tax wedge is based on OECD data, which is the sum of personal income taxes, payroll taxes paid by employers and all social security contributions (from employers and employees) less the family benefits they receive in the form of cash transfers as a percentage of total labor cost. Thus, compared with Nickell et al. (2005), this measure does not incorporate consumption taxes.

benefit system tries to achieve a stable relation of unemployment benefits to after-tax wages. Empirically, many studies do find a strong adverse relationship between the tax wedge and unemployment (e.g., Belot and van Ours, 2004; Nickell, 1997).

Figure 2.11 plots the changes in the measure of the tax wedge (as a percentage of total labor cost for the employer) for each country, based on the OECD data. All countries exhibit a stable level over the period from 1999 to 2013. The tax wedges roughly remain between 30% and 40% of total labor cost, apart from in Ireland and Luxembourg with less than a 20% tax wedge.

## 2.4 Estimation Methodology

I aim to test the impact of the shocks and labor market institutions discussed above on unemployment patterns across time and countries. Following BW and Nickell et al. (2005), I do this in two steps: Section 2.4.1 considers the direct effects of shocks and labor market institutions; and Section 2.4.2 considers the indirect effects of labor market institutions.

In the following expressions, the subscript $c$ is a country index, $t$ a period index, $i$ a shock index and $j$ an institution index. The dependent variable, $u_{ct}$ is the unemployment rate in country $c$ in period $t$. The independent variables include $X_{cit}$ and $LMI_{cjt}$, which represent the value of shock $i$ in country $c$ in period $t$, and the value of institution $j$ in country $c$ in period $t$, respectively. In addition, all regression models include country fixed effects $c_c$ and period fixed effects $t_t$. The country fixed effects control for unobservable country factors that are constant over time. The period fixed effects control for unobservable time factors that are common across countries. $\varepsilon_{ct}$ is the error term.

### 2.4.1 Direct Effects of Shocks and Institutions

The equation in the first step relies on a simple linear relation between the unemployment rate and a set of measures of labor market institutions and observable shocks. The equation used is the following:

$$u_{ct} = \sum_i \beta_i X_{cit} + \sum_j \gamma_j LMI_{cjt} + c_c + t_t + \varepsilon_{ct} \tag{2.2}$$

The direct effect of the shocks on the unemployment rate is captured by the parameters $\beta_i$. The direct effect of labor market institutions is captured by the parameters $\gamma_j$.

### 2.4.2 Indirect Effects of Institutions

In the second step, two variant forms of Equation (2.2) capture the contribution of interactions between shocks and institutions on unemployment patterns across the EA, that is, the indirect effects of institutions. In the spirit of BW, the equations are as following:

$$u_{ct} = \left(1 + \sum_j \gamma_j LMI_{cjt}\right) t_t + c_c + \varepsilon_{ct} \tag{2.3}$$

$$u_{ct} = \left(1 + \sum_j \gamma_j LMI_{cjt}\right)\left(\sum_i \beta_i X_{cit}\right) + c_c + t_t + \varepsilon_{ct} \tag{2.4}$$

In Equation (2.3), the unemployment rate is explained by the unobservable common time effects interacted with the institution variables, called the unobservable shock specification, corresponding to the basic equation in Table 1 of BW. Equation (2.4) replaces the unobservable time effects by a set of observable shocks discussed in Section 2.2, named the observable shock specification, corresponding to Table 5 of BW.

With respect to the sample used for all regressions, as mentioned above, the sample countries are the first group of countries which joined the EA at the official launch of the Euro on 1 January 1999: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain. The sample period begins from 1999 and ends in 2013, covering the GFC and the preceding economic expansion period. Additionally, all the measures of the independent variables (shocks and institutions) are constructed as deviations from their sample mean across time and countries. All regressions are estimated by non-linear least squares, in line with the literature (Bertola et al., 2007; BW, 2000). I use non-linear least squares because the shock coefficients, both for the unobservable shocks in Equation (2.3) and for the observable shocks in Equation (2.4), are simultaneously estimated both for the shocks alone and for the interaction with institutions. Equation (2.2) is also estimated by non-linear least squares, in order to keep the estimates comparable. Standard errors are estimated using robust Huber/White sandwich formation.

It is worth noting that I use annual data for all estimations, rather than the five-year averages used by BW. BW split the observation period into 8 five-year sub-periods. For each sub-period, they compute the average of annual data for each variable. Instead, I look at year-to-year movements in institutions and in shocks following Belot and van Ours (2001) and Nickell et al. (2005), which allows for a full exploration of the dynamic effects.

Another difference from BW in this study is the regressions are based on the time-varying measures of all eight labor market institutions, instead of the time-invariant measures. In BW, the measures of labor market institutions are time-invariant, which are the averages of 1983-88 and 1989-94 values from the Nickell (1997) database. However, BW further construct time series for replacement rates and for employment protection. After that, a group of subsequent studies have updated the sample of BW into the time-varying measures for some of the institutions, like Bachmann and Felder (2020), Bassanini and Duval (2007), Belot and van Ours (2001) and Bertola (2017). In this chapter, the methods for constructing the time-varying measures of institutions are introduced in Section 2.3 and detailed in Appendix 2.A.1.

## 2.5 Estimation Results

### 2.5.1 Direct Effects of Shocks and Institutions

I begin by examining the direct effects of shocks and labor market institutions on unemployment evolutions across the EA between 1999 and 2013. Table 2.1 presents the estimation results of Equation (2.2). Column I reports the coefficient estimates by regressing the reduced form of Equation (2.2), only focusing on shocks, column II only focusing on institutions, and column III combining both together.

We firstly look at the role of shocks. The most significant shock, no matter which specification, is the real long-term interest rate, revealing a positive impact on the unemployment rate. Specifically, a rise in the real interest rate of 8 pp, as has happened in Ireland and Portugal between 2007 and 2011, leads to an increase in the unemployment rate of 7% if leaving institutions out, or 5% if allowing for both shocks and institutions. These magnitudes are consistent with the coefficients reported in Bertola (2017, Tables 4 and 10) which are estimated over the sample period 1960-2014. Furthermore, for the specification that allows for shocks and institutions (Column III), labor demand shocks become strongly significant, with the expected sign. A decrease in the labor demand shock of 10 pp, translates into an increase in the unemployment rate of about 3%. Additionally, the impact of TFP shocks on the unemployment rate is negative in Column III but insignificant. Finally, ECB money supply shocks and unsystematic monetary policy shocks do not show any significant effects.

With respect to the direct effects of labor market institutions on unemployment, all coefficients of institutions have the expected signs when they are significant. ALMPs expectedly display negative association with the unemployment rate. Increasing the expenditures on ALMPs tends to reduce the unemployment rate. The negative impact of EPLs on the unemployment rate is not theoretically surprising. The strong system of EPLs is correlated with reductions in the unemployment rate due to lower inflows into unemployment as mentioned in Section 2.3. As for the labor tax wedge, its significantly positive coefficient suggests that large tax wedges are positively correlated with institutional constraints on wage flexibility, hence inducing higher unemployment. Union density might in principle capture some of the institutional features on real wage resistance. On the other hand, wage-setting coordination is significantly correlated with reductions in the unemployment rate, as might be expected. A generous unemployment benefit system, in terms of both benefit levels and benefit durations, tends to be associated with increases in the unemployment rate, which is in line with the literature (e.g., Elmeskov et al., 1998; Nickell and Layard, 1999 and Scarpetta, 1996). However, the estimate of the replacement rate here is not as large as results in these previous studies, which on average indicate a 1.1 pp rise in equilibrium unemployment for every 10 pp rise in the benefit replacement rate (Layard et al., 2005), but it is comparable to the study focusing on more recent data by Bertola (2017).

### 2.5.2 Indirect Effects of Institutions

Turning to the indirect effects of labor market institutions on the unemployment rate, Table 2.2 reports the estimation results of two equations allowing for interactions between shocks and institutions, namely the unobservable shock specification and the observable shock specification.

As for the coefficient estimates of the unobservable shock specification (see Column I), when I estimate the coefficients all measures of institutions are constructed as deviations from the cross-country mean. In this way, the time effects give the evolution of the unemployment rate for a country with mean values for all eight institutions. Hence, the estimate implies that the time effects are highly significant and generate a rise in the unemployment rate between 1999 and 2013 of 1.31 pp if a country had mean values for all eight institutions. This is much smaller than the 7.3 pp reported in BW and the 6.9 pp in Nickell et al. (2005), because of the differences in the sample period and countries, and the use of time-varying institutions rather than time invariant institutions.

Then, the institutions which can be significantly interacted with time effects include

ALMPs, tax wedge and union coverage. Specifically, ALMPs have a significantly negative shock-interaction coefficient, mitigating the impact of shocks on unemployment. Moreover, union coverage's interaction coefficient is positive, as might be expected, amplifying the impact of shocks. The institution with the unexpected sign is the tax wedge, indicating that higher tax wedges lead to a smaller effect of shocks on unemployment.

Column II in Table 2.2 shows the regression results of the observable shock specification that allows for both observable shocks and the interactions with institutions. Firstly, the effects of the real interest rate and the labor demand shock on unemployment are strongly significant and very similar to the estimated results in Table 2.1. But the magnitude of the effect of the real interest rate becomes larger than that in Table 2.1, and the effect of the labor demand shift becomes smaller. An increase in the real interest rate of 8 pp leads to an increase in the unemployment rate of around 8%. A reduction in the adjusted labor share of 10 pp leads to a rise in the unemployment rate of about 2%. In addition, the impacts of TFP shocks and ECB monetary policy shocks are still insignificant. Secondly, for the interaction terms showing the institutions' indirect effects, more institution variables become significant, including the replacement rate, tax wedge, union coverage and union density. There is some evidence that higher replacement rates tend to reduce the impact of the shocks on unemployment, which does not seem to be in line with theoretical predictions. However, it is consistent with the results reported by Bachmann and Felder (2020, Table 2), who also find the diminished (but insignificant) role of the benefit replacement rate for the same period covering 1999-2013. The interaction effect of ALMPs is negative but loses its significance in the observable shock specification. The tax wedge's interaction becomes positive and very significant. Higher tax wedges tend to amplify the impact of shocks on unemployment, which is in line with Bertola (2017, Table 6) and with the theoretical prediction. Finally, two indicators related to trade unions display significantly negative interaction effects. The negative interaction coefficient of union density is consistent with the coefficient estimate reported in Bertola (2017, Table 6). Higher degrees of union density and union coverage lead to a smaller effect of shocks on the unemployment rate. One explanation could be that the objective of trade unions is to provide job security to their members, which leads to more moderate labor market reactions, with both lower worker inflows into unemployment in response to an adverse shock and lower worker outflows from unemployment under a favorable shock.

To summarize, the shocks significantly affecting the unemployment rate are the real interest rate and the labor demand shift. Higher real interest rates and less labor demand increase the unemployment rate. As for labor market institutions, generous unemployment benefits tend to directly increase the unemployment rate but could indirectly reduce the impact of shocks on unemployment. Trade unions show the same role as the unemployment benefit system. ALMPs and wage-setting coordination play a favorable role on affecting unemployment. The impact of wage-setting coordination is more about directly reducing unemployment, while ALMPs tend to alleviate unemployment in both a direct and an indirect way. The impact of EPLs on the labor market is also favorable, decreasing unemployment but with no significant interaction with shocks. In contrast, a higher labor tax wedge tends to have an adverse effect on unemployment, leading to not only higher unemployment but also a larger effect of shocks on unemployment.

## 2.6 Robustness

In order to support the findings with respect to the role of shocks and institutions in affecting unemployment, I run a battery of robustness tests.

First, Tables 2.3, 2.4 and 2.5 look at the implications of using alternative measures for some of the institutions. Table 2.3 presents the estimation results based on Equation (2.2), Table 2.4 for Equation (2.3) and Table 2.5 for Equation (2.4). In each table, column I reports the results using alternative measure for ALMPs, that is, public expenditures on ALMPs as a share of GDP. Column II reports the results using alternative measure for the replacement rate, which is the average replacement rate during years 2 to 5 of an unemployment spell. Columns III and IV report the results using alternative measures for EPLs, namely the indicators measuring the strictness of EPLs on regular contracts and temporary contracts, respectively. The most significantly different results from using alternative measures concern ALMPs, such that they tend to increase unemployment and have no significant interaction with shocks. The replacement rate, by using its alternative measure, tends to diminish the impact of shocks on unemployment, which is consistent with the results in Table 2.2. The direct effects of EPLs on both regular contracts and temporary contracts on unemployment are very similar to Table 2.1, displaying negative and significant coefficients. However, it is interesting that the stricter EPLs on regular contracts tend to reduce the impact of shocks on unemployment, while the stricter EPLs on temporary contracts tend to increase the impact of shocks, as shown in Table 2.5. Coefficients on other labor market institutions and shocks are largely the same as in Tables 2.1 and 2.2.

Second, I evaluate the cross-sectional stability of the results. That is, I delete one country at a time from the sample and re-estimate Equations (2.2) and (2.4). Table 2.6 shows re-estimation results of Equation (2.2) and Table 2.7 for Equation (2.4). In Table 2.6, dropping one country at a time makes little difference to the results. In Table 2.7, the labor tax wedge is always significant while benefit duration and EPLs are always insignificant, regardless of which country is excluded. The effect of union coverage is no longer significant when Portugal or Spain is dropped from the estimation. Wage setting coordination is found to be negatively significant when dropping Finland or France. Additionally, it is worth noting the importance of Portugal in determining the interaction coefficient on ALMPs. When dropping Portugal, the interaction coefficient on ALMPs becomes negatively significant.

Third, I also test the period stability of my results by re-estimating Equations (2.2) and (2.4) on different sub-periods, namely 2000-2006 and 2007-2013, to see if the period before or after the GFC influences the results. The estimation results are displayed in Table 2.8. Overall, the results are robust and do not appear to be driven by any particular period.

Finally, I test endogeneity for the results in the estimation of Equations (2.2) and (2.4). Endogeneity poses a threat for identification, because of the potential for reverse causality between the evolution of unemployment on the one hand, and institutions and shocks on the other hand. Institutional reforms may be induced by unfavorable labor market conditions, and changes in unemployment may influence the shocks. I therefore run regressions on Equations (2.2) and (2.4) with: 1) shock measures lagged by one period; and 2) institution measures lagged by one period. The estimated results with lagged shocks are presented in Table 2.9 and the results with lagged institutions are shown in Table 2.10. By comparison, the results with the lagged terms are basically consistent with the original results in Tables 2.1 and 2.2. The exceptions are, for the re-estimations of Equation (2.2), the labor demand shock becomes insignificant while the replacement rate becomes positively significant when shocks lagged, ALMPs lose significance when institutions lagged, and union density is significant and correctly signed in both lagged models. For the re-estimations of Equation (2.4), the differences are EPLs become significant to amplify the impact of shocks on unemployment in both lagged models, and ALMPs become significant to reduce the impact of shocks when institutions lagged. On the whole, the results are robust against endogeneity.

## 2.7 Conclusion

In this chapter, I examined the role of shocks and labor market institutions in explaining unemployment patterns across the EA countries for the time period 1999 to 2013. In my analysis, I employed the methodology of BW and Nickell et al. (2005), to separately identify the direct effects of shocks and labor market institutions on unemployment on the one hand, and the indirect effects of labor market institutions on changing the transmission of shocks to unemployment on the other hand. I extended the existing literature by using time-varying data and analyzing the time period of the GFC as well as the preceding decade.

The results suggest the following. First, the real long-term interest rate and the labor demand shock tend to have a significant direct impact on the unemployment rate in the EA. Particularly, an increase in the real interest rate or a decrease in labor demand push up the unemployment rate. However, two monetary policy shocks from the ECB do not show any significant impact on national unemployment. Second, for the direct effect of labor market institutions on unemployment, generous unemployment benefits and large tax wedges tend to be correlated with increases in the unemployment rate, while EPLs, ALMPs and wage-setting coordination play a favorable role in reducing unemployment. Third, unemployment benefits, tax wedges and trade unions further play important channeling roles on affecting the transmission of shocks to national labor markets. Higher tax wedges tend to have an adverse effect and amplify the impact of shocks on unemployment. In contrast, unemployment benefit generosity and pervasive unionization lead to a smaller effect of shocks on the unemployment rate. Overall, the results in this chapter imply that institutional heterogeneity matters within the EA.

Finally, we can have some confidence that the findings are robust despite the high variations in the sample data during the GFC. Labor market institutions across the EA countries are generally employment-friendly apart from the tax wedge. The outlook toward the unemployment problems in the EA could be mildly optimistic if lower real interest rates and resurgent labor demand can persist into the future.

# Appendix to Chapter 2

## 2.A.1 Data Description

**Dependent Variable:**

*Unemployment rate*

Definition: The number of unemployed as a percentage of the labor force.

Construction: This is calculated as unemployment divided by the labor force.

Source: OECD, ALFS Summary tables.

**Country-specific Shocks:**

*Total factor productivity shock*

Definition: The rate of TFP growth.

Construction: The logarithmic first difference of the AMECO database's total economy factor productivity series.

Source: The Annual Macroeconomic (AMECO) database, May 2019 update.

*Real long-term interest rate*

Definition: The nominal long-term interest rate less the current rate of inflation (unit: percentage).

Construction: Difference between the long-term nominal interest rate and the current rate of inflation. The inflation rate is measured by the growth rate of the GDP deflator.

Source: The Annual Macroeconomic (AMECO) database, May 2019 update.

*Labor demand shock*

Definition: Following BW, I assume that technology is characterized by a Cobb-Douglas production function $\mathrm{Y} = (aN)^{\alpha}(K)^{1-\alpha}$, with technological progress assumed to be labor augmenting. Under perfect competition in both goods and labor markets, the marginal product of labor is equal to the real wage ($\mathrm{MPL} = \mathrm{w}$), that is $\alpha \cdot a \cdot (Y/aN) = w$. Taking logs yields $log(\alpha) = log(w/a) + log(aN) - log(Y)$, so that a decrease in the log of the labor share, $log(\alpha)$, leads to an equal decrease in the log of the adjusted employment, $log(aN)$, given output and the real wage. Thus, labor demand shocks could be measured by the log of the adjusted labor share, that is, the sum of the adjusted log wage indicator and the adjusted log employment indicator, less the log of real GDP.

Constructions: To obtain the data of labor demand shocks, I need to construct the adjusted log wage indicator ($log(w/a)$), the adjusted log employment indicator ($log(aN)$) and the log of real GDP ($log(Y)$), respectively. First, the adjusted log wage indicator can be computed by the AMECO data: I begin to construct labor efficiency, that is $log(a)$ above, by calculating the log of the ratio of "total factor productivity: total economy" to "adjusted wage share: total economy: as percentage of GDP at current prices". Then, I subtract labor efficiency from the log of "real compensation per employee, deflator GDP: total economy". Next, I follow BW to adjust this wage measure for taking account of gradual adjustment of factor proportions. Thus, the final adjusted log wage indicator is an average of the adjusted wage with weight 0.8 on the current year and 0.2 on the previous year. Second, the adjusted log employment indicator also can be computed by the AMECO data: adding labor efficiency to the log of "employment, persons: all domestic industries (National accounts)" proxies the adjusted log employment indicator. Finally, the log of real GDP can be obtained by the OECD data, that is, calculating the log of "gross domestic product (output approach), OECD base year".

Hence, the labor demand shock, measured by the log of the adjusted labor share, is the sum of the adjusted log wage indicator and the adjusted log employment indicator less the log of real GDP.

Sources: AMECO database, OECD.

**Common Monetary Policy Shocks:**

*ECB money supply shock*

Definition: Changes in money supply growth.

Constructions: The yearly ECB money supply shock is calculated by taking the average of monthly changes in the growth rate of the nominal money stock, that is, the second difference of the log money supply. The nominal money stock is monthly monetary aggregates, M2 (unit: millions of Euro).

Source: ECB, Statistical Data Warehouse.

*ECB unsystematic monetary policy shock*

Definition: The residuals from estimating an interest rate rule.

Constructions: As shown in Equation (2.A.1), I use the nominal short-term interest rates ($r_t$) as the dependent variable and one period lagged values of the dependent variable ($r_{t-1}$) as the independent variable along with: constant, the current inflation ($\pi_t$), and the current output gap ($y_t^{gap}$). As instruments, I use the lags of all right-hand-side variables up to lag four. The regression is estimated by the generalized method of moments and passes the weak instrument tests and over-identifying restriction tests. We can have some confidence that the instruments are exogenous and not weak.

$$r_t = \alpha + \beta\pi_t + \gamma y_t^{gap} + \delta r_{t-1} + \mu_t^M \tag{2.A.1}$$

The residuals are obtained by regressing Equation (2.A.1) using quarterly time series of all variables covering 1999Q1-2013Q4. The annual ECB unsystematic monetary policy shock is measured as the average of the quarterly residuals. Data on short-term nominal interest rates are nominal interest rates on ECB marginal lending facilities. Data on inflation rates and output gaps are expressed by the percentage change of CPI on the same period of the previous year and the ratio of the output gap to potential GDP, respectively.

Sources: ECB, Statistical Data Warehouse; OECD, Economic Outlook No 105 – May 2019.

**Time-varying Institutions:**

*The replacement rate of unemployment benefits*

Definition: The net replacement rate in unemployment is the ratio of the net household income during a selected month of the unemployment spell to the net household income before the job loss. The original data are the net unemployment benefit replacement rate at two earnings levels (average and two-thirds of average earnings) for three different family types (single, with dependent spouse, with spouse at work) in 14 different duration categories (2 months, 4 months, 6 months, 8 months, 10 months, 12 months, 18 months, 24 months, 30 months, 36 months, 42 months, 48 months, 54 months and 60 months).

Construction: The average net replacement rate during the 1st year of unemployment, averaged over two income situations (100% and 67% of average earnings) and three family situations (single, with dependent spouse, with spouse at work); The average net replacement rate during years 2 to 5 of an unemployment spell, averaged over two income situations (100% and 67% of average earnings) and three family situations (single, with dependent spouse, with spouse at work). The data are available since 2001 for all countries of the sample. I impute the values for 1999 and 2000 from the values in 2001.

Source: OECD, net replacement rates in unemployment.

*Unemployment benefit duration*

Definition: An index of benefit duration equal to [0.6 * (2$^{nd}$ and 3$^{rd}$ year replacement rate) + 0.4 * (4$^{th}$ and 5$^{th}$ year replacement rate)] / (1$^{st}$ year replacement rate).

Construction:

2$^{nd}$ and 3$^{rd}$ year replacement rate: the average net replacement rate during years 2 to 3 of an unemployment spell, averaged over all categories.

4$^{th}$ and 5$^{th}$ year replacement rate: the average net replacement rate during years 4 to 5 of an unemployment spell, averaged over all categories.

1$^{st}$ year replacement rate: the average net replacement rate during the first year of unemployment, averaged over all categories.

The data are available since 2001 for all countries of the sample. I impute the values for 1999 and 2000 from the values in 2001.

Source: OECD, net replacement rates in unemployment.

*Active labor market policies*

Definition: The measures of ALMPs cover the expenditures on active programs excluding public employment services and administration, which include training, employment incentives, sheltered and supported employment and rehabilitation, direct job creation and start-up incentives.[31]

Construction: The OECD reports "public expenditures on ALMPs as a share of GDP (%)" and "public expenditures on ALMPs, national currency units". For "public expenditures on ALMPs, national currency units", I use this to calculate public expenditures on ALMPs per unemployed worker as a share of GDP per member of the

[31] Because the data on the expenditures on public employment services and administration are not available for Italy before 2004.

labor force. The number of the unemployed and labor force are available on the OECD. The data on nominal GDP are also obtained from the OECD.

Source: OECD, public expenditure and participant stocks in LMP.

*Employment protection index*

Definition: The OECD reports indicators measuring the strictness of the regulation covering the individual dismissal of employees on regular contracts (EPRC) and temporary contracts (EPT) (excludes collective dismissals). I select version 1 to keep in line with the literature (Bachmann and Felder, 2020; BW, 2000; Nickell et al., 2005).

Construction: Following OECD Employment Outlook (1999, Table 2.5) and BW, I also calculate a summary indicator of overall employment protection, which is the average of indicators for regular contracts and temporary contracts.

Source: OECD, strictness of employment protection – individual dismissals (regular contracts)/temporary contracts.

*Union contract coverage*

Definition: Employees covered by valid collective bargaining agreements as a proportion of all wage and salary earners in employment with the right to bargaining, expressed as a percentage, adjusted for the possibility that some sectors or occupations are excluded from the right to bargain.

Construction: For the missing values, I impute the previous nearest year's value which is available.

Sources: OECD, collective bargaining coverage

*Union density*

Definition: The ICTWSS database reports the union density rate, which is the net union membership as a proportion of wage and salary earners in employment. Net union membership indicates total union membership minis union members outside the active, dependent and employed labor force (i.e. retired workers, independent workers, students, unemployed).

Source: J. Visser, ICTWSS Database. version 6.0. Amsterdam: Amsterdam Institute for Advanced Labor Studies (AIAS), University of Amsterdam. June 2019.

*Coordination in wage bargaining*

Definition: The ICTWSS database reports an indicator of the degree of coordination based on a set of expectations about which institutional features of wage setting arrangements are likely to generate more or less coordination.

Source: J. Visser, ICTWSS Database. version 6.0. Amsterdam: Amsterdam Institute for Advanced Labor Studies (AIAS), University of Amsterdam. June 2019.

*Tax wedge*

Definition: The labor tax wedge measures the difference between the labor cost to the employer and the corresponding net take-home pay of the employee for a single-earner couple with two children earning 100% of average earnings. The OECD reports the tax wedge (%), which is the sum of personal income taxes, payroll taxes paid by employers and all social security contributions (from employers and employees) less the family benefits they receive in the form of cash transfers as a percentage of total labor cost.

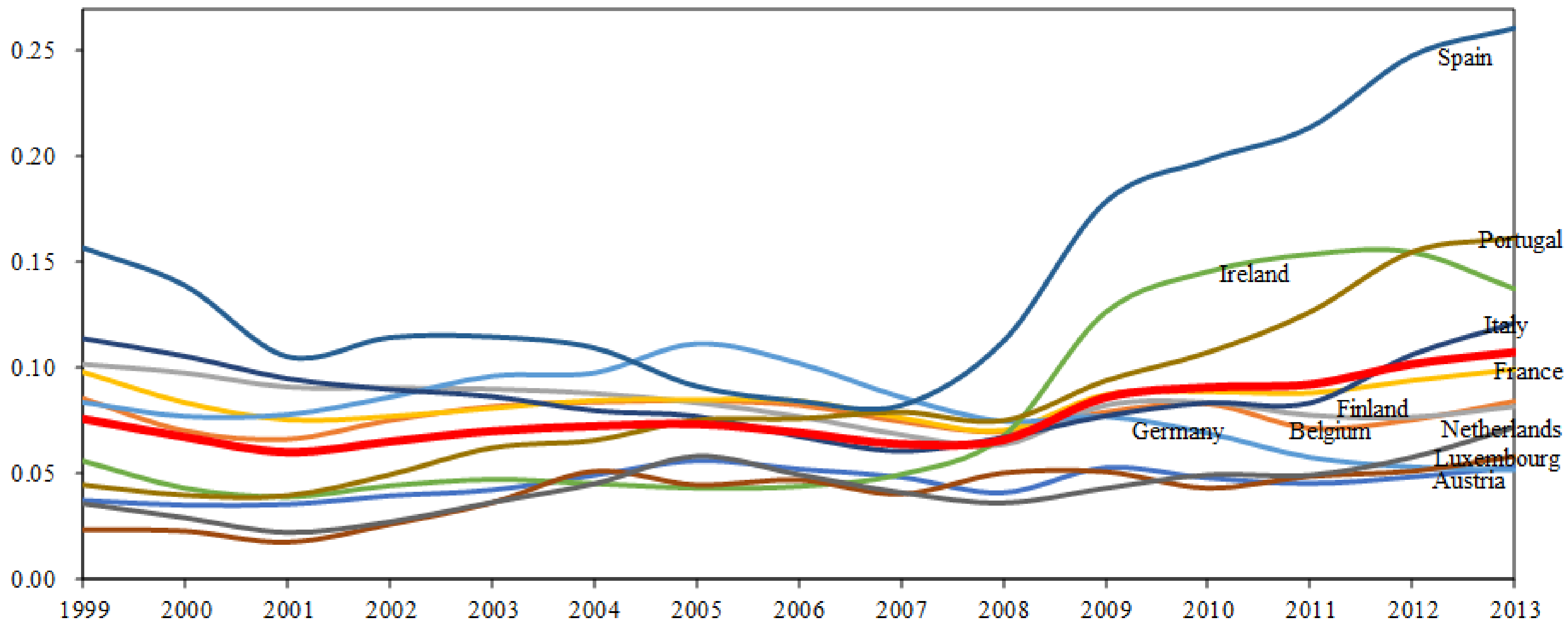
Thus, compared with Nickell et al. (2005), this measure above does not incorporate consumption taxes but incorporate family benefits.

Construction: Since its values are missing for all countries in 1999, I use the data of 2000 instead.

Source: OECD, Taxing Wages.

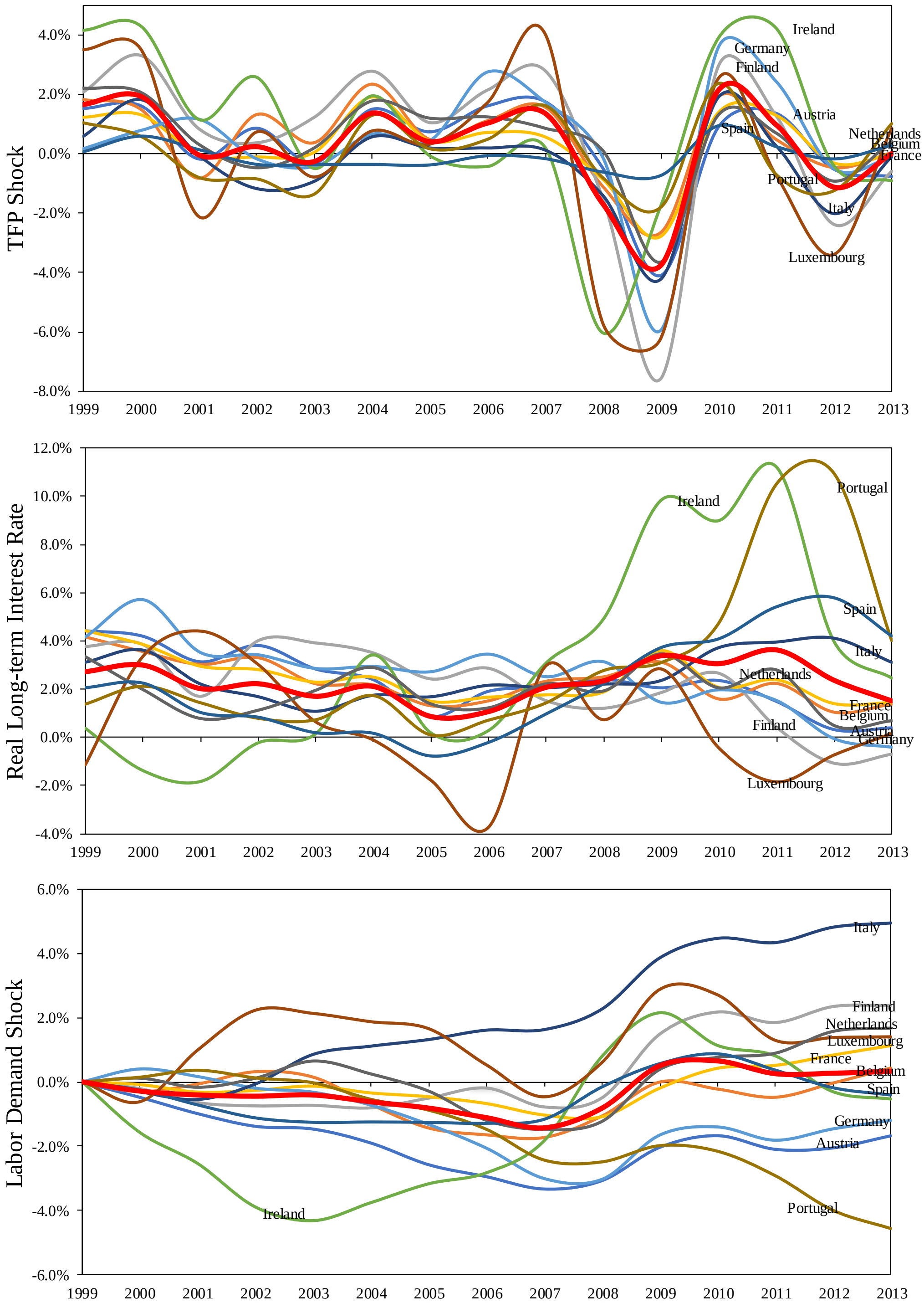
### 2.B.1 Figures

Figure 2.1 Annual Unemployment Rates for EA11



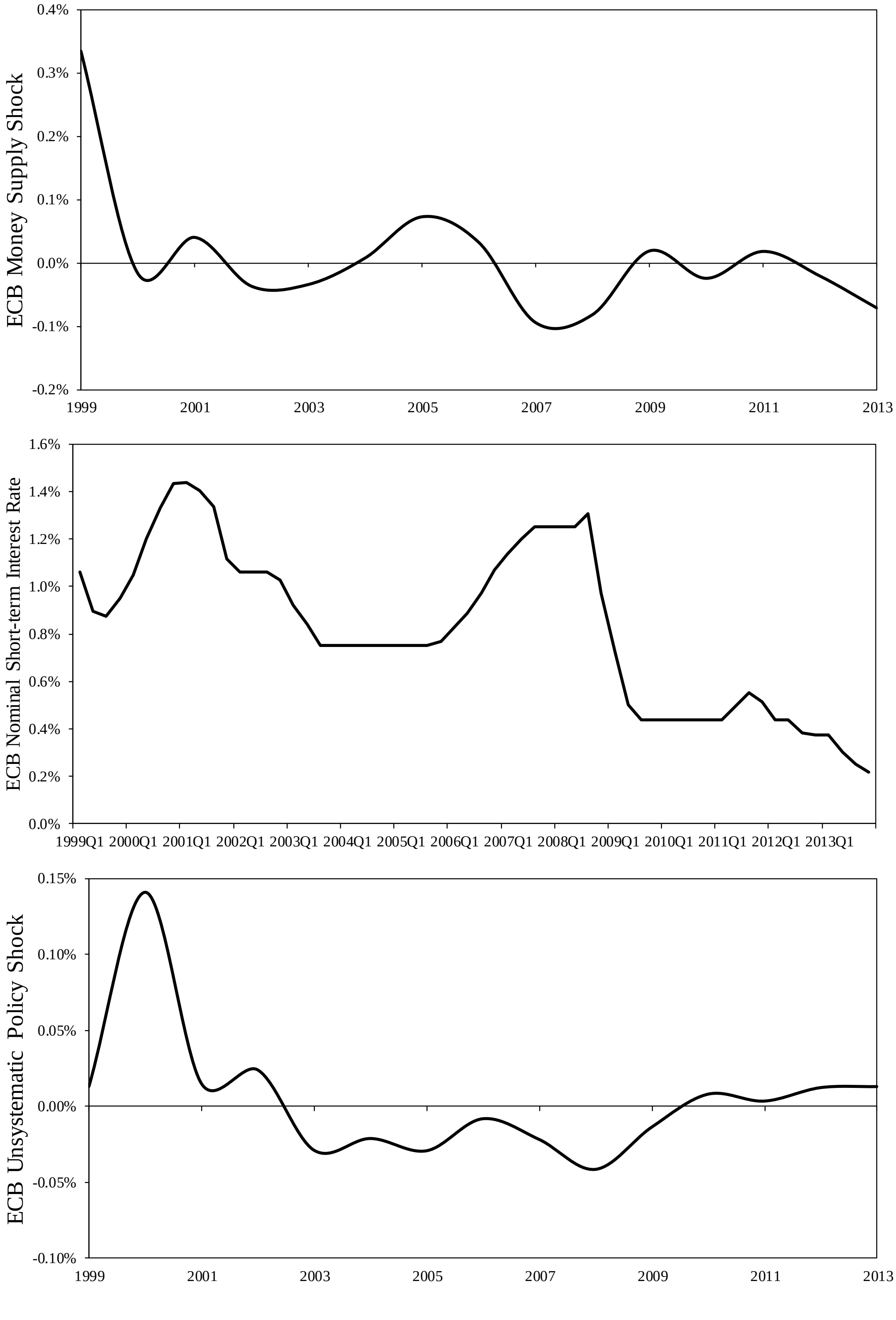

Note: The unemployment rate is calculated as unemployment divided by the labor force (or the currently active population). Red line plots unweighted average. Source: OECD, ALFS Summary tables.

Figure 2.2 Time Paths of Annual Country-specific Shock Indicators for EA11



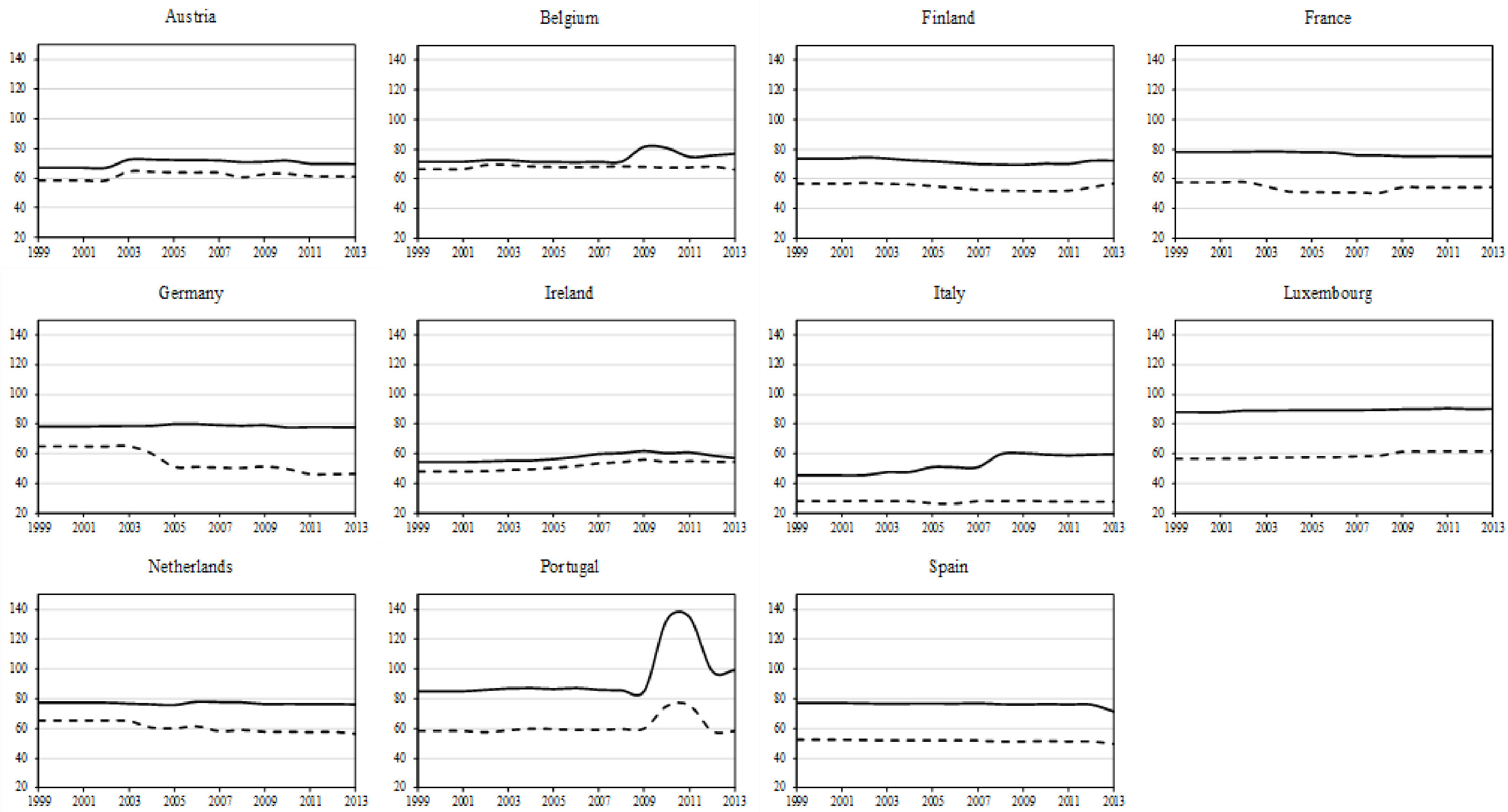

Note: Red lines plot unweighted averages. Labor demand shocks are normalized to equal zero in 1999. See Appendix 2.A.1 for definitions, constructions and sources.

Figure 2.3 Time Paths of Common Monetary Policy Shocks Across the EA



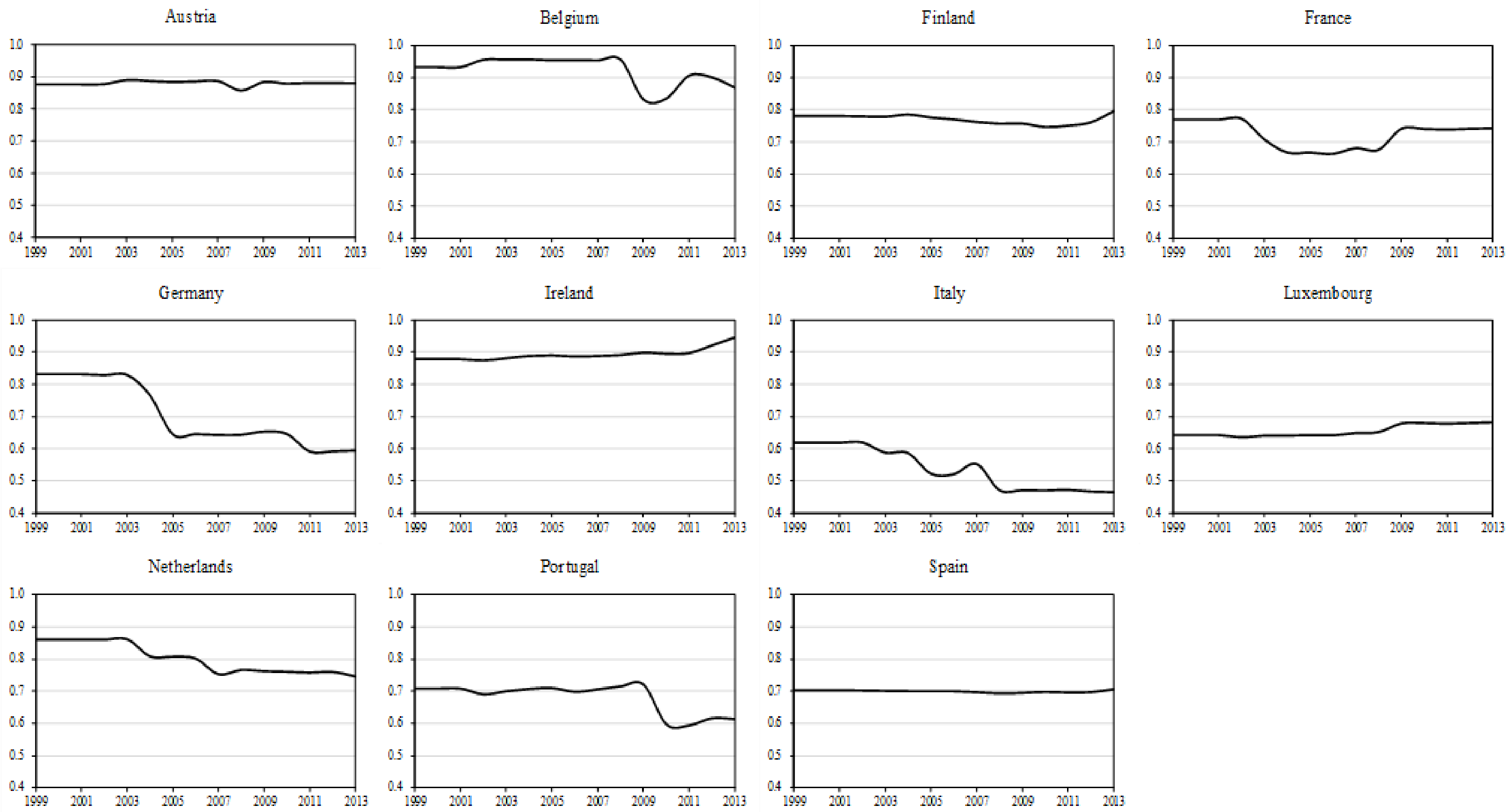

Note: See Appendix 2.A.1 for definitions, constructions and sources.

Figure 2.4 Time Paths of the Unemployment Benefit Replacement Rate (%) for EA11



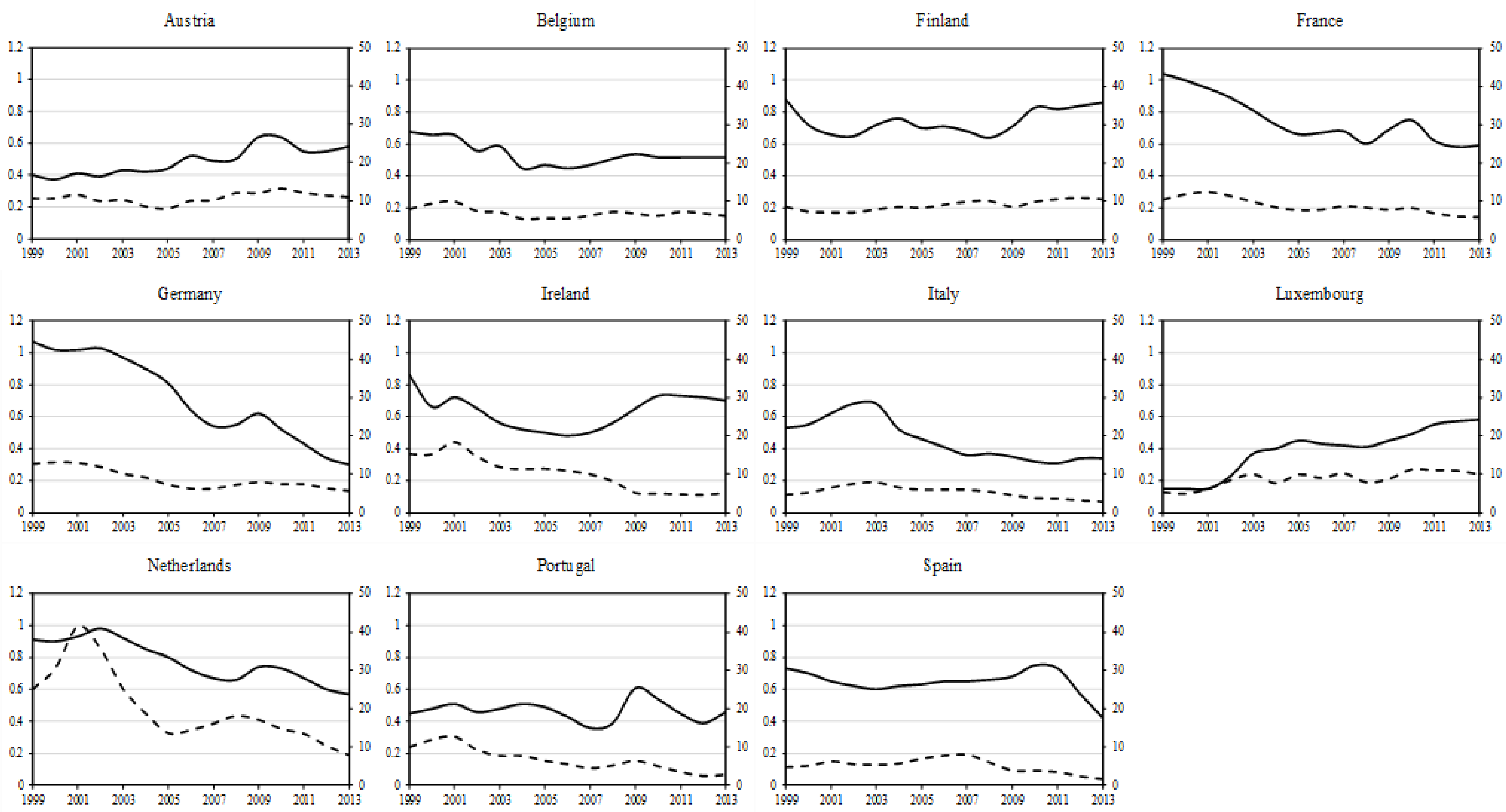

Note: The solid line represents the average net replacement rate during the 1st year of unemployment and the dash line represents the average net replacement rate during years 2 to 5 of an unemployment spell. See Appendix 2.A.1 for definitions, constructions and sources.

Figure 2.5 Time Paths of the Index of Benefit Duration for EA11



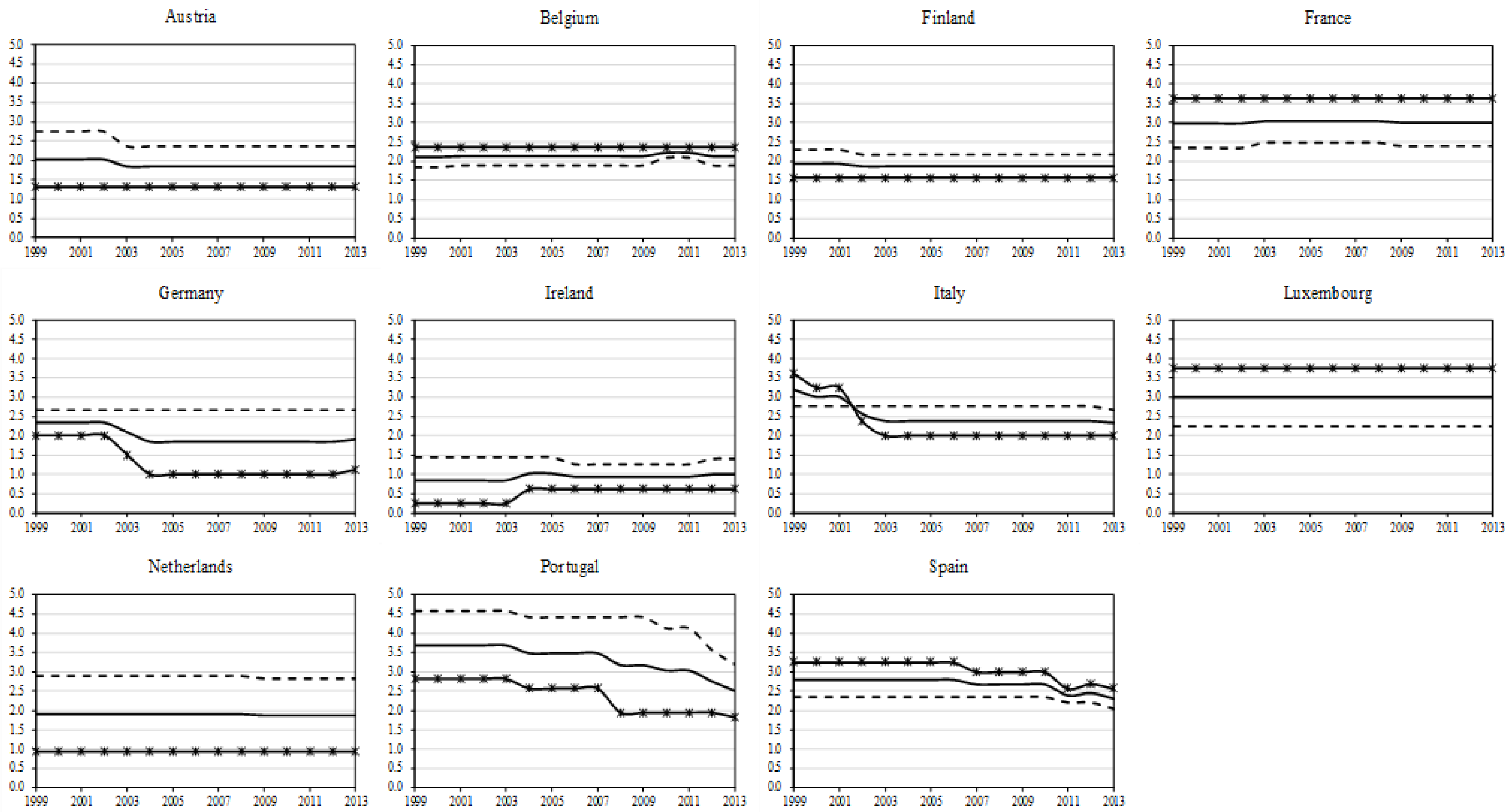

Note: The index of benefit duration measures the level of the benefit in the later years of an unemployment spell normalized on the benefit in the first year of the unemployment spell. See Appendix 2.A.1 for definitions, constructions and sources.

Figure 2.6 Time Paths of the Measures for Public Expenditures on ALMPs for EA11



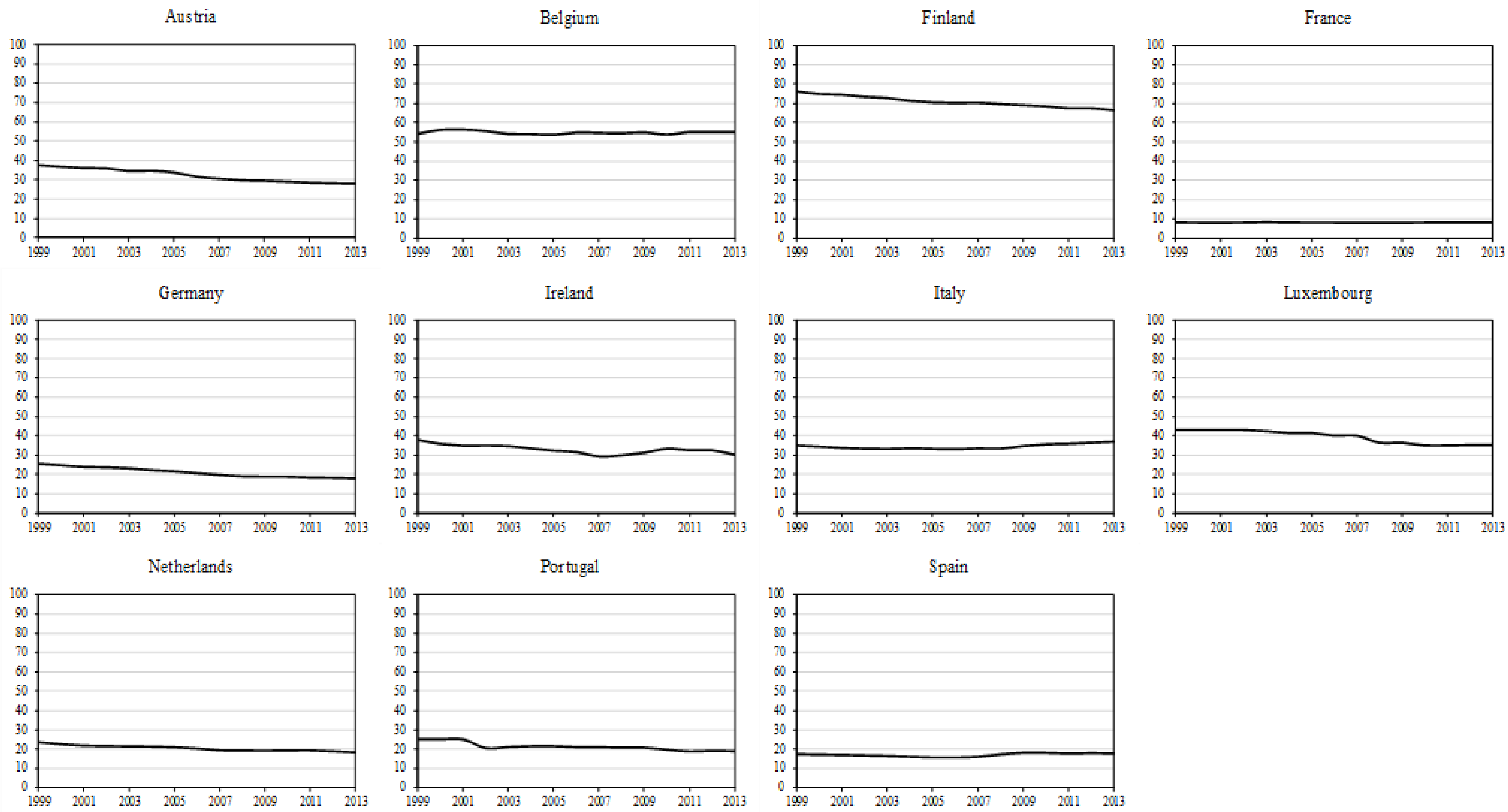

Note: The solid line represents public expenditures on ALMPs as a share of GDP (%) (left axis) and the dash line represents public expenditures on ALMPs per unemployed worker as a share of GDP per member of the labor force (%) (right axis). See Appendix 2.A.1 for definitions, constructions and sources.

Figure 2.7 Time Paths of the Indicators Measuring the Strictness of Employment Protection Laws for EA11



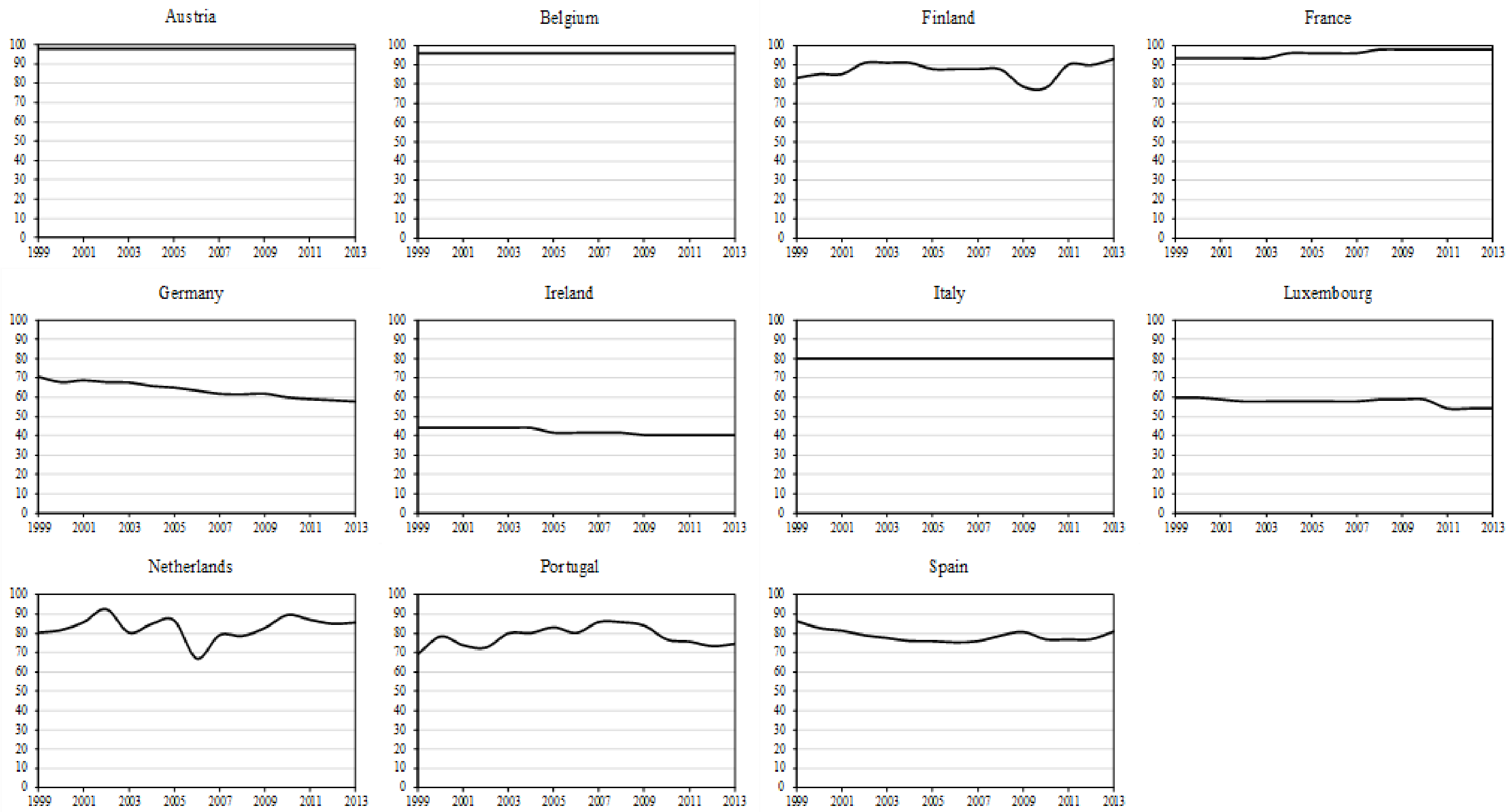

Note: The dash line represents the indicators measuring the strictness of regulation of individual dismissal of employees on regular contracts, the star line represents the indicators measuring the strictness of regulation of individual dismissal of employees on temporary contracts and the solid line represents the summary indicators taking average of indicators for regular contracts and temporary contracts. See Appendix 2.A.1 for definitions, constructions and sources.

Figure 2.8 Time Paths of the Measure for Union Density (%) for EA11



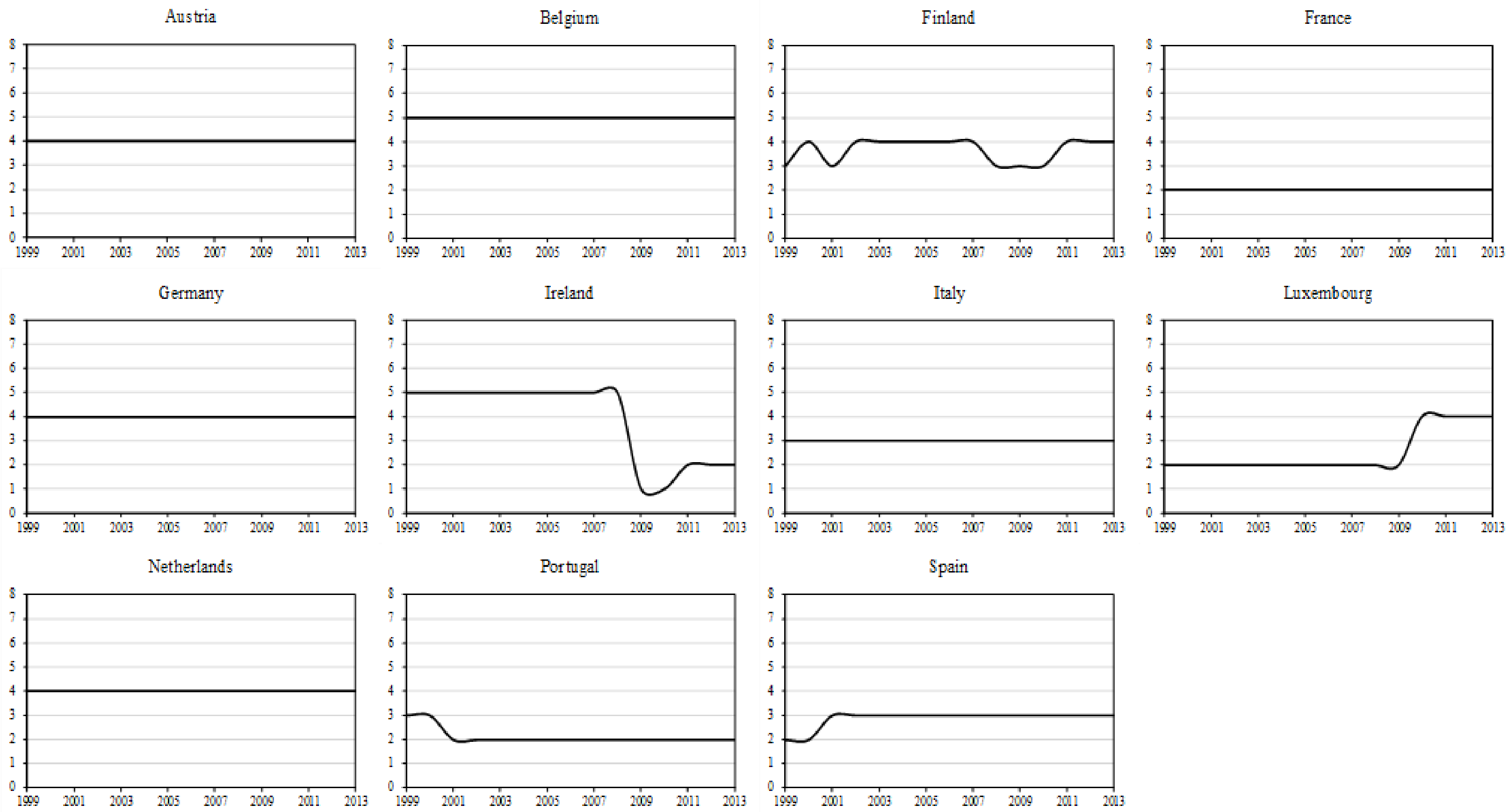

Note: See Appendix 2.A.1 for definitions, constructions and sources.

Figure 2.9 Time Paths of the Measure for Union Contract Coverage (%) for EA11



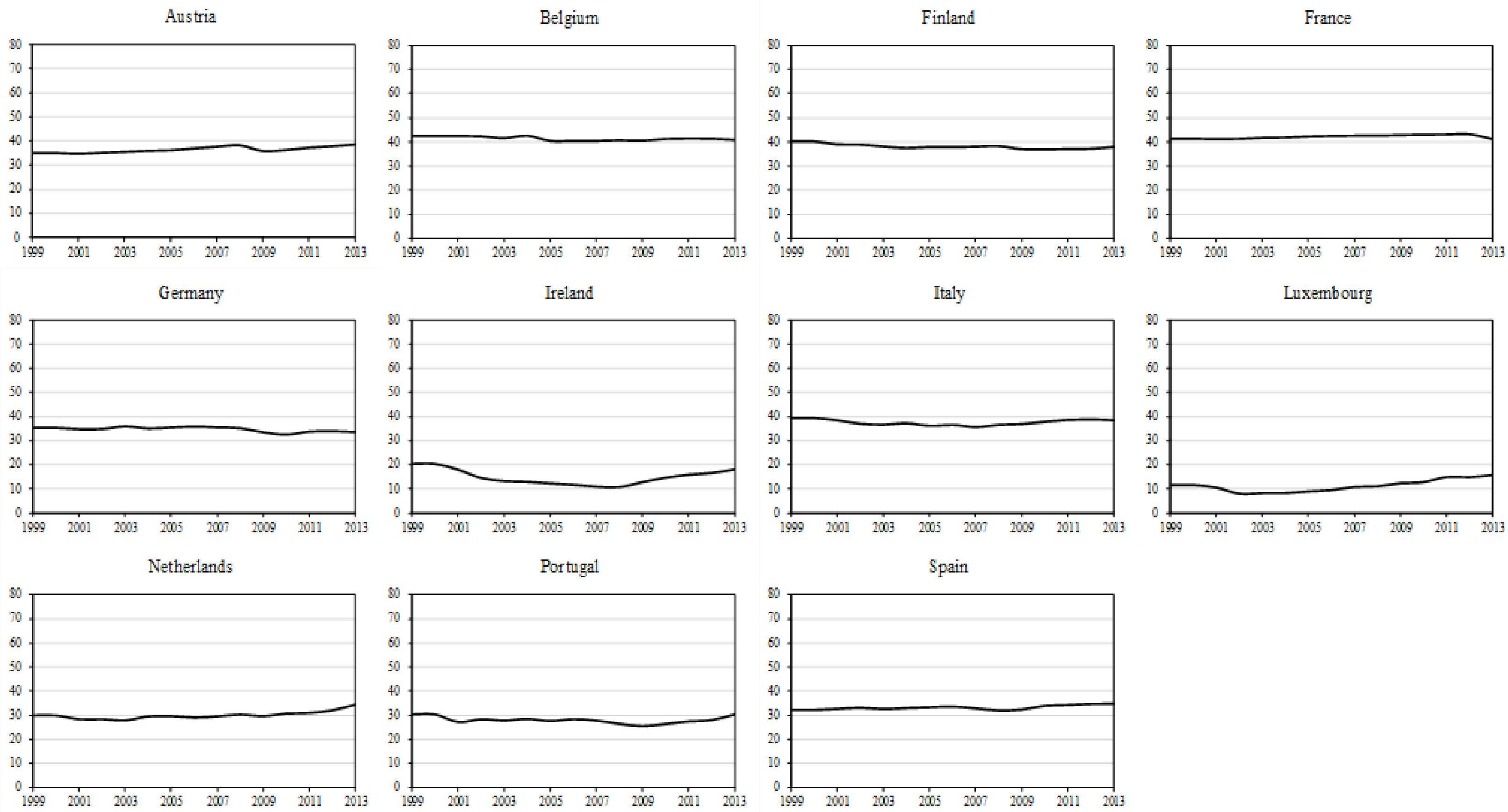

Note: See Appendix 2.A.1 for definitions, constructions and sources.

Figure 2.10 Time Paths of the Indicator Measuring Coordination in Wage Bargaining for EA11




Note: See Appendix 2.A.1 for definitions, constructions and sources.

Figure 2.11 Time Paths of the Measure for the Tax Wedge (% of Total Labor Cost) for EA11




Note: See Appendix 2.A.1 for definitions, constructions and sources.

### 2.B.2 Tables

Table 2.1 Direct Effects of Shocks and Institutions on the Unemployment Rate

| | **Dependent Variable: $u$** | | |
|---|---|---|---|
| **Independent Variables** | I | II | III |
| Time effects[††] | 45 | 24.8** | 38.9 |
| | (0.26) | (2.59) | (0.11) |
| **Direct effect of shocks ($\boldsymbol{\beta_i}$):** | | | |
| Labor demand shock | -206 | | -276** |
| | (-1.59) | | (-2.05) |
| TFP shock | 182 | | -12.4 |
| | (1.48) | | (-0.10) |
| Real interest rate | 827*** | | 595*** |
| | (11.09) | | (6.54) |
| ECB money supply shock | -0.00000017 | | -0.000835 |
| | (-0.00) | | (-0.00) |
| ECB unsystematic policy shock | -0.000000387 | | 0.000127 |
| | (-0.00) | | (0.00) |
| **Direct effect of institutions ($\boldsymbol{\gamma_j}$):** | | | |
| Replacement rate[†] | | 0.741** | -0.00302 |
| | | (2.50) | (-0.01) |
| Benefit length | | 304*** | 191*** |
| | | (6.93) | (4.50) |
| Active labor policy[‡] | | -2.47*** | -1.10** |
| | | (-4.76) | (-2.19) |
| Employment protection[§] | | -60.9*** | -34.9*** |
| | | (-5.61) | (-3.28) |
| Tax wedge | | 2.83*** | 3.48*** |
| | | (2.72) | (3.66) |
| Union coverage | | -0.0828 | 0.314 |
| | | (-0.18) | (0.76) |
| Union density | | 1.92** | 1.29 |
| | | (2.10) | (1.42) |
| Coordination | | -12.2*** | -8.25*** |
| | | (-4.58) | (-3.28) |
| Country effects | yes | yes | yes |
| Adjusted $R^2$ | 0.781 | 0.795 | 0.843 |
| Parameters | 31 | 34 | 39 |
| Observations | 165 | 165 | 165 |

Notes: The estimates are rescaled by using permillage. t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation). * p<0.10 ** p<0.05 *** p<0.01.

[††] Time effects: Estimated time effect for 2013 minus estimated time effect for 1999 ($t_{2013} - t_{1999}$).

[†] This measure of the replacement rate refers to the average net replacement rate during the 1st year of unemployment.

[‡] This measure of ALMPs refers to public expenditures on ALMPs per unemployed worker as a share of GDP per member of the labor force.

[§] This measure of EPLs refers to the summary indicator taking average of the indicators for EPLs on regular contracts and EPLs on temporary contracts.

Table 2.2 Effects of Interactions between Shocks and Institutions on the Unemployment Rate

| | Dependent Variable: $u$ | |
|---|---|---|
| **Independent Variables** | I | II |
| Time effects[††] | 0.0131*** | 0.0547*** |
| | (2.83) | (4.71) |
| **Direct effect of shocks ($\beta_i$):** | | |
| Labor demand shock | | -0.156*** |
| | | (-3.60) |
| TFP shock | | 0.0787 |
| | | (0.81) |
| Real interest rate | | 0.981*** |
| | | (10.74) |
| ECB money supply shock | | 1.908 |
| | | (0.97) |
| ECB unsystematic policy shock | | -0.00908 |
| | | (-0.19) |
| **Indirect effect of institutions ($\gamma_j$):** | | |
| Replacement rate[†] | -0.0159 | -0.0173** |
| | (-0.74) | (-2.56) |
| Benefit length | 4.807 | 0.129 |
| | (1.57) | (0.11) |
| Active labor policy[‡] | -1.157** | -0.0202 |
| | (-2.48) | (-1.00) |
| Employment protection[§] | -1.468 | 0.254 |
| | (-1.44) | (1.35) |
| Tax wedge | -0.712** | 0.0833*** |
| | (-2.60) | (5.12) |
| Union coverage | 0.275** | -0.0320*** |
| | (2.46) | (-3.08) |
| Union density | -0.0215 | -0.00839* |
| | (-1.03) | (-1.70) |
| Coordination | -0.472 | -0.0771 |
| | (-1.48) | (-1.07) |
| Country effects | yes | yes |
| Adjusted $R^2$ | 0.861 | 0.857 |
| Parameters | 34 | 39 |
| Observations | 165 | 165 |

Notes: t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation).
* p<0.10 ** p<0.05 *** p<0.01
[††] Time effects: Estimated time effect for 2013 minus estimated time effect for 1999 ($t_{2013} - t_{1999}$).
[†] This measure of the replacement rate refers to the average net replacement rate during the 1st year of unemployment.
[‡] This measure of ALMPs refers to public expenditures on ALMPs per unemployed worker as a share of GDP per member of the labor force.
[§] This measure of EPLs refers to the summary indicator taking average of the indicators for EPLs on regular contracts and EPLs on temporary contracts.

Table 2.3 Direct Effects of Shocks and Institutions. Alternative Measures

| | Dependent Variable: $u$ | | | |
|---|---|---|---|---|
| **Independent Variables** | I | II | III | IV |
| **Direct effect of shocks ($\beta_i$):** | | | | |
| Labor demand shock | -413*** | -275** | -262* | -354*** |
| | (-3.03) | (-2.12) | (-1.86) | (-2.72) |
| TFP shock | -47.9 | -16.4 | 25.1 | -10.5 |
| | (-0.39) | (-0.13) | (0.20) | (-0.08) |
| Real interest rate | 694*** | 604*** | 589*** | 650*** |
| | (8.00) | (6.81) | (6.06) | (7.34) |
| ECB money supply shock | -0.0000000000776 | -0.0803 | -0.00101 | 2.61 |
| | (-0.00) | (-0.00) | (-0.00) | (.) |
| ECB unsystematic shock | 0.000000000112 | -0.01 | -0.00124 | -0.0415 |
| | (0.00) | (-0.00) | (-0.00) | (.) |
| **Direct effect of institutions ($\gamma_j$):** | | | | |
| RR1[ǀ] | -0.372 | | 0.00398 | 0.0491 |
| | (-1.19) | | (0.01) | (0.17) |
| RR25[††] | | -0.117 | | |
| | | (-0.25) | | |
| Benefit length | 70.6 | 197*** | 140*** | 191*** |
| | (1.32) | (4.43) | (3.53) | (4.35) |
| ALMPs1[ǀ] | | -1.08** | -0.847* | -1.02** |
| | | (-2.21) | (-1.73) | (-2.04) |
| ALMPs2[†] | 36.5** | | | |
| | (2.30) | | | |
| EPLs regular[‡] | | | -30.7** | |
| | | | (-2.44) | |
| EPLs temporary[§] | | | | -17.3*** |
| | | | | (-2.71) |
| EPLs[ǀ] | -24.3** | -35.1*** | | |
| | (-2.31) | (-3.42) | | |
| Tax wedge | 3.34*** | 3.49*** | 3.44*** | 3.53*** |
| | (3.46) | (3.79) | (3.61) | (3.71) |
| Union coverage | 0.38 | 0.322 | 0.331 | 0.35 |
| | (0.93) | (0.80) | (0.81) | (0.85) |
| Union density | 2.11** | 1.28 | 1.85* | 1.03 |
| | (2.19) | (1.46) | (1.97) | (1.12) |
| Coordination | -9.6*** | -8.24*** | -7.61*** | -8.31*** |
| | (-3.93) | (-3.31) | (-2.99) | (-3.26) |
| Time and country effects | yes | yes | yes | yes |
| Adjusted $R^2$ | 0.844 | 0.843 | 0.837 | 0.841 |
| Parameters | 39 | 39 | 39 | 39 |
| Observations | 165 | 165 | 165 | 165 |

Notes: The estimates are rescaled by using permillage. t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation). * p<0.10 ** p<0.05 *** p<0.01.
[††] RR25: the average net replacement rate during years 2 to 5 of an unemployment spell.
[†] ALMPs2: public expenditures on ALMPs as a share of GDP.
[‡] EPLs regular: the indicator measuring the strictness of EPLs on regular contracts.
[§] EPLs temporary: the indicator measuring the strictness of EPLs on temporary contracts.
[ǀ] The definitions of RR1, ALMPs1 and EPLs are consistent with those in Tables 2.1 and 2.2.

Table 2.4 Interactions between Time Effects and Institutions. Alternative Measures

| | Dependent Variable: $u$ | | | |
|---|---|---|---|---|
| **Independent Variables** | I | II | III | IV |
| **Time effects:** | 0.0410*** | 0.0133*** | 0.0134*** | 0.0155*** |
| | (5.27) | (2.85) | (2.66) | (3.45) |
| **Indirect effect of institutions ($\gamma_j$):** | | | | |
| RR1[ǀ] | 0.00812 | | -0.00703 | -0.0246 |
| | (0.76) | | (-0.26) | (-1.32) |
| RR25[††] | | -0.0320 | | |
| | | (-0.80) | | |
| Benefit length | 0.728 | 6.873* | 4.753 | 5.992** |
| | (0.52) | (1.82) | (1.43) | (2.18) |
| ALMPs1[ǀ] | | -1.141** | -1.081** | -0.985*** |
| | | (-2.50) | (-2.42) | (-2.92) |
| ALMPs2[†] | -0.640 | | | |
| | (-0.60) | | | |
| EPLs regular[‡] | | | -1.263 | |
| | | | (-0.93) | |
| EPLs temporary[§] | | | | -0.347 |
| | | | | (-1.19) |
| EPLs[ǀ] | -0.440 | -1.389 | | |
| | (-1.20) | (-1.37) | | |
| Tax wedge | -0.0995*** | -0.704*** | -0.633** | -0.584*** |
| | (-2.73) | (-2.63) | (-2.56) | (-3.14) |
| Union coverage | 0.0332* | 0.272** | 0.238** | 0.216*** |
| | (1.88) | (2.49) | (2.39) | (2.97) |
| Union density | -0.00248 | -0.0213 | -0.0193 | -0.0127 |
| | (-0.27) | (-1.03) | (-0.90) | (-0.78) |
| Coordination | -0.855*** | -0.425 | -0.535 | -0.408 |
| | (-4.27) | (-1.29) | (-1.58) | (-1.52) |
| Time and country effects | yes | yes | yes | yes |
| Adjusted $R^2$ | 0.734 | 0.861 | 0.858 | 0.859 |
| Parameters | 34 | 34 | 34 | 34 |
| Observations | 165 | 165 | 165 | 165 |

Notes: t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation).
* p<0.10 ** p<0.05 *** p<0.01
[††] RR25: the average net replacement rate during years 2 to 5 of an unemployment spell.
[†] ALMPs2: public expenditures on ALMPs as a share of GDP.
[‡] EPLs regular: the indicator measuring the strictness of EPLs on regular contracts.
[§] EPLs temporary: the indicator measuring the strictness of EPLs on temporary contracts.
[ǀ] The definitions of RR1, ALMPs1 and EPLs are consistent with those in Tables 2.1 and 2.2.

Table 2.5 Interactions between Shocks and Institutions. Alternative Measures

| | Dependent Variable: $u$ | | | |
|---|---|---|---|---|
| **Independent Variables** | I | II | III | IV |
| **Direct effect of shocks ($\beta_i$):** | | | | |
| Labor demand shock | -0.165*** | -0.152*** | -0.258*** | -0.161*** |
| | (-3.52) | (-3.36) | (-4.06) | (-4.58) |
| TFP shock | 0.0820 | 0.0764 | 0.0652 | 0.0747 |
| | (0.83) | (0.81) | (0.63) | (0.70) |
| Real interest rate | 1.008*** | 0.960*** | 1.083*** | 1.033*** |
| | (11.24) | (10.71) | (11.06) | (11.52) |
| ECB money supply shock | 1.673 | 1.892 | 1.650 | 0.473 |
| | (0.81) | (0.98) | (0.75) | (0.26) |
| ECB unsystematic shock | -0.0365 | 0.0000671 | -0.00345 | -0.0273 |
| | (-0.70) | (0.00) | (-0.06) | (-0.60) |
| **Indirect effect of institutions ($\gamma_j$):** | | | | |
| RR1[ǀ] | -0.0171** | | -0.0121** | -0.0116* |
| | (-2.45) | | (-2.04) | (-1.81) |
| RR25[††] | | -0.0307** | | |
| | | (-2.43) | | |
| Benefit length | -0.437 | 2.132* | -1.346* | 1.119 |
| | (-0.34) | (1.77) | (-1.81) | (1.10) |
| ALMPs1[ǀ] | | -0.0196 | 0.00278 | -0.0202 |
| | | (-0.94) | (0.18) | (-1.04) |
| ALMPs2[†] | 0.307 | | | |
| | (0.53) | | | |
| EPLs regular[‡] | | | -0.145* | |
| | | | (-1.95) | |
| EPLs temporary[§] | | | | 0.295*** |
| | | | | (3.24) |
| EPLs[ǀ] | 0.210 | 0.276 | | |
| | (1.17) | (1.39) | | |
| Tax wedge | 0.0783*** | 0.0837*** | 0.0681*** | 0.0893*** |
| | (4.17) | (4.96) | (5.74) | (5.96) |
| Union coverage | -0.0297*** | -0.0319*** | -0.0160** | -0.0342*** |
| | (-2.87) | (-2.94) | (-2.42) | (-3.97) |
| Union density | -0.00952* | -0.00766 | -0.0113*** | -0.0107** |
| | (-1.90) | (-1.52) | (-2.66) | (-2.32) |
| Coordination | -0.0979 | -0.0750 | -0.132** | -0.0712 |
| | (-1.47) | (-1.00) | (-2.26) | (-1.08) |
| Time and country effects | yes | yes | yes | yes |
| Adjusted $R^2$ | 0.856 | 0.857 | 0.859 | 0.866 |
| Parameters | 39 | 39 | 39 | 39 |
| Observations | 165 | 165 | 165 | 165 |

Notes: t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation).
* p<0.10 ** p<0.05 *** p<0.01
[††] RR25: the average net replacement rate during years 2 to 5 of an unemployment spell.
[†] ALMPs2: public expenditures on ALMPs as a share of GDP.
[‡] EPLs regular: the indicator measuring the strictness of EPLs on regular contracts.
[§] EPLs temporary: the indicator measuring the strictness of EPLs on temporary contracts.
[ǀ] The definitions of RR1, ALMPs1 and EPLs are consistent with those in Tables 2.1 and 2.2.

Table 2.6 Cross-Sectional Stability. Equation (2.2)

| | Direct effect of institutions ($\gamma_j$)[§] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Institutions** | Austria | Belgium | Finland | France | Germany | Ireland | Italy | Luxembour g | Netherlands | Portugal | Spain |
| RR1[††] | -0.00000302 | -0.00000302 | -0.00000302 | -0.00000302 | -0.00000302 | -0.00000302 | -0.00000302 | -0.00000302 | -0.00000302 | -0.00000302 | -0.00000302 |
| | (-0.01) | (-0.01) | (-0.01) | (-0.01) | (-0.01) | (-0.01) | (-0.01) | (-0.01) | (-0.01) | (-0.01) | (-0.01) |
| Benefit length | 0.191*** | 0.191*** | 0.191*** | 0.191*** | 0.191*** | 0.191*** | 0.191*** | 0.191*** | 0.191*** | 0.191*** | 0.191*** |
| | (4.53) | (4.52) | (4.50) | (4.54) | (4.54) | (4.55) | (4.46) | (4.49) | (4.55) | (4.52) | (4.53) |
| ALMPs1[†] | -0.00110** | -0.00110** | -0.00110** | -0.00110** | -0.00110** | -0.00110** | -0.00110** | -0.00110** | -0.00110** | -0.00110** | -0.00110** |
| | (-2.22) | (-2.21) | (-2.21) | (-2.20) | (-2.21) | (-2.22) | (-2.21) | (-2.21) | (-2.23) | (-2.21) | (-2.22) |
| EPLs[‡] | -0.0349*** | -0.0349*** | -0.0349*** | -0.0349*** | -0.0349*** | -0.0349*** | -0.0349*** | -0.0349*** | -0.0349*** | -0.0349*** | -0.0349*** |
| | (-3.32) | (-3.32) | (-3.32) | (-3.33) | (-3.32) | (-3.33) | (-3.31) | (-3.31) | (-3.34) | (-3.32) | (-3.33) |
| Tax wedge | 0.00348*** | 0.00348*** | 0.00348*** | 0.00348*** | 0.00348*** | 0.00348*** | 0.00348*** | 0.00348*** | 0.00348*** | 0.00348*** | 0.00348*** |
| | (3.70) | (3.69) | (3.69) | (3.69) | (3.69) | (3.70) | (3.68) | (3.68) | (3.70) | (3.67) | (3.51) |
| Union coverage | 0.000314 | 0.000314 | 0.000314 | 0.000314 | 0.000314 | 0.000314 | 0.000314 | 0.000314 | 0.000314 | 0.000314 | 0.000314 |
| | (0.77) | (0.77) | (0.77) | (0.77) | (0.77) | (0.77) | (0.77) | (0.77) | (0.77) | (0.77) | (0.77) |
| Union density | 0.00129 | 0.00129 | 0.00129 | 0.00129 | 0.00129 | 0.00129 | 0.00129 | 0.00129 | 0.00129 | 0.00129 | 0.00129 |
| | (1.44) | (1.43) | (1.41) | (1.43) | (1.43) | (1.44) | (1.42) | (1.43) | (1.44) | (1.43) | (1.44) |
| Coordination | -0.00825*** | -0.00825*** | -0.00825*** | -0.00825*** | -0.00825*** | -0.00825*** | -0.00825*** | -0.00825*** | -0.00825*** | -0.00825*** | -0.00825*** |
| | (-3.28) | (-3.28) | (-3.28) | (-3.26) | (-3.27) | (-3.29) | (-3.26) | (-3.28) | (-3.29) | (-3.28) | (-3.29) |

Notes: The table gives the coefficient of each institution variable when one country at the time is dropped, as well as the country which is dropped.
t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation).
* p<0.10 ** p<0.05 *** p<0.01
[††] This measure of the replacement rate refers to the average net replacement rate during the 1st year of unemployment.
[†] This measure of ALMPs refers to public expenditures on ALMPs per unemployed worker as a share of GDP per member of the labor force.
[‡] This measure of EPLs refers to the summary indicator taking average of the indicators for EPLs on regular contracts and EPLs on temporary contracts.
[§] Corresponding to Equation (2.2).

## Table 2.7 Cross-Sectional Stability. Equation (2.4)

| | | | | | Indirect effect of institutions ($\gamma_j$)§ | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Institutions** | Austria | Belgium | Finland | France | Germany | Ireland | Italy | Luxembour g | Netherlands | Portugal | Spain |
| RR1†† | -0.0130** | -0.00722 | -0.00449 | -0.00449 | -0.00811* | -0.0107** | -0.00710 | -0.0135** | -0.0128** | -0.00475 | -0.00312 |
| | (-2.31) | (-1.52) | (-1.12) | (-1.13) | (-1.81) | (-2.08) | (-1.61) | (-2.38) | (-2.25) | (-1.47) | (-1.32) |
| Benefit length | 0.361 | -0.190 | -0.743 | -0.724 | 0.310 | -0.468 | -0.0421 | 0.135 | 0.464 | -0.947 | -0.131 |
| | (0.37) | (-0.25) | (-1.13) | (-1.11) | (0.40) | (-0.58) | (-0.06) | (0.14) | (0.47) | (-1.20) | (-0.36) |
| ALMPs1† | -0.0102 | -0.00926 | -0.00114 | 0.000314 | -0.00707 | -0.00741 | -0.00669 | -0.0114 | -0.0107 | -0.0372*** | -0.00117 |
| | (-0.64) | (-0.71) | (-0.10) | (0.03) | (-0.57) | (-0.52) | (-0.58) | (-0.69) | (-0.66) | (-2.66) | (-0.26) |
| EPLs‡ | 0.181 | -0.0258 | -0.106 | -0.111 | 0.134 | -0.0381 | 0.0590 | 0.187 | 0.202 | -0.217 | -0.0383 |
| | (1.08) | (-0.24) | (-1.21) | (-1.28) | (0.84) | (-0.34) | (0.43) | (1.09) | (1.18) | (-1.57) | (-0.61) |
| Tax wedge | 0.0754*** | 0.0597*** | 0.0496*** | 0.0500*** | 0.0441*** | 0.0602*** | 0.0404*** | 0.0726*** | 0.0778*** | 0.0289** | 0.00762* |
| | (5.14) | (5.22) | (4.85) | (4.89) | (3.63) | (5.47) | (3.67) | (5.05) | (5.14) | (2.31) | (1.80) |
| Union coverage | -0.0269*** | -0.0163** | -0.0117** | -0.0111** | -0.0168** | -0.0187*** | -0.0155** | -0.0268*** | -0.0285*** | -0.00440 | -0.00313 |
| | (-3.00) | (-2.47) | (-2.08) | (-2.00) | (-2.34) | (-2.70) | (-2.34) | (-2.95) | (-3.08) | (-0.68) | (-1.19) |
| Union density | -0.00724* | -0.00583* | -0.00411 | -0.00594* | -0.00458 | -0.00780** | -0.00408 | -0.00651 | -0.00722* | -0.0102*** | -0.000775 |
| | (-1.77) | (-1.71) | (-1.34) | (-1.93) | (-1.47) | (-2.15) | (-1.39) | (-1.57) | (-1.74) | (-2.70) | (-0.57) |
| Coordination | -0.0509 | -0.0575 | -0.0832* | -0.0907* | 0.0275 | -0.0656 | 0.0144 | -0.0538 | -0.0510 | 0.0882 | -0.0143 |
| | (-0.76) | (-1.05) | (-1.67) | (-1.81) | (0.48) | (-1.17) | (0.27) | (-0.79) | (-0.75) | (1.39) | (-0.42) |

Notes: The table gives the coefficient of each institution variable when one country at the time is dropped, as well as the country which is dropped.
t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation).
* $p<0.10$ ** $p<0.05$ *** $p<0.01$
†† This measure of the replacement rate refers to the average net replacement rate during the 1st year of unemployment.
† This measure of ALMPs refers to public expenditures on ALMPs per unemployed worker as a share of GDP per member of the labor force.
‡ This measure of EPLs refers to the summary indicator taking average of the indicators for EPLs on regular contracts and EPLs on temporary contracts.
§ Corresponding to Equation (2.4).

Table 2.8 Period Stability

| | Direct effect of institutions ($\gamma_j$)[§] | | Indirect effect of institutions ($\gamma_j$)[‖] | |
|---|---|---|---|---|
| **Institutions** | 2000 - 2006 | 2007 - 2013 | 2000 - 2006 | 2007 - 2013 |
| RR1[††] | -0.0000382 | 0.0000442 | -0.00522 | -0.0126* |
| | (-0.14) | (0.15) | (-1.36) | (-1.70) |
| Benefit length | 0.184*** | 0.191*** | 0.114 | 1.017 |
| | (4.44) | (4.55) | (0.20) | (0.79) |
| ALMPs1[†] | -0.00118** | -0.00155*** | -0.0000346 | -0.00124 |
| | (-2.39) | (-3.36) | (-0.00) | (-0.07) |
| EPLs[‡] | -0.0408*** | -0.0391*** | -0.0263 | 0.309 |
| | (-4.00) | (-3.75) | (-0.25) | (1.54) |
| Tax wedge | 0.00396*** | 0.00317*** | 0.0227*** | 0.0927*** |
| | (4.36) | (3.38) | (3.05) | (4.97) |
| Union coverage | 0.000396 | 0.000302 | -0.0112** | -0.0381*** |
| | (0.98) | (0.75) | (-2.38) | (-3.28) |
| Union density | 0.00120 | 0.000602 | -0.00164 | -0.0101* |
| | (1.40) | (0.71) | (-0.57) | (-1.90) |
| Coordination | -0.00898*** | -0.00798*** | -0.0432 | -0.0693 |
| | (-3.63) | (-3.19) | (-0.83) | (-0.95) |

Notes: The table gives the coefficient of each institution variable when regressing on different sub-periods.
t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation).
* p<0.10 ** p<0.05 *** p<0.01
[††] This measure of the replacement rate refers to the average net replacement rate during the 1st year of unemployment.
[†] This measure of ALMPs refers to public expenditures on ALMPs per unemployed worker as a share of GDP per member of the labor force.
[‡] This measure of EPLs refers to the summary indicator taking average of the indicators for EPLs on regular contracts and EPLs on temporary contracts.
[§] Corresponding to Equation (2.2).
[‖] Corresponding to Equation (2.4).

## Table 2.9 Test for Endogeneity. Lagged Shocks

| | Dependent Variable: $u$ | | | |
|---|---|---|---|---|
| **Independent Variables** | I | II | III | IV |
| **Direct effect of shocks ($\beta_i$):** | | | | |
| Labor demand shock | -0.276** | 0.0353 | -0.156*** | -0.0902*** |
| | (-2.05) | (0.24) | (-3.60) | (-3.46) |
| TFP shock | -0.0124 | 0.0646 | 0.0787 | -0.0984 |
| | (-0.10) | (0.54) | (0.81) | (-1.17) |
| Real interest rate | 0.595*** | 0.540*** | 0.981*** | 1.032*** |
| | (6.54) | (6.22) | (10.74) | (10.45) |
| ECB money supply shock | -0.000000835 | 0.0000000345 | 1.908 | 0.678 |
| | (-0.00) | (0.00) | (0.97) | (0.45) |
| ECB unsystematic shock | 0.000000127 | -0.000000262 | -0.00908 | -0.0270 |
| | (0.00) | (-0.00) | (-0.19) | (-0.76) |
| **Direct or Indirect effect of institutions ($\gamma_j$):** | | | | |
| RR1†† | -0.00000302 | 0.000471* | -0.0173** | -0.0339*** |
| | (-0.01) | (1.82) | (-2.56) | (-3.83) |
| Benefit length | 0.191*** | 0.217*** | 0.129 | -0.212 |
| | (4.50) | (5.19) | (0.11) | (-0.17) |
| ALMPs1† | -0.00110** | -0.00140*** | -0.0202 | -0.0272 |
| | (-2.19) | (-2.90) | (-1.00) | (-1.27) |
| EPLs‡ | -0.0349*** | -0.0427*** | 0.254 | 0.549** |
| | (-3.28) | (-3.71) | (1.35) | (2.32) |
| Tax wedge | 0.00348*** | 0.00302*** | 0.0833*** | 0.0808*** |
| | (3.66) | (3.02) | (5.12) | (4.58) |
| Union coverage | 0.000314 | 0.000108 | -0.0320*** | -0.0365*** |
| | (0.76) | (0.24) | (-3.08) | (-3.23) |
| Union density | 0.00129 | 0.00177* | -0.00839* | -0.0103* |
| | (1.42) | (1.80) | (-1.70) | (-1.77) |
| Coordination | -0.00825*** | -0.00557** | -0.0771 | -0.0588 |
| | (-3.28) | (-2.10) | (-1.07) | (-0.72) |
| Time and country effects | yes | yes | yes | yes |
| Adjusted $R^2$ | 0.843 | 0.847 | 0.857 | 0.870 |
| Parameters | 39 | 39 | 39 | 39 |
| Observations | 165 | 154 | 165 | 154 |

Notes: This table shows the sensitivity of the results in Tables 2.1 and 2.2 by replacing shocks with their one period lagged values. Column I presents the original results of Equation (2.2), corresponding to Column III in Table 2.1. Column II presents its comparison results estimated by lagged shock values. Column III presents the original results of Equation (2.4), corresponding to Column II in Table 2.2. Column IV presents its comparison results estimated by lagged shock values.

t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation).

* p<0.10 ** p<0.05 *** p<0.01

†† This measure of the replacement rate refers to the average net replacement rate during the 1st year of unemployment.

† This measure of ALMPs refers to public expenditures on ALMPs per unemployed worker as a share of GDP per member of the labor force.

‡ This measure of EPLs refers to the summary indicator taking average of the indicators for EPLs on regular contracts and EPLs on temporary contracts.

Table 2.10 Test for Endogeneity. Lagged Institutions

| | Dependent Variable: $u$ | | | |
|---|---|---|---|---|
| **Independent Variables** | I | II | III | IV |
| **Direct effect of shocks ($\beta_i$):** | | | | |
| Labor demand shock | -0.276** | -0.249* | -0.156*** | -0.138*** |
| | (-2.05) | (-1.74) | (-3.60) | (-2.76) |
| TFP shock | -0.0124 | 0.0206 | 0.0787 | 0.0848 |
| | (-0.10) | (0.16) | (0.81) | (0.78) |
| Real interest rate | 0.595*** | 0.693*** | 0.981*** | 1.093*** |
| | (6.54) | (6.47) | (10.74) | (10.66) |
| ECB money supply shock | -0.000000835 | 0.0000120 | 1.908 | 2.316 |
| | (-0.00) | (0.00) | (0.97) | (0.55) |
| ECB unsystematic shock | 0.000000127 | -0.0000153 | -0.00908 | -0.0240 |
| | (0.00) | (-0.00) | (-0.19) | (-0.52) |
| **Direct or Indirect effect of institutions ($\gamma_j$):** | | | | |
| RR1[††] | -0.00000302 | -0.0000784 | -0.0173** | -0.0171** |
| | (-0.01) | (-0.22) | (-2.56) | (-2.52) |
| Benefit length | 0.191*** | 0.209*** | 0.129 | 1.651 |
| | (4.50) | (4.47) | (0.11) | (1.41) |
| ALMPs1[†] | -0.00110** | -0.000812 | -0.0202 | -0.0528** |
| | (-2.19) | (-1.46) | (-1.00) | (-2.28) |
| EPLs[‡] | -0.0349*** | -0.0257** | 0.254 | 0.416** |
| | (-3.28) | (-2.12) | (1.35) | (2.26) |
| Tax wedge | 0.00348*** | 0.00252** | 0.0833*** | 0.0715*** |
| | (3.66) | (2.33) | (5.12) | (4.72) |
| Union coverage | 0.000314 | -0.000186 | -0.0320*** | -0.0291*** |
| | (0.76) | (-0.43) | (-3.08) | (-2.73) |
| Union density | 0.00129 | 0.00252*** | -0.00839* | -0.0137*** |
| | (1.42) | (2.62) | (-1.70) | (-2.79) |
| Coordination | -0.00825*** | -0.00644** | -0.0771 | 0.0199 |
| | (-3.28) | (-2.45) | (-1.07) | (0.41) |
| Time and country effects | yes | yes | yes | yes |
| Adjusted $R^2$ | 0.843 | 0.827 | 0.857 | 0.861 |
| Parameters | 39 | 39 | 39 | 39 |
| Observations | 165 | 154 | 165 | 154 |

Notes: This table shows the sensitivity of the results in Tables 2.1 and 2.2 by replacing institutions with their one period lagged values. Column I presents the original results of Equation (2.2), corresponding to Column III in Table 2.1. Column II presents its comparison results estimated by lagged institution values. Column III presents the original results of Equation (2.4), corresponding to Column II in Table 2.2. Column IV presents its comparison results estimated by lagged institution values.
t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation).
* $p<0.10$ ** $p<0.05$ *** $p<0.01$
[††] This measure of the replacement rate refers to the average net replacement rate during the 1st year of unemployment.
[†] This measure of ALMPs refers to public expenditures on ALMPs per unemployed worker as a share of GDP per member of the labor force.
[‡] This measure of EPLs refers to the summary indicator taking average of the indicators for EPLs on regular contracts and EPLs on temporary contracts.

# Chapter 3: Macroeconomic Shocks and the Gender Unemployment Gap Across the Euro Area

*Note: A version of this essay has been published as Reading Department of Economics Discussion Paper Series No. 2020-26. This article was co-authored with Dr Alexander Mihailov and Prof. Giovanni Razzu; e-mails: a.mihailov@reading.ac.uk and g.razzu@reading.ac.uk. Alexander and Giovanni have agreed that the essay can appear within this thesis, and that it represents a significant contribution on my part.*

## 3.1 Introduction

Heterogeneity in unemployment trends across European countries during the 2007 GFC has been well-documented (e.g., Bertola, 2017; Bachmann and Felder, 2020). It is noticeable that cross-country differences are not only in unemployment rates but also in gender unemployment gaps. Table 3.1 shows unemployment rates by gender in the 11 countries that have been part of the EA from its onset, averaged over 2000-2013.[32] While the gender gap in unemployment rates, defined as the difference between female and male unemployment rates, is small (or even negative) in some countries, there are others in which it is very large. For example, in Ireland, the female unemployment rate is 1.99 pp below the male unemployment rate on average, while in Spain it is 4.35 pp above. Figure 3.1 displays the evolution of unemployment rates by gender, over the 2000-2013 period. In some countries, the gap in unemployment rates between women and men is very small, such as in Austria, Finland and Germany. Other countries that used to have large gaps, more recently have had small gaps, for example, Italy and Spain. Interestingly, Ireland has witnessed a negative gender gap since the outbreak of the GFC, but did not have a gender gap earlier.

Chapters 1 and 2 have provided robust evidence on the significant effect of macroeconomic shocks on the unemployment rate in the EA, along with interactions with labor market institutions, which is in line with the literature.[33] A natural question is raised: are women much more likely to be unemployed than men under adverse

[32] The countries are Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain.
[33] Amongst others, see Bassanini and Duval (2007); Bertola (2017); BW (2000).

shocks, and does an adverse shock lead to larger increases in unemployment rates for some demographic groups relative to others?

The labor market position of different demographic groups has always been an important issue in light of widespread concerns about the integration of women into the labor market, youth employment problems, as well as the employment of the less-educated.[34] For example, earlier research on gender unemployment gaps focused on the US (Barrett and Morgenstern, 1974; Niemi, 1974; Johnson, 1983; Sahin et al., 2012; Albanesi and Şahin, 2018), while more recent analyses included other countries, such as Spain, Italy, and Argentina[35] and comparative investigations across countries on gender unemployment differences (e.g., Baussola et al., 2015; Razzu and Singleton, 2016). These papers typically focused on labor market flows, industry composition and human capital characteristics as the determinants of the gender unemployment gap. Furthermore, some multi-country studies added important insights into the effect of labor market institutions. Azmat et al. (2006), for instance, assessing the cross-country differences in the gender unemployment gap in 15 countries among the members of the OECD, find that the interactions between gender differences in human capital accumulation and labor market institutions are an important part of the explanation. Similarly, Bertola et al. (2007) and Dieckhoff et al. (2015), based on data from 17 OECD and 18 EU countries, find that some labor market institutions, such as trade unions, significantly influence gender employment gaps.

The effects of labor market institutions in shaping the gender unemployment gap have been found to be relevant in at least two ways: 1) through their impact on wages; and 2) by affecting the likelihood of workers who are less firmly attached to the labor force to stay in employment. There may be institutions common to both of these ways. For example, strong trade unions, represented by large-scale union membership and collective bargaining agreement coverage, may have the ability to exert upward pressure on wages, at the cost of lower employment (Layard et al., 2005). The job losses incurred may fall primarily on those groups with lower levels of labor market attachment.[36] Likewise, the labor tax wedge, which measures the difference between

[34] See Blau and Kahn (1997) and Ruhm (1998) on women's employment; Blanchflower and Freeman (2007) on youth employment; and OECD (2011) on the employment of the less-educated.
[35] Ortega Masagué (2008) explores the factors explaining the gender gap in unemployment rates in Argentina; Belloc and Tilli (2013) study unemployment by gender in the Italian regions; De la Rica and Rebollo-Sanz (2017) focus on the case of Spain during the GFC.
[36] Bertola et al. (2007) do find evidence that unionization raises the unemployment rates of women and young people.

the labor cost to the employer and the corresponding net take-home pay of the employee, may increase the reservation wage and reduce the incentive of the employer to hire workers with lower levels of labor market attachment. Furthermore, EPLs, which can be considered as proxies for the costs that firms face when they dismiss an employee, seem to reduce involuntary separations and hence lower inflows into unemployment, especially for workers with long job tenures. However, stricter EPLs may also make firms more cautious about filling vacancies and reduce the hiring rate. This reduction in hiring will tend to increase the gap in unemployment rates between workers with high and low levels of labor market attachment. As for ALMPs, they may narrow the gap in unemployment rates across demographic groups, through enhancing the ability of labor market attachment for low-skilled workers. Finally, generous unemployment benefits, on the one hand, may decrease the likelihood of workers who are less firmly attached to the labor force to stay in employment; on the other hand, they may push up the reservation wage due to the lower opportunity cost of unemployment, which may be associated with higher unemployment rates for workers with low levels of labor market attachment.

The existing literature on how the unemployment rate of various demographic groups responds to macroeconomic shock mainly concentrates on the US. For example, Ewing et al. (2002) examine how unanticipated changes in real output affect the unemployment rate of black male , white male, black female and white female during 1972-1999. Hoynes et al. (2012) measure and illustrate how unemployment has changed in the GFC for persons of different ages, educational attainment, race, and gender. Note that there is very limited literature studying the effect of macroeconomic shocks on the unemployment rate of different groups in the EA. Our study fills in this gap in the literature. More specifically, this chapter examines the direct impact of four sources of macro-shocks on unemployment rates by gender across the EA: 1) the rate of TFP growth; 2) the real long-term interest rate; 3) labor demand shocks; and 4) ECB monetary policy shocks.[37] We further compare the impact of shocks on unemployment rates of different demographic groups, by considering the intersection between gender, age, marital status and education. In addition, we also assess the extent to which the effects of the initial macro-shocks on gender unemployment are intermediated by various labor market institutions, categorized into five types: 1) the wage setting system;

[37] See, for instance, BW and Rumler and Scharler (2011).

2) the labor tax wedge; 3) the EPLs; 4) ALMPs; and 5) the unemployment benefit system.

The empirical work we present here is based on a panel data set of 11 EA countries, as listed in Table 3.1, over the course of a whole business cycle, covering the period between 2000 and 2013. Our approach allows for a novel analysis of the interaction between macro-shocks and labor market institutions on female and male unemployment rates under the same monetary policy. We find that adverse macro-shocks, such as abrupt labor demand reductions or a tight monetary policy environment, do have a differential impact on the unemployment rate of various demographic groups. Labor market institutions play a role too in shaping out the severity of these shocks on the unemployment rate of women and men, thereby contributing to the dynamics of the gender unemployment gap.

The remainder of this chapter is arranged as follows: Section 3.2 looks at the data and methodology used for the empirical analysis; Section 3.3 presents the main results about the impact of shocks on unemployment rates by gender, and the effect of labor market institutions on changing the impact of shocks; Section 3.4 further disaggregates unemployment rates and analyzes the impact of shocks on unemployment rates of various demographic groups; and Section 3.5 concludes.

## 3.2 Data and Methodology

### 3.2.1 The Data

In order to assess the impact of macro-shocks on unemployment rates by gender, we use a panel data set of 11 EA countries over the course of a whole business cycle, covering the period between 2000 and 2013. The sample includes the first group of countries that joined the EMU at the official launch of the Euro on 1 January 1999, listed in Table 3.1. The sample period thus covers the economic expansion period preceding the GFC as well as its aftermath.

BW find empirical evidence that three country-specific shocks can significantly affect the unemployment rate, namely TFP shocks, the real long-term interest rate and labor demand shocks, and, accordingly, we focus on them. The TFP shock is measured by the rate of TFP growth. The real long-term interest rate is proxied by the long-term nominal interest rate less the yearly growth rate of the GDP deflator. The measure of the labor demand shock is the sum of the adjusted log wage indicator and the adjusted log employment indicator, less the log of real GDP. Additionally, the fourth macro-shock we examine, the common monetary policy shock across the EA, is proxied by the estimated residuals obtained through regressing an interest rate rule. This measure of the common monetary policy shock follows Rumler and Scharler (2011), capturing the unsystematic component of ECB's monetary policy.[38] The evolutions of these four macro-shocks over the sample period are plotted in Figure 3.2.

In addition, labor market institutions are also involved in the estimations, as they are expected to channel and shape out the intermediated response of female and male unemployment rates to a macroeconomic shock. In this chapter, labor market institutions include the system of wage determination, the labor tax wedge, EPLs, ALMPs and the unemployment benefit system. The system of wage determination is measured by the percentage of employees who are union members (union density), the proportion of employees covered by collective agreements (union contract coverage) and the degree of coordination of wage bargaining. The measure of the labor tax wedge consists of personal income taxes, social security contributions from employees, and social security contributions from employers (as a percentage of total labor cost). As for EPLs, the OECD reports indicators measuring the strictness of the regulation covering the individual dismissal of employees on regular contracts and temporary contracts, respectively. Moreover, the indicator of ALMPs is measured as public expenditures on ALMPs per unemployed worker as a share of GDP per member of the labor force. Finally, the measure of the unemployment benefit system includes the benefit replacement rate during the 1st year of unemployment and the benefit duration.[39]

### 3.2.2 Benchmark Model

Following BW, we regress unemployment rates by gender on four sources of macro-shocks, controlling for interactions between shocks and labor market institutions. The benchmark equation used is the following:

$$u_{ct}^{i} = \left(\beta_1^i TFP_{ct} + \beta_2^i RIR_{ct} + \beta_3^i LD_{ct} + \beta_4^i ECB_{ct-1}\right)$$
$$+\gamma' LMI_{ct} * \left(\beta_1^i TFP_{ct} + \beta_2^i RIR_{ct} + \beta_3^i LD_{ct} + \beta_4^i ECB_{ct-1}\right) + c_c + t_t + \varepsilon_{ct}^{i} \quad (3.1)$$

where the superscript $i = f, m$. The dependent variable is the female unemployment

[38] See Appendix 2.A.1 for the details on definitions, constructions and data sources.
[39] Appendix 3.A.1 presents the details on how to construct the measure for each indicator of labor market institutions.

rate when $i = f$, and is the male unemployment rate when $i = m$.[40] The subscripts $c$ and $t$ are country index and period index, respectively. $TFP_{ct}$ is a TFP shock, $RIR_{ct}$ is a shock in the real long-term interest rate, $LD_{ct}$ is a labor demand shock, and $ECB_{ct-1}$ is a ECB unsystematic monetary policy shock. Note that the values of the ECB unsystematic monetary policy shock are lagged one period (year), since unemployment is expected to be affected by monetary policy with a usual lag of a year or so. $\beta$ is the parameter vector capturing the impact of macro-shocks on unemployment rates by gender.

$LMI_{ct}$ is a vector of labor market institutions, including the following elements:

$$\gamma' LMI_{ct} = \gamma_1^i UD_{ct} + \gamma_2^i UC_{ct} + \gamma_3^i CO_{ct} + \gamma_4^i IT_{ct} + \gamma_5^i SSCEE_{ct} + \gamma_6^i SSCER_{ct}$$
$$+\gamma_7^i EPLR_{ct} + \gamma_8^i EPLT_{ct} + \gamma_9^i BRR_{ct} + \gamma_{10}^i BD_{ct} + \gamma_{11}^i ALMP_{ct} \qquad (3.2)$$

where $UD_{ct}$ is union density, $UC_{ct}$ is union contract coverage, $CO_{ct}$ is wage bargaining coordination, $IT_{ct}$ is personal income taxes as a percentage of total labor costs, $SSCEE_{ct}$ is social security contributions from employees as a percentage of total labor costs, $SSCER_{ct}$ is social security contributions from employers as a percentage of total labor costs, $EPLR_{ct}$ is the strictness of EPLs on regular contracts, $EPLT_{ct}$ is the strictness of EPLs on temporary contracts, $BRR_{ct}$ is the unemployment benefit replacement rate during the 1st year of unemployment, $BD_{ct}$ is the unemployment benefit duration, and $ALMP_{ct}$ is the measure of ALMPs. Note that all institutional variables are time-varying measures (see Appendix 3.A.1). $\gamma$ is the parameter vector capturing the effect of labor market institutions on changing the transmission of shocks to the female and male unemployment rates. In addition, country fixed effects $c_c$ and period fixed effects $t_t$ are included in Equation (3.1). $\varepsilon_{ct}^i$ is the stochastic residual.

The data for all variables are at the annual frequency. All the measures of the shocks and institutions are constructed as deviations from their sample mean across time and countries. The regressions are estimated by nonlinear least squares, in line with the literature (BW, 2000; Bertola et al., 2007).

[40] The sample is restricted to the working-age population.

## 3.3 Shocks, Institutions and Unemployment Rates by Gender

### 3.3.1 Benchmark Regression Results

3.3.1.1. Direct Effects of Macro Shocks on Unemployment Rates by Gender

Benchmark regression results are presented in Table 3.2. Columns I and II report the coefficient estimates for the female and male unemployment rate respectively.

The top panel reports the estimates of the different impact of shocks on the unemployment rates by gender. First, the real long-term interest rate reveals a significantly positive correlation with the unemployment rates for both women and men. A rise in the real interest rate, for instance of 8 pp as in the case of Ireland and Portugal between 2007 and 2011, is associated with an increase in the female unemployment rate of 6.8%, and in the male unemployment rate of 10.6%. The response of the male unemployment rate is more elastic relative to the response of the female unemployment rate, following real interest rate shocks. Second, the labor demand shock is statistically significant too and negatively correlated with both the female and male unemployment rates. A decrease in the labor demand of 10 pp translates into an increase in the unemployment rate of about 2.2% for women and 2.1% for men, with only a slight contribution to affecting the gender gap. Third, it is noticeable that ECB unsystematic monetary policy shocks are found to have a statistically significant one-year lagged effect on the female unemployment rate, but not on the male unemployment rate. An increase in the measure of the ECB monetary policy shock of 3 pp, that is, a contractionary monetary policy such as that implemented in the heat of the GFC between 2008 and 2009, is associated with an increase in the female unemployment rate of 0.4% and no significant effect on the male unemployment rate. Therefore, gender unemployment rate differences are likely to be amplified under a tight monetary policy environment. Finally, the impacts of the TFP shock on the unemployment rates are insignificant, both for women and men.

3.3.1.2. Interactions between Shocks and Labor Market Institutions

The second panel in Table 3.2 reports the effect of labor market institutions on changing the impact of shocks on the unemployment rate, that is, the estimates of $\gamma'$ in Equation (3.1). We look at five subgroups of labor market institutions. The first one is the system of wage determination, which, overall, tends to mitigate the impact of shocks on the unemployment rate. In this subgroup, union contract coverage displays a significantly negative interaction effect with macro-shocks for the unemployment rate of both women and men. In other words, a higher degree of union coverage tends to reduce the impact of shocks on the female and male unemployment rates. Furthermore, union density's interaction coefficient is also significantly negative in column II, indicating that higher union density is related to a smaller impact of shocks on the male unemployment rate. These estimates are consistent with the results in Chapter 2, implying pervasive unionization leads to more moderate labor market reactions. Yet our estimates here show that union density helps mitigate the impact of shocks only for men who tend to be better represented in trade unions, and not for women who are less attached to labor markets and, hence, trade unions.

On the contrary, the second subgroup, tax wedges, tends to amplify the impact of shocks on unemployment for both women and men. Specifically, personal income taxes and social security contributions from employers have significantly positive shock-interaction coefficients for both the female and male unemployment rates. We also find that an increase in income taxes or social security contributions from employers is associated with a larger amplification on the impact of shocks on the female unemployment rate than that on the male unemployment rate. This is in line with the standard theoretical prediction according to which higher tax wedges are likely to reduce the incentive of the employer to hire workers with lower levels of labor market attachment, making female unemployment more sensitive to shocks.

In the third subgroup, stringent EPLs on temporary contracts appear to amplify the impact of macro-shocks on the male, but not female, unemployment rate, possibly reflecting the important contribution of temporary workers to male unemployment. The other independent variables in this subgroup are found to be not statistically significant.

Finally, in the fourth subgroup, a higher replacement rate during the first year of unemployment is found to lessen the impact of shocks on the female unemployment rate only. For the fifth subgroup, the estimates suggest that there is no significant effect of ALMPs on changing the impact of shocks on unemployment rates by gender.

### 3.3.2 Robustness

The benchmark results in Table 3.2 should be taken with some caution when considering the small size of the panel data set employed. In order to check the robustness of these results, we carry out a battery of sensitivity tests.

First, we evaluate the cross-sectional stability of the results by eliminating one country at a time from the sample and re-estimating Equation (3.1) for the resulting 11 subsamples. Table 3.3 shows the coefficient estimate of each shock when one country at the time is dropped, as well as the country which is dropped. The top panel refers to the female unemployment rate. It can be observed that dropping one country at a time makes little difference to the results. The real interest rate and the ECB monetary policy shock are always positively significant, and the labor demand shock is always negatively significant. Additionally, the TFP shock is found to be insignificant in all subsamples. The bottom panel reports the re-estimation results for the male unemployment rate, showing that the real interest rate is always significant with the correct sign, regardless of which country is excluded. The significance of the labor demand shock changes to the positive sign in only two cases, when Finland or Italy is dropped from the estimation. Correspondingly, the coefficient of the TFP shock in these two subsamples becomes significant but has the unexpected sign. The ECB monetary policy shock becomes positively correlated with the male unemployment rate when Belgium or Spain is dropped. Overall, this confirms the benchmark results. Tables 3.4 and 3.5 also report the interaction coefficient estimate of each labor market institution for the 11 subsamples. The results are, again, stable and in line with the benchmark estimations discussed earlier.

Second, we similarly test the period stability of the results by removing one year at a time from the sample and re-estimating Equation (3.1) on the 14 subperiods, to see if any specific year during the GFC influences the results. The re-estimation results are displayed in Table 3.6. Again, the coefficient estimates of the shocks for the female unemployment rate are very robust and do not appear to be driven by any particular year. For the male unemployment rate, the impact of the TFP shock is significant but unexpectedly signed when the data in 2001, 2002, 2004 or 2013 are removed. The coefficient estimate of the labor demand shock changes its sign to be positive when 2001, 2002 or 2013 are excluded. The ECB monetary policy shock significantly impacts the male unemployment rate only when 2011 is dropped. The impact of the real interest rate is always positive and significant in all of the subsamples. With regard to the interaction effect of labor market institutions for the 14 subperiods, the results are also robust (see Tables 3.7 and 3.8). This consolidates the overall picture presented in our analysis of the benchmark results.

Third, one important concern for identification is any potential endogeneity of macroeconomic shocks and labor market institutions. Particularly, the time-varying measures of labor market institutions used for the benchmark estimations are potentially subject to an endogeneity problem. In order to deal with these issues, four strategies are followed: 1) shock measures are lagged by one period; 2) institution measures are lagged by one period; 3) the sample period from 2000 to 2013 is split into five three-year subperiods (2000-2002, 2003-2005, 2006-2008, 2009-2011 and 2012-2013), with the institution measures being fixed at the values in the first year for each time window; 4) institution measures are fixed at their values in the first year of the observation period, 2000.

To be more specific, we reduce the potential problem of endogeneity of the macro-shocks by using their respective one-year lagged values. The re-estimation results are presented in Table 3.9 and are generally robust. The exceptions are the labor demand shock, union coverage, and personal income taxes for the regression on the male unemployment rate, which change the signs. The amplification effect of EPLs on temporary contracts on the male unemployment rate becomes insignificant, while EPLs on regular contracts are found to lessen the impact of shocks on the female unemployment rate.

With respect to potential institutional endogeneity, Table 3.10 shows the estimated results by replacing labor market institutions with their one-period lagged values. The results are consistent with the original results in Table 3.2, particularly in regards to the moderating role of trade unions and the amplifying role of labor tax wedges. The most noticeable difference is that the interaction coefficient of the replacement rate is significantly positive, increasing the impact of shocks on the female unemployment rate. Furthermore, Table 3.11 shows the results from restricting the variation in the institutional variables by considering only their values in the first year for each subperiod and in the first year of the sample period (2000). It can be observed that the impacts of the shocks are overall very robust, although some labor market institutions change their signs when fixed at their values in 2000. On the whole, the results are robust against endogeneity.

Finally, multicollinearity among institutional measures arises if the indicators are strongly correlated with each other. As Table 3.12 shows, this is clearly an issue here. Typically, the consequences of multicollinearity are sensitive estimates and inflated standard errors. Hence, we run the benchmark model by involving only one institutional variable at a time in the estimation, to check the stability of the estimates. The results are illustrated in Table 3.13. The impact of the real interest rate is consistent with the benchmark results for both the female and male unemployment rate, and the impact of the labor demand shock is also strongly robust for the female unemployment rate. The ECB monetary policy shock loses its significance on the female unemployment rate in most cases, as well as the labor demand shock on the male unemployment rate. Otherwise, and overall, the interaction effects of labor market institutions are very similar to those presented in Table 3.2.

## 3.4 Demographic Composition of Unemployment Rates by Gender

In fact, there exists considerable heterogeneity in unemployment: for example, low-skilled and younger workers tend to have relatively higher unemployment rates (Mincer 1991; Shimer 1998). So far, our analysis focuses on the unemployment rates for women and men, but it does not tell anything about who the women and men are whose unemployment rates are mostly affected by the shocks? In this section, we can provide depth to the previous results by estimating the impact of macro-shocks on the gendered unemployment rates of different demographic groups, disaggregated by age, marital status and education.

### 3.4.1 Age

Table 3.14 shows the unemployment rates by gender and three age groups, 15 to 24, 25 to 54, and 55 to 64 years old, in each EA country, averaged over 2000-2013. The youngest age group, for both female and male, tends to have the highest unemployment rate relative to the prime aged and the older, in all countries except Germany, where the unemployment rate of women in the oldest age group is the highest of all. Moreover, the prime age-female unemployment rate is higher than the older-female unemployment rate apart from Germany in all sample countries.

Table 3.15 reports the results of the benchmark model on the age subgroups of the female and male unemployment rates. The adverse impact of the higher real interest rate on both female and male unemployment rates is largest for the youngest age group and smallest for prime age workers. For each age subgroup, a rise in the real interest rate is related to a larger increase in the male unemployment rate than that in the female unemployment rate, in line with the benchmark results. Similarly, a decrease in the labor demand shock is correlated with a relatively larger increase in the youth unemployment rate compared with the increases in the unemployment rates of prime age and older workers. The impact of the labor demand shock on the unemployment rate is larger in absolute value for females than for males for all age subgroups. Additionally, the lagged ECB monetary policy shock has a significant impact on the unemployment rate only for 15 to 24 and 25 to 54 years old females. To compare the magnitude of the impact, the ECB monetary policy has a greater impact on the youth female unemployment rate, that is, a contractionary monetary policy is likely to result in an increase in the unemployment rate of young female workers. There is no significant association between the ECB monetary policy shock and the male and older female unemployment rates. Overall, all adverse shocks, when they are significant, empirically lead to a larger increase in the youth unemployment rate. Particularly, the labor demand shock and the ECB monetary policy shock result in a female youth unemployment rate rise that is higher than for any other subgroups.

With regard to labor market institutions, the role of trade unions on moderating the impact of shocks is mainly seen in the prime age and older age groups. However, higher union density does significantly reduce the impact of shocks on the male unemployment rate of the youngest age group, and higher wage bargaining coordination tends to lessen the impact of shocks on the female unemployment rate of the same age group. The amplifying role of labor tax wedges is particularly reflected by the adverse effects of personal income taxes and social security contributions from employers on the male unemployment rate across all age groups. Furthermore, the amplification effect of EPLs on temporary contracts on the male unemployment rate, as observed in the benchmark results, mainly applies to prime age men. The moderating effect of unemployment benefits is found to work on women for all age groups. In addition, expenditures on ALMPs significantly enlarge the impact of shocks on the female unemployment rate of the young age group.

### 3.4.2 Marital Status

Table 3.16 displays the female and male unemployment rates for each country averaged over the sample period, disaggregated by marital status: single/widowed/divorced and married/union/cohabiting. The unemployment rate for single people, either for women or for men, tends to be twice as high as for married people in all countries but in Spain. Amongst married people, women report a higher unemployment rate than men, except in Ireland.

Table 3.17 shows that the impact of the real interest rate on the unemployment rate is larger for the married than for the single subgroup, and larger for men if comparing by gender. A reduction in labor demand is associated with a larger increase in the unemployment rate for single women than for married women. Moreover, in response to an adverse labor demand shock, the increase in the unemployment rate of single men is even larger than that for single women. Finally, a contractionary monetary policy is significantly correlated with a rise in the unemployment rate of single women. These results may suggest that the unemployment rate of married people is more sensitive to changes in the real interest rate, while the unemployment rate of single people appears to be more sensitive to the labor demand shock, with single women's unemployment rate appearing to be more sensitive to tighter monetary policy.

Turning to labor market institutions, wage bargaining coordination lessens the impact of shocks on the unemployment rate of the single group, while union density reduces the impact of shocks on the unemployment rate of the married group. However, the amplification effects of union coverage and wage bargaining coordination on the married male unemployment rate are unexpected. The amplifying role of personal income taxes and social security contributions from employers on the unemployment rate of single individuals is robust. In contrast, social security contributions from employees significantly reduce the impact of shocks on the unemployment rate of all subgroups. As for EPLs on temporary contracts, the results suggest that it amplifies the impact of shocks on the unemployment rate of married women and men. Besides, unemployment benefits tend to enlarge the impact of shocks on the male unemployment rate disaggregated by both marital statuses. ALMPs also significantly enlarge the impact of shocks on the unemployment rate of single people and married women.

### 3.4.3 Education

There are also considerable differences in unemployment across different levels of education. Table 3.18 shows the average unemployment rates disaggregated by gender and education. Basic is primary and lower secondary education, International Standard Classification of Education (ISCED) 1-2; intermediate is upper secondary and post-secondary non-tertiary education, ISCED 3-4; advanced is tertiary education, ISCED 5-8. For both women and men, as expected, the lower the level of education, the higher the unemployment rate, and vice versa. In most countries, the unemployment rate for people with basic education is two to four times that for people with higher (advanced) education. In addition, the unemployment rate for females is generally higher than for males with the same level of education.

Table 3.19 reports the estimated impact of shocks on the unemployment rate for each educational attainment subgroup. A rise in the real interest rate is correlated with an increase in the unemployment rate, with the larger increase reported for less-educated people and the smaller increase for more-educated people. In columns IV and V, the impacts of the labor demand shock and the TFP shock on the unemployment rate for men having basic and intermediate educational attainments are unexpectedly signed. For other subgroups, in response to a reduction in labor demand, the increase in the unemployment rate is larger for less-educated women than for more-educated women, and larger for more-educated women than for more-educated men. The results also suggest a significant impact of the ECB monetary policy shock on the unemployment rate of women with various educational attainments, but an insignificant impact on the male unemployment rate. Specifically, the unemployment rate of women with basic education or advanced education is more affected by monetary policy, compared with the unemployment rate of women having intermediate education. Generally speaking, the empirical evidence finds that the unemployment rate of less educated people, especially less educated women, are likely to be more vulnerable to adverse shocks.

For interactions between labor market institutions and shocks, the moderating role of trade unions and the amplifying role of tax wedges are still significant for all education subgroups, except for the unexpected signs in columns IV and V. Stricter EPLs on temporary contracts tend to amplify the impact of shocks on the unemployment rate of women with basic education, but lessen the impact of shocks for women with advanced education. Generous unemployment benefit replacement rate is found to reduce the impact of shocks on the unemployment rate of women with intermediate educational attainment, whereas more expenditures on ALMPs are likely to increase the impact of shocks on the unemployment rate of women with advanced educational level.

## 3.5 Conclusion

In this chapter, we examined empirically the impact of macroeconomic shocks and labor market institutions on gendered unemployment rates, more generally and also disaggregated by age, marital status and education. The analysis was based on a panel data set of 11 EA countries over the time period between 2000 and 2013, thus after the ECB began operating a single monetary policy in the EA. We considered four sources of macro-shocks, including shocks to TFP, real long-term interest rates, labor demand shocks, and ECB monetary policy shocks. We also assessed whether labor market institutions mitigate or amplify the impact of macro-shocks on the gender unemployment rates.

The following novel results from our empirical analysis stand out robustly. First, a rise in the long-run real interest rate is significantly correlated with an increase in unemployment rates, with larger increases for men, particularly for those who are young, married, or less-educated. Second, a decrease in the labor demand by firms, typical in times of economic recessions and crises, is associated with a relatively larger increase in unemployment rates for women, especially for young or less-educated women. Third, the lagged ECB monetary policy shock has a strongly significant impact on the female unemployment rate, while it does not show any significant impact on the male unemployment rate. A contractionary monetary policy is likely to increase the unemployment rate of women, particularly young and less-educated women. Fourth, the impact of the TFP shock on unemployment rates comes out as insignificant, for both women and men. Fifth, strong trade unions tend to reduce the impact of macroeconomic shocks on both female and male unemployment rates, and this is more so for prime age and older workers. However, higher tax wedges, specifically, personal income taxes and social security contributions from employers, tend to amplify the impact of macro-shocks on unemployment for both women and men, but by a larger extent on the unemployment rates of women and single individuals. Finally, the extensive modification and stability checks for our econometric specifications provide evidence that the summarized key findings are robust, despite the high variations in the sample data during the GFC.

Thus, overall, adverse macroeconomic shocks, in particular labor demand reductions or tightening of monetary policy, do have a differential impact on the unemployment rate by gender, which is relatively stronger for young and less-educated women. Labor market institutions, however, play a role in shaping the severity of impact of these shocks on the unemployment rate of men and women, thereby contributing to the dynamics and demographic composition of the gender unemployment gap.

# Appendix to Chapter 3

## 3.A.1 Data Description

**Dependent variable:**

*Female unemployment rate*

Definition: The percentage of unemployed 15-64 year-old females among the 15-64 year-old female labor force.

Source: Eurostat, unemployment rates by sex, age and educational attainment level (%).

*Male unemployment rate*

Definition: The percentage of unemployed 15-64 year-old males among the 15-64 year-old male labor force.

Source: Eurostat, unemployment rates by sex, age and educational attainment level (%).

*Gender gap in unemployment rates*

Definition: the difference between female and male unemployment rates (15-64 years old).

*Age composition*

Definition: The female/male unemployment rate is shown for three age groups: people aged 15 to 24 (those just entering the labor market following education); people aged 25 to 54; and people aged 55 to 64. For each age group, the female/male unemployment rate is measured in the number of the unemployed in one age group as a percentage of the labor force in the same age group.

Construction: For the missing values, we impute the nearest year's value which is available.

Source: Eurostat, unemployment rates by sex, age and educational attainment level (%); OECD, LFS by sex and age.

*Marital status composition*

Definition: The female/male unemployment rate is disaggregated by marital status. ILOSTAT contains the statistics according to two kinds of marital status: single/widowed/divorced and married/union/cohabiting. For each category, the female/male unemployment rate (restricted to those ages 15-64 inclusive) is measured in the number of the unemployed with one marital status as a percentage of the labor force with the same marital status.

Source: ILOSTAT, unemployment rate by sex, age and marital status (%) – Annual.

*Education composition*

Definition: The female/male unemployment rate is disaggregated by level of educational attainment. ILOSTAT contains the statistics according to three levels of education: basic, intermediate and advanced, corresponding to primary and lower secondary education (levels 1-2); upper secondary and post-secondary non-tertiary education (levels 3 and 4); and tertiary education (levels 5-8) in the International Standard Classification of Education (ISCED) 2011.[41] For each education level, the female/male unemployment rate (restricted to those ages 15-64 inclusive) is measured in the number of the unemployed at one education level as a percentage of the labor force at the same education level.

Source: ILOSTAT, unemployment rate by sex, age and education (%) – Annual.

**Time-varying institutions:**

*The replacement rate of unemployment benefits during the 1st year of unemployment*

Refer to Appendix 2.A.1.

*Unemployment benefit duration*

Refer to Appendix 2.A.1.

*Active labor market policies*

Refer to Appendix 2.A.1 for the construction of public expenditures on ALMPs per unemployed worker as a share of GDP per member of the labor force.

*Employment protection index*

Refer to Appendix 2.A.1.

*Union contract coverage*

Refer to Appendix 2.A.1.

*Union density*

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[41] For further details on categories of educational attainment, see ILOSTAT: indicator description: employment by education; https://ilostat.ilo.org/resources/methods/description-employment-by-education/.

Refer to Appendix 2.A.1.

*Coordination in wage bargaining*

Refer to Appendix 2.A.1.

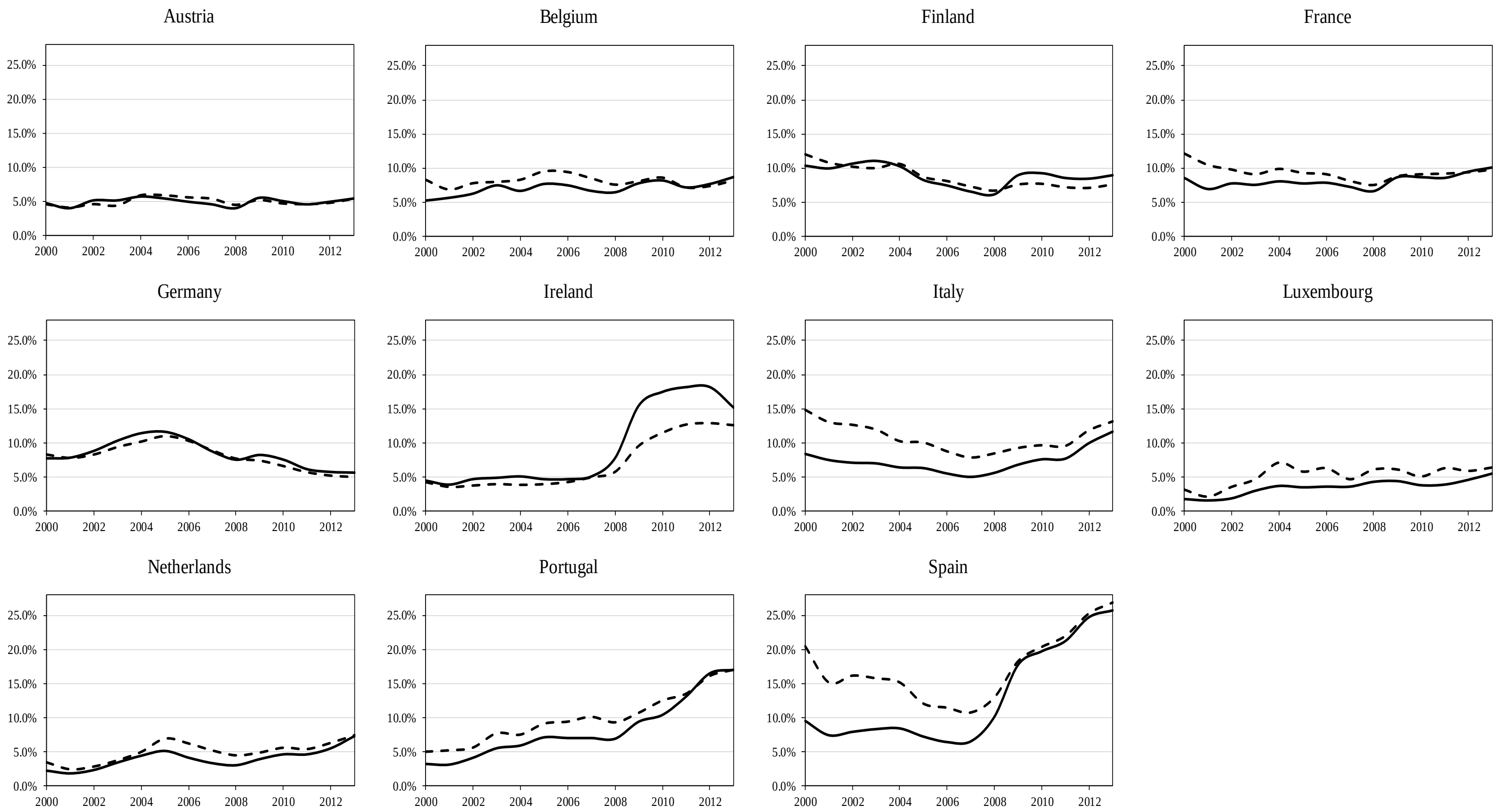
*Tax wedge*

Definition: The labor tax wedge measures the difference between the labor cost to the employer and the corresponding net take-home pay of the employee for a single-earner couple with two children earning 100% of average earnings. The OECD reports the indicators for specific taxes: personal income taxes as a percentage of total labor costs, social security contributions from employers as a percentage of total labor costs, and social security contributions from employees as a percentage of total labor costs.

Source: OECD, Taxing wedges.

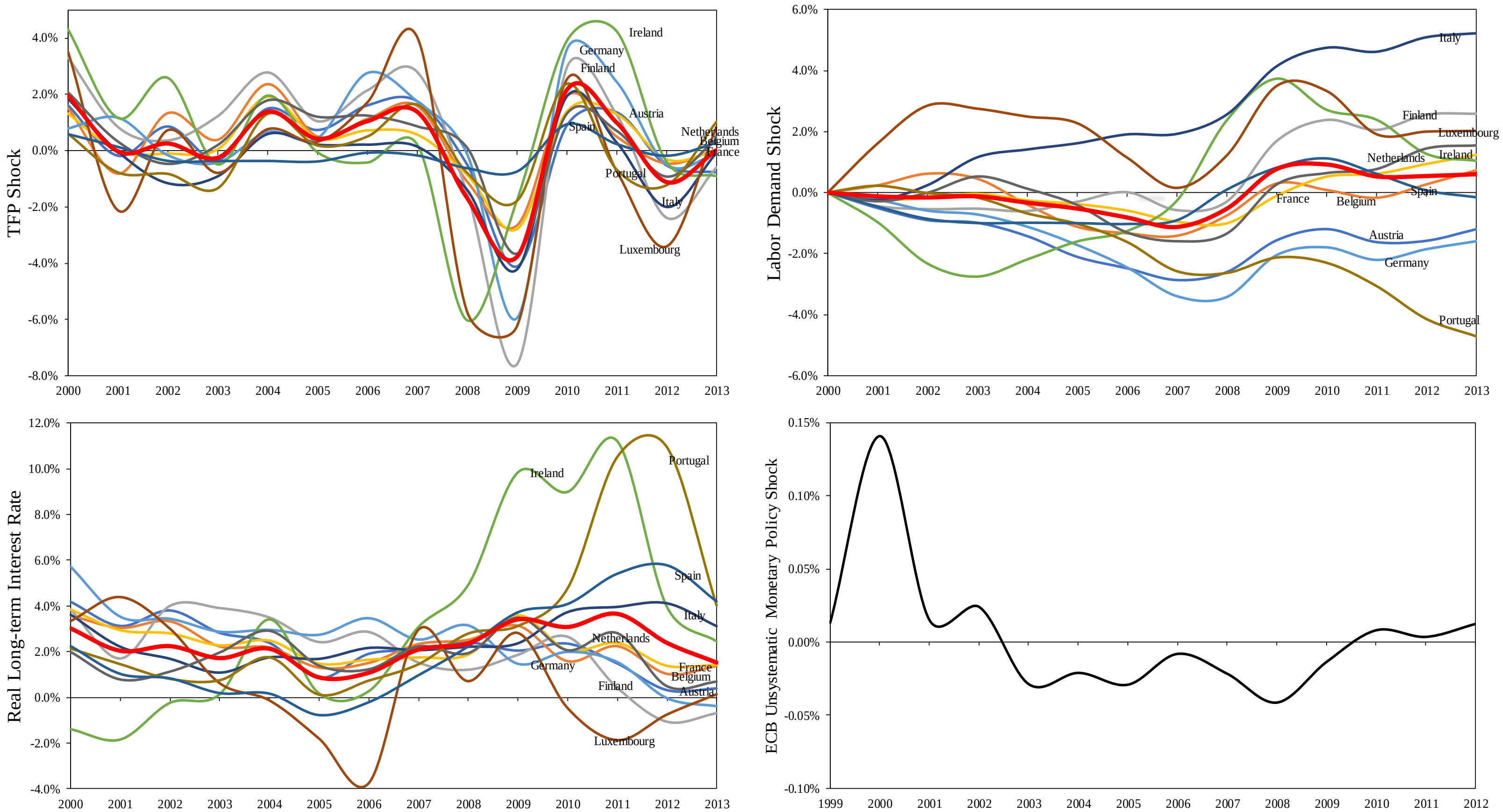
## 3.B.1 Figures

Figure 3.1 Unemployment Rates by Gender Over Time




Note: y-axis: % of the economically active population. The solid line represents the male unemployment rate and the dash line represents the female unemployment rate. See Appendix 3.A.1 for definitions, constructions and sources.

Figure 3.2 Time Paths of Annual Macro Shock Indicators for EA11




Note: Red lines plot unweighted averages. Labor demand shocks are normalized to equal zero in 2000. See Appendix 2.A.1 for definitions, constructions and sources.

### 3.B.2 Tables

Table 3.1 Gender Gaps in Unemployment Rates Across the EA: 2000-2013 Average

| | **Average unemployment rate** | | |
|---|---|---|---|
| **Country** | Female | Male | Difference |
| **Austria** | 4.84 | 4.65 | 0.19 |
| **Belgium** | 8.43 | 7.26 | 1.17 |
| **Finland** | 8.26 | 8.32 | -0.06 |
| **France** | 9.39 | 8.16 | 1.23 |
| **Germany** | 7.95 | 8.29 | -0.34 |
| **Ireland** | 7.48 | 9.47 | -1.99 |
| **Italy** | 10.80 | 7.28 | 3.52 |
| **Luxembourg** | 5.25 | 3.51 | 1.74 |
| **Netherlands** | 5.34 | 4.16 | 1.18 |
| **Portugal** | 10.01 | 8.39 | 1.62 |
| **Spain** | 17.31 | 12.96 | 4.35 |

Source: OECD, LFS by sex and age. All data are calculated based on the working age population (15-64).

Table 3.2 Benchmark Regression Results for Unemployment Rates by Gender

| | Dependent Variables | |
|---|---|---|
| | I | II |
| **Independent Variables** | $u_{ct}^{f}$ | $u_{ct}^{m}$ |
| **Impact of shocks ($\beta$):** | | |
| TFP shock | -0.0348 | 0.0471 |
| | (-0.36) | (0.33) |
| Real interest rate | 0.849*** | 1.324*** |
| | (7.53) | (10.57) |
| Labor demand shock | -0.222*** | -0.205*** |
| | (-3.46) | (-3.36) |
| Lagged ECB unsystematic shock | 0.124*** | 0.0302 |
| | (2.64) | (0.61) |
| **Interaction LMIs/shocks ($\gamma$):** | | |
| Wage determination system | | |
| Union density | -0.0135 | -0.0203*** |
| | (-1.45) | (-2.68) |
| Union coverage | -0.0371** | -0.0219** |
| | (-2.35) | (-2.07) |
| Coordination | -0.0515 | -0.0226 |
| | (-0.69) | (-0.35) |
| The labor tax wedge | | |
| Income taxes | 0.0826** | 0.0785** |
| | (2.05) | (2.39) |
| Employee SSC | -0.00839 | 0.0401 |
| | (-0.23) | (1.44) |
| Employer SSC | 0.133*** | 0.0927*** |
| | (3.45) | (3.66) |
| Employment protection laws | | |
| EPLs on regular contracts | 0.117 | -0.114 |
| | (0.77) | (-1.09) |
| EPLs on temporary contracts | 0.0967 | 0.198* |
| | (0.70) | (1.78) |
| Unemployment benefit system | | |
| Replacement rate, 1st year | -0.0153** | -0.00844 |
| | (-2.14) | (-1.30) |
| Benefit length | -1.907 | -0.107 |
| | (-1.55) | (-0.10) |
| Active labor market policies | 0.0147 | -0.0268 |
| | (0.59) | (-1.05) |
| Time effects | yes | yes |
| Country effects | yes | yes |
| Adjusted $R^2$ | 0.866 | 0.841 |
| Parameters | 40 | 40 |
| Observations | 154 | 154 |

Notes: Nonlinear least squares estimation. The sample is restricted to those ages 15-64 inclusive.
t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation).
* p<0.10 ** p<0.05 *** p<0.01

Table 3.3 Cross-sectional Stability

| | Austria | Belgium | Finland | France | Germany | Ireland | Italy | Luxembourg | Netherlands | Portugal | Spain |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | **Dependent Variable: $u_{ct}^{f}$** | | | | | |
| TFP shock | -0.0412 | -0.0366 | 0.0221 | -0.0865 | 0.00134 | -0.0415 | -0.0195 | -0.00556 | -0.0614 | -0.152 | -0.0741 |
| | (-0.37) | (-0.34) | (0.19) | (-0.89) | (0.02) | (-0.57) | (-0.28) | (-0.04) | (-0.53) | (-1.62) | (-1.08) |
| RIR | 0.912*** | 0.901*** | 0.834*** | 0.782*** | 0.680*** | 0.750*** | 0.775*** | 0.996*** | 0.924*** | 0.888*** | 0.460*** |
| | (7.69) | (7.52) | (6.66) | (6.78) | (5.69) | (6.67) | (6.94) | (7.58) | (7.74) | (7.54) | (4.90) |
| LD shock | -0.242*** | -0.229*** | -0.171*** | -0.196*** | -0.214** | -0.148*** | -0.124*** | -0.369*** | -0.210*** | -0.482*** | -0.222*** |
| | (-3.43) | (-3.39) | (-3.45) | (-3.38) | (-2.59) | (-4.21) | (-3.71) | (-2.97) | (-3.50) | (-4.34) | (-2.76) |
| ECB shock | 0.128** | 0.119** | 0.100** | 0.112** | 0.0947** | 0.158*** | 0.117*** | 0.107** | 0.110** | 0.133** | 0.195** |
| | (2.46) | (2.53) | (2.53) | (2.32) | (2.23) | (2.78) | (2.63) | (2.08) | (2.02) | (2.58) | (2.22) |
| | | | | | | **Dependent Variable: $u_{ct}^{m}$** | | | | | |
| | Austria | Belgium | Finland | France | Germany | Ireland | Italy | Luxembourg | Netherlands | Portugal | Spain |
| TFP shock | 0.0351 | -0.00169 | 0.199** | -0.0995 | 0.140 | -0.0615 | 0.281** | 0.116 | 0.0748 | -0.128 | -0.0776 |
| | (0.23) | (-0.01) | (2.40) | (-0.71) | (1.07) | (-0.52) | (2.61) | (0.68) | (0.41) | (-1.14) | (-1.17) |
| RIR | 1.336*** | 1.248*** | 0.921*** | 1.222*** | 1.189*** | 1.103*** | 1.003*** | 1.536*** | 1.452*** | 1.265*** | 0.663*** |
| | (9.98) | (9.40) | (8.24) | (10.10) | (10.00) | (8.99) | (8.64) | (11.39) | (10.73) | (9.75) | (6.00) |
| LD shock | -0.204*** | -0.148*** | 0.165*** | -0.212*** | -0.146** | -0.127*** | 0.218*** | -0.336*** | -0.226*** | -0.423*** | -0.180*** |
| | (-3.22) | (-3.25) | (3.93) | (-3.68) | (-2.56) | (-4.19) | (3.32) | (-3.19) | (-3.33) | (-4.57) | (-3.23) |
| ECB shock | 0.0314 | 0.0716** | -0.0214 | 0.0115 | -0.0520 | -0.00960 | -0.0274 | -0.103 | 0.0223 | 0.0183 | 0.0878** |
| | (0.59) | (2.02) | (-0.67) | (0.23) | (-1.23) | (-0.22) | (-0.64) | (-1.28) | (0.33) | (0.43) | (2.21) |

Notes: The table gives the coefficient of each shock variable when one country at the time is dropped, as well as the country which is dropped.
Nonlinear least squares estimation. The sample is restricted to those ages 15-64 inclusive.
t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation).
* p<0.10 ** p<0.05 *** p<0.01

## Table 3.4 Cross-sectional Stability, The Female Unemployment Rate

| | **Dependent Variable:** $u_{ct}^{f}$ | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Austria | Belgium | Finland | France | Germany | Ireland | Italy | Luxembourg | Netherlands | Portugal | Spain |
| Union density | -0.0128 | -0.0128 | -0.0403*** | -0.0218* | -0.0225** | -0.00770 | -0.0111 | -0.0141 | -0.0170 | 0.00189 | 0.0101 |
| | (-1.40) | (-1.35) | (-2.78) | (-1.91) | (-2.01) | (-0.69) | (-1.01) | (-1.40) | (-0.94) | (0.26) | (1.06) |
| Union coverage | -0.0333** | -0.0375** | -0.0468** | -0.0415** | -0.000426 | -0.0831*** | -0.0569*** | -0.0294** | -0.0444** | -0.0481*** | -0.0563** |
| | (-2.20) | (-2.25) | (-2.41) | (-2.23) | (-0.03) | (-3.23) | (-2.73) | (-2.24) | (-2.29) | (-2.84) | (-2.55) |
| Coordination | -0.0535 | -0.0413 | -0.00691 | -0.113 | -0.185** | 0.144 | -0.0603 | 0.00352 | -0.0106 | -0.191*** | -0.294** |
| | (-0.73) | (-0.55) | (-0.08) | (-1.25) | (-2.04) | (0.79) | (-0.63) | (0.06) | (-0.13) | (-3.48) | (-2.59) |
| Income taxes | 0.0761* | 0.0865** | 0.0914* | 0.102** | 0.0978** | -0.0147 | 0.138*** | 0.0755* | 0.103* | 0.0216 | 0.0862** |
| | (1.96) | (2.09) | (1.95) | (2.12) | (2.14) | (-0.30) | (2.69) | (1.95) | (1.72) | (0.96) | (2.07) |
| Employee SSC | -0.000750 | 0.00680 | 0.0386 | -0.00403 | -0.200** | -0.212*** | 0.0254 | 0.0207 | -0.00270 | -0.0989** | 0.0521 |
| | (-0.02) | (0.18) | (0.92) | (-0.10) | (-2.48) | (-3.07) | (0.62) | (0.65) | (-0.07) | (-2.26) | (1.22) |
| Employer SSC | 0.125*** | 0.133*** | 0.126*** | 0.164*** | 0.0640 | 0.155*** | 0.188*** | 0.103** | 0.132** | 0.157*** | 0.151*** |
| | (3.42) | (3.23) | (2.96) | (3.48) | (1.57) | (3.54) | (3.58) | (2.36) | (2.25) | (4.24) | (2.93) |
| EPLs regular | 0.0887 | 0.111 | 0.134 | 0.0520 | 0.00691 | 0.281 | 0.259 | 0.0149 | 0.207 | 1.705*** | 0.496** |
| | (0.60) | (0.71) | (0.74) | (0.30) | (0.03) | (1.47) | (1.27) | (0.10) | (1.21) | (2.83) | (2.03) |
| EPLs temporary | 0.0801 | 0.130 | 0.336* | 0.186 | 0.412** | -0.321* | 0.0582 | 0.151 | 0.191 | -0.291** | -0.199* |
| | (0.59) | (0.85) | (1.85) | (1.11) | (2.10) | (-1.68) | (0.36) | (0.77) | (1.22) | (-2.36) | (-1.73) |
| RR, 1st year | -0.0143** | -0.0144** | -0.0190** | -0.0170** | -0.00356 | -0.0252*** | -0.0393*** | -0.00775 | -0.0151** | 0.0207 | -0.0110* |
| | (-2.08) | (-2.02) | (-2.20) | (-2.02) | (-0.47) | (-2.99) | (-3.12) | (-1.41) | (-2.00) | (1.40) | (-1.75) |
| Benefit length | -1.649 | -1.395 | 0.0148 | -1.899 | 0.447 | 2.651 | -6.248*** | -0.982 | -1.520 | 1.141 | -0.139 |
| | (-1.32) | (-0.95) | (0.01) | (-1.31) | (0.30) | (1.28) | (-3.09) | (-0.93) | (-0.96) | (0.88) | (-0.12) |
| ALMPs | 0.0147 | 0.00883 | -0.00513 | 0.0265 | 0.0580** | 0.0434 | 0.0267 | -0.00802 | -0.000280 | 0.0209 | 0.0228 |
| | (0.60) | (0.33) | (-0.16) | (0.86) | (2.03) | (1.60) | (0.82) | (-0.42) | (-0.01) | (1.01) | (1.19) |

Notes: The table gives the coefficient of each institution variable when one country at the time is dropped, as well as the country which is dropped.
Nonlinear least squares estimation. The sample is restricted to those ages 15-64 inclusive.
t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation). * $p<0.10$ ** $p<0.05$ *** $p<0.01$

Table 3.5 Cross-sectional Stability, The Male Unemployment Rate

| | Dependent Variable: $u_{ct}^{m}$ | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Austria | Belgium | Finland | France | Germany | Ireland | Italy | Luxembourg | Netherlands | Portugal | Spain |
| Union density | -0.0202** | -0.0178** | -0.0513*** | -0.0287*** | -0.0329*** | -0.0187** | -0.0165** | -0.00634 | -0.0112 | -0.00473 | 0.0153 |
| | (-2.56) | (-2.09) | (-4.02) | (-3.33) | (-4.29) | (-2.35) | (-2.21) | (-0.83) | (-0.73) | (-0.70) | (1.39) |
| Union coverage | -0.0219* | -0.0329** | 0.0338*** | -0.0231** | 0.00942 | -0.0472** | 0.0262*** | -0.00843 | -0.0289** | -0.0325** | -0.0584*** |
| | (-1.90) | (-2.44) | (3.05) | (-2.02) | (0.85) | (-2.61) | (2.63) | (-1.08) | (-2.08) | (-2.28) | (-3.04) |
| Coordination | -0.0207 | 0.0621 | 0.303*** | -0.117* | -0.0772 | 0.474** | 0.240*** | -0.0545 | 0.00316 | -0.158*** | -0.311*** |
| | (-0.30) | (0.77) | (3.16) | (-1.70) | (-1.20) | (2.39) | (2.74) | (-1.13) | (0.05) | (-3.37) | (-3.10) |
| Income taxes | 0.0798** | 0.105*** | -0.125*** | 0.0869** | 0.0945*** | -0.0623 | -0.0672** | 0.0272 | 0.0592 | -0.00327 | 0.114*** |
| | (2.28) | (2.72) | (-3.58) | (2.49) | (2.97) | (-1.27) | (-2.38) | (0.95) | (1.24) | (-0.14) | (2.70) |
| Employee SSC | 0.0454 | 0.0748** | -0.0899*** | 0.0395 | -0.109** | -0.210*** | -0.0861*** | 0.0720*** | 0.0383 | -0.132*** | 0.143*** |
| | (1.49) | (2.19) | (-2.63) | (1.33) | (-2.46) | (-3.41) | (-2.71) | (3.10) | (1.40) | (-3.12) | (3.20) |
| Employer SSC | 0.0927*** | 0.113*** | 0.00274 | 0.126*** | 0.0159 | 0.0772*** | 0.0340 | 0.00989 | 0.113** | 0.135*** | 0.122*** |
| | (3.51) | (3.46) | (0.08) | (4.52) | (0.57) | (2.84) | (1.06) | (0.30) | (2.37) | (4.83) | (3.16) |
| EPLs regular | -0.121 | -0.0628 | -0.896*** | -0.231** | -0.0667 | 0.106 | -0.594*** | -0.396*** | -0.0531 | 1.754*** | 0.554** |
| | (-1.08) | (-0.45) | (-3.57) | (-2.07) | (-0.45) | (0.73) | (-2.86) | (-3.69) | (-0.47) | (2.90) | (2.39) |
| EPLs temporary | 0.199* | 0.327** | -0.101 | 0.252** | 0.560*** | -0.223 | -0.140 | 0.492*** | 0.201* | -0.426*** | -0.235 |
| | (1.68) | (2.33) | (-1.06) | (2.05) | (4.30) | (-1.22) | (-1.58) | (2.78) | (1.73) | (-3.09) | (-1.60) |
| RR, 1st year | -0.00792 | -0.00488 | 0.000614 | -0.0113* | 0.00423 | -0.0179*** | -0.00377 | -0.00242 | -0.00756 | 0.0432*** | -0.0161** |
| | (-1.17) | (-0.67) | (0.14) | (-1.67) | (0.63) | (-2.64) | (-0.89) | (-0.45) | (-1.21) | (2.63) | (-2.18) |
| Benefit length | 0.0235 | 1.534 | 0.553 | -0.245 | 3.872*** | 2.911 | -1.257 | -0.276 | 0.469 | 2.233 | 0.242 |
| | (0.02) | (1.07) | (0.52) | (-0.21) | (3.10) | (1.60) | (-1.13) | (-0.32) | (0.39) | (1.48) | (0.18) |
| ALMPs | -0.0285 | -0.0703* | -0.0439** | -0.00482 | 0.00894 | 0.00229 | -0.0285 | -0.00389 | -0.0441 | -0.0367* | -0.0198 |
| | (-1.04) | (-1.94) | (-2.04) | (-0.18) | (0.48) | (0.09) | (-1.48) | (-0.23) | (-1.52) | (-1.82) | (-0.67) |

Notes: The table gives the coefficient of each institution variable when one country at the time is dropped, as well as the country which is dropped.
Nonlinear least squares estimation. The sample is restricted to those ages 15-64 inclusive.
t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation). * p<0.10 ** p<0.05 *** p<0.01

## Table 3.6 Period Stability

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dependent Variable: $u_{ct}^{f}$** | | | | | | | | | | | | | | |
| TFP shock | -0.0846 | -0.0610 | -0.00595 | -0.0230 | 0.00764 | -0.0322 | -0.0251 | -0.0373 | -0.0347 | -0.0316 | -0.0197 | -0.0361 | -0.0686 | -0.0712 |
| | (-0.76) | (-0.65) | (-0.06) | (-0.23) | (0.07) | (-0.31) | (-0.24) | (-0.39) | (-0.36) | (-0.22) | (-0.18) | (-0.37) | (-0.73) | (-0.89) |
| RIR | 0.889*** | 0.732*** | 0.855*** | 0.906*** | 0.875*** | 0.870*** | 0.854*** | 0.817*** | 0.836*** | 0.882*** | 0.883*** | 0.859*** | 0.821*** | 0.787*** |
| | (7.41) | (6.52) | (7.19) | (7.66) | (7.76) | (7.38) | (7.17) | (7.11) | (7.22) | (7.21) | (7.33) | (7.20) | (6.52) | (7.16) |
| LD shock | -0.247*** | -0.173*** | -0.181*** | -0.213*** | -0.212*** | -0.253*** | -0.252*** | -0.214*** | -0.210*** | -0.252*** | -0.248*** | -0.213*** | -0.223*** | -0.312*** |
| | (-3.32) | (-2.96) | (-3.77) | (-3.58) | (-3.45) | (-3.32) | (-3.20) | (-3.45) | (-3.46) | (-3.38) | (-3.58) | (-2.82) | (-3.09) | (-3.73) |
| ECB shock | 0.133** | 0.443*** | 0.100*** | 0.110** | 0.148** | 0.132** | 0.125** | 0.116*** | 0.110** | 0.115** | 0.108** | 0.128*** | 0.134** | 0.107*** |
| | (2.55) | (2.66) | (2.91) | (2.51) | (2.46) | (2.48) | (2.40) | (2.63) | (2.53) | (2.29) | (2.49) | (2.65) | (2.52) | (2.72) |
| **Dependent Variable: $u_{ct}^{m}$** | | | | | | | | | | | | | | |
| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
| TFP shock | 0.0719 | 0.211** | 0.259** | 0.0667 | 0.296* | 0.0778 | 0.0457 | 0.0168 | 0.111 | -0.105 | 0.00620 | 0.00733 | -0.0958 | 0.218** |
| | (0.45) | (2.22) | (2.45) | (0.45) | (1.76) | (0.51) | (0.31) | (0.12) | (0.70) | (-0.53) | (0.04) | (0.06) | (-0.74) | (2.17) |
| RIR | 1.428*** | 0.938*** | 1.000*** | 1.355*** | 1.307*** | 1.367*** | 1.357*** | 1.297*** | 1.336*** | 1.421*** | 1.369*** | 1.296*** | 1.311*** | 0.852*** |
| | (10.35) | (8.17) | (8.76) | (10.37) | (10.56) | (10.45) | (10.27) | (10.04) | (10.38) | (10.55) | (10.24) | (9.90) | (9.64) | (7.69) |
| LD shock | -0.209*** | 0.189*** | 0.239*** | -0.221*** | -0.180*** | -0.219*** | -0.246*** | -0.193*** | -0.217*** | -0.236*** | -0.346*** | -0.124*** | -0.152*** | 0.224*** |
| | (-3.16) | (3.52) | (3.75) | (-3.25) | (-2.64) | (-3.15) | (-3.29) | (-3.30) | (-3.30) | (-3.53) | (-4.34) | (-3.33) | (-2.63) | (3.24) |
| ECB shock | -0.0184 | 0.0102 | -0.0640 | 0.0175 | -0.0140 | 0.0281 | 0.0268 | 0.0445 | 0.0154 | -0.00919 | 0.0145 | 0.0775** | 0.0548 | -0.0202 |
| | (-0.29) | (0.11) | (-1.48) | (0.32) | (-0.22) | (0.50) | (0.48) | (0.96) | (0.28) | (-0.16) | (0.31) | (2.29) | (1.41) | (-0.55) |

Notes: The table gives the coefficient of each shock variable when one year at the time is removed, as well as the year which is removed.
Nonlinear least squares estimation. The sample is restricted to those ages 15-64 inclusive.
t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation).
* $p<0.10$ ** $p<0.05$ *** $p<0.01$

## Table 3.7 Period Stability, The Female Unemployment Rate

| | Dependent Variable: $u_{ct}^{f}$ | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
| Union density | -0.0116 | -0.0209* | -0.0178* | -0.0155 | -0.0132 | -0.00927 | -0.0104 | -0.0130 | -0.0146 | -0.0124 | -0.0138 | -0.0117 | -0.0114 | -0.0166* |
| | (-1.31) | (-1.88) | (-1.76) | (-1.64) | (-1.43) | (-1.03) | (-1.14) | (-1.34) | (-1.44) | (-1.33) | (-1.51) | (-1.16) | (-1.10) | (-1.95) |
| Union coverage | -0.0296** | -0.0443** | -0.057*** | -0.0367** | -0.0359** | -0.0312** | -0.0317** | -0.0397** | -0.0437** | -0.0325** | -0.0310** | -0.0407** | -0.0344** | -0.0247** |
| | (-2.10) | (-2.15) | (-2.73) | (-2.34) | (-2.32) | (-2.15) | (-2.13) | (-2.34) | (-2.41) | (-2.06) | (-2.08) | (-2.20) | (-2.07) | (-2.10) |
| Coordination | -0.0738 | 0.0434 | 0.00436 | -0.0431 | 0.0450 | -0.0784 | -0.0683 | -0.0444 | -0.0634 | -0.101 | -0.0704 | -0.0521 | -0.0682 | -0.0922 |
| | (-1.03) | (0.46) | (0.05) | (-0.56) | (0.53) | (-1.09) | (-0.94) | (-0.54) | (-0.70) | (-1.32) | (-0.92) | (-0.66) | (-0.91) | (-1.60) |
| Income taxes | 0.0613* | 0.0923* | 0.129** | 0.0924** | 0.0661* | 0.0685* | 0.0715* | 0.0873** | 0.100** | 0.0714* | 0.0775** | 0.0865* | 0.0726* | 0.0717** |
| | (1.69) | (1.81) | (2.57) | (2.26) | (1.66) | (1.87) | (1.87) | (2.06) | (2.08) | (1.83) | (2.16) | (1.81) | (1.75) | (2.32) |
| Employee SSC | -0.000160 | -0.0491 | 0.0265 | -0.000377 | -0.0285 | 0.0000069 | -0.00167 | -0.00403 | 0.00205 | -0.00746 | 0.00278 | -0.00898 | -0.0352 | -0.0496 |
| | (-0.00) | (-1.19) | (0.65) | (-0.01) | (-0.77) | (0.00) | (-0.05) | (-0.10) | (0.05) | (-0.20) | (0.08) | (-0.22) | (-0.87) | (-1.23) |
| Employer SSC | 0.122*** | 0.115** | 0.163*** | 0.130*** | 0.119*** | 0.129*** | 0.125*** | 0.138*** | 0.146*** | 0.135*** | 0.122*** | 0.138*** | 0.128*** | 0.118*** |
| | (3.44) | (2.49) | (3.61) | (3.46) | (3.08) | (3.38) | (3.21) | (3.33) | (3.48) | (3.23) | (3.18) | (3.30) | (3.07) | (3.53) |
| EPLs regular | 0.0304 | 0.276 | 0.287 | 0.129 | 0.133 | 0.0620 | 0.0795 | 0.154 | 0.148 | 0.0497 | 0.110 | 0.174 | 0.157 | -0.0563 |
| | (0.22) | (1.27) | (1.46) | (0.82) | (0.85) | (0.45) | (0.54) | (0.94) | (0.89) | (0.35) | (0.72) | (1.02) | (0.94) | (-0.53) |
| EPLs temporary | 0.0395 | 0.237 | 0.294* | 0.134 | 0.0937 | 0.0320 | 0.0681 | 0.119 | 0.155 | 0.0474 | 0.134 | 0.0895 | 0.00806 | -0.0315 |
| | (0.30) | (1.30) | (1.69) | (0.94) | (0.70) | (0.25) | (0.52) | (0.82) | (0.98) | (0.34) | (1.01) | (0.55) | (0.06) | (-0.32) |
| RR, 1st year | -0.0150** | -0.0125* | -0.0161** | -0.0173** | -0.0149** | -0.0139** | -0.0131* | -0.0159** | -0.0153** | -0.0159** | -0.0252** | -0.0141* | -0.0144* | -0.0129** |
| | (-2.21) | (-1.71) | (-2.01) | (-2.32) | (-2.06) | (-2.04) | (-1.90) | (-2.13) | (-2.01) | (-2.23) | (-2.04) | (-1.73) | (-1.97) | (-2.37) |
| Benefit length | -1.737 | -0.113 | -1.010 | -2.007 | -1.667 | -1.947 | -1.688 | -1.638 | -1.843 | -2.079* | -1.841 | -1.985 | -2.543* | -3.504*** |
| | (-1.45) | (-0.10) | (-0.72) | (-1.56) | (-1.39) | (-1.60) | (-1.40) | (-1.27) | (-1.38) | (-1.67) | (-1.46) | (-1.52) | (-1.86) | (-2.82) |
| ALMPs | 0.00935 | 0.0117 | -0.0110 | 0.0131 | 0.0222 | 0.0193 | 0.0127 | 0.00467 | 0.0150 | 0.0166 | 0.00919 | 0.0122 | 0.0332 | 0.0217 |
| | (0.40) | (0.36) | (-0.33) | (0.49) | (0.92) | (0.83) | (0.52) | (0.17) | (0.55) | (0.68) | (0.37) | (0.47) | (1.35) | (1.16) |

Notes: The table gives the coefficient of each institution variable when one year at the time is removed, as well as the year which is removed.
Nonlinear least squares estimation. The sample is restricted to those ages 15-64 inclusive.
t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation). * $p<0.10$ ** $p<0.05$ *** $p<0.01$

## Table 3.8 Period Stability, The Male Unemployment Rate

| | Dependent Variable: $u_{ct}^{m}$ | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
| Union density | -0.022*** | -0.0172** | -0.020*** | -0.0191** | -0.022*** | -0.0183** | -0.0165** | -0.0194** | -0.021*** | -0.022*** | -0.0135** | -0.026*** | -0.0197** | -0.0207** |
| | (-2.95) | (-2.00) | (-2.69) | (-2.52) | (-2.88) | (-2.42) | (-2.23) | (-2.46) | (-2.69) | (-2.84) | (-2.05) | (-3.02) | (-2.32) | (-2.35) |
| Union coverage | -0.0204* | 0.0341*** | 0.0365*** | -0.0194* | -0.0157 | -0.0187* | -0.0176* | -0.0226* | -0.0214* | -0.0204* | -0.0122 | -0.040*** | -0.0207* | 0.0319*** |
| | (-1.95) | (3.04) | (3.77) | (-1.89) | (-1.52) | (-1.82) | (-1.80) | (-1.97) | (-1.97) | (-1.91) | (-1.51) | (-2.74) | (-1.80) | (2.88) |
| Coordination | -0.0188 | 0.327*** | 0.273*** | -0.0472 | 0.0598 | -0.0353 | -0.0486 | 0.00913 | -0.0445 | -0.0686 | -0.0941* | 0.0878 | -0.0386 | 0.244** |
| | (-0.30) | (3.05) | (3.15) | (-0.74) | (0.78) | (-0.55) | (-0.79) | (0.13) | (-0.62) | (-1.05) | (-1.73) | (1.15) | (-0.59) | (2.39) |
| Income taxes | 0.0656** | -0.10*** | -0.084*** | 0.0702** | 0.0513 | 0.0701** | 0.0652** | 0.0770** | 0.0785** | 0.0813** | 0.0466** | 0.149*** | 0.0779** | -0.094*** |
| | (2.03) | (-2.90) | (-3.01) | (2.19) | (1.45) | (2.17) | (2.11) | (2.21) | (2.23) | (2.47) | (2.00) | (3.42) | (2.24) | (-2.84) |
| Employee SSC | 0.0439 | -0.115*** | -0.089*** | 0.0364 | 0.00397 | 0.0422 | 0.0403 | 0.0395 | 0.0427 | 0.0493* | 0.0383 | 0.0824** | 0.0273 | -0.153*** |
| | (1.57) | (-3.04) | (-2.86) | (1.31) | (0.13) | (1.49) | (1.47) | (1.33) | (1.45) | (1.84) | (1.57) | (2.60) | (0.95) | (-3.73) |
| Employer SSC | 0.0932*** | 0.0186 | 0.00593 | 0.0921*** | 0.0778*** | 0.0918*** | 0.0873*** | 0.0918*** | 0.0935*** | 0.0920*** | 0.0833*** | 0.0884*** | 0.0898*** | 0.0147 |
| | (3.74) | (0.52) | (0.19) | (3.69) | (2.92) | (3.65) | (3.56) | (3.35) | (3.65) | (3.54) | (3.71) | (2.83) | (3.22) | (0.42) |
| EPLs regular | -0.155 | -0.786*** | -0.717*** | -0.124 | -0.118 | -0.142 | -0.143 | -0.0786 | -0.132 | -0.153 | -0.0987 | -0.00830 | -0.0205 | -0.397 |
| | (-1.49) | (-3.26) | (-3.57) | (-1.18) | (-1.05) | (-1.41) | (-1.47) | (-0.69) | (-1.27) | (-1.54) | (-1.09) | (-0.05) | (-0.15) | (-1.37) |
| EPLs temporary | 0.173 | -0.153 | -0.0984 | 0.158 | 0.151 | 0.169 | 0.174 | 0.211* | 0.194* | 0.206* | 0.148 | 0.404*** | 0.169 | -0.0404 |
| | (1.61) | (-1.40) | (-1.12) | (1.43) | (1.43) | (1.59) | (1.63) | (1.81) | (1.68) | (1.77) | (1.55) | (2.84) | (1.43) | (-0.43) |
| RR, 1st year | -0.00584 | 0.00159 | 0.00237 | -0.0104 | -0.00555 | -0.00751 | -0.00882 | -0.00934 | -0.00795 | -0.00857 | -0.025*** | -0.00648 | -0.0139** | 0.000458 |
| | (-0.86) | (0.38) | (0.69) | (-1.57) | (-0.80) | (-1.15) | (-1.42) | (-1.38) | (-1.19) | (-1.40) | (-2.73) | (-0.56) | (-2.17) | (0.12) |
| Benefit length | 0.603 | -0.454 | 0.311 | -0.495 | 0.276 | -0.0240 | -0.274 | 0.166 | -0.147 | -0.0226 | -0.950 | 0.756 | -0.883 | 0.997 |
| | (0.55) | (-0.41) | (0.34) | (-0.45) | (0.28) | (-0.02) | (-0.26) | (0.15) | (-0.14) | (-0.02) | (-0.96) | (0.65) | (-0.76) | (0.90) |
| ALMPs | -0.00953 | -0.0483 | -0.0360* | -0.0157 | -0.00694 | -0.0202 | -0.0208 | -0.0402 | -0.0179 | -0.0167 | -0.0149 | -0.0773** | -0.0431 | -0.0325 |
| | (-0.40) | (-1.63) | (-1.95) | (-0.65) | (-0.31) | (-0.82) | (-0.85) | (-1.38) | (-0.73) | (-0.70) | (-0.75) | (-2.38) | (-1.56) | (-1.56) |

Notes: The table gives the coefficient of each institution variable when one year at the time is removed, as well as the year which is removed.
Nonlinear least squares estimation. The sample is restricted to those ages 15-64 inclusive.
t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation). * p<0.10 ** p<0.05 *** p<0.01

Table 3.9 Test for Endogeneity. Lagged Shocks

| | Dependent Variables | |
|---|---|---|
| | I | II |
| **Independent Variables** | $u_{ct}^{f}$ | $u_{ct}^{m}$ |
| **Impact of shocks ($\beta$):** | | |
| TFP shock | -0.103 | -0.000999 |
| | (-1.34) | (-0.01) |
| Real interest rate | 1.043*** | 1.006*** |
| | (9.78) | (8.74) |
| Labor demand shock | -0.399*** | 0.451*** |
| | (-4.72) | (4.36) |
| Lagged ECB unsystematic shock | 0.0522* | -0.0655 |
| | (1.88) | (-1.53) |
| **Interaction LMIs/shocks ($\gamma$):** | | |
| Union density | -0.0181*** | -0.0227*** |
| | (-2.76) | (-3.14) |
| Union coverage | -0.0124* | 0.0172*** |
| | (-1.78) | (2.68) |
| Coordination | -0.147*** | 0.0931 |
| | (-3.40) | (1.45) |
| Income taxes | 0.0477** | -0.0672*** |
| | (2.47) | (-3.13) |
| Employee SSC | -0.0287 | -0.146*** |
| | (-1.00) | (-4.61) |
| Employer SSC | 0.108*** | 0.0279 |
| | (4.99) | (1.12) |
| EPLs on regular contracts | -0.185*** | 0.159 |
| | (-2.93) | (0.86) |
| EPLs on temporary contracts | -0.0281 | -0.0144 |
| | (-0.40) | (-0.20) |
| Replacement rate, 1st year | -0.0152*** | 0.00412 |
| | (-4.07) | (1.65) |
| Benefit length | -3.734*** | 1.581** |
| | (-3.95) | (2.06) |
| Active labor market policies | 0.0175 | -0.0227 |
| | (1.12) | (-1.64) |
| Time and country effects | yes | yes |
| Adjusted $R^2$ | 0.910 | 0.867 |
| Parameters | 40 | 40 |
| Observations | 143 | 143 |

Notes: This table shows the sensitivity of the results in Table 3.2 by replacing shocks with their one period lagged values.
Nonlinear least squares estimation. The sample is restricted to those ages 15-64 inclusive.
t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation).
* p<0.10 ** p<0.05 *** p<0.01

## Table 3.10 Test for Endogeneity. Lagged Institutions

| | Dependent Variables | |
|---|---|---|
| | I | II |
| **Independent Variables** | $u_{ct}^{f}$ | $u_{ct}^{m}$ |
| **Impact of shocks ($\beta$):** | | |
| TFP shock | 0.239 | 0.0635 |
| | (1.62) | (0.42) |
| Real interest rate | 0.983*** | 1.431*** |
| | (8.07) | (10.35) |
| Labor demand shock | -0.713*** | -0.181*** |
| | (-4.42) | (-3.06) |
| Lagged ECB unsystematic shock | 0.125** | 0.0303 |
| | (2.16) | (0.58) |
| **Interaction LMIs/shocks ($\gamma$):** | | |
| Union density | -0.00783 | -0.0238*** |
| | (-1.41) | (-3.06) |
| Union coverage | -0.00383 | -0.0251** |
| | (-0.71) | (-2.05) |
| Coordination | -0.0971*** | 0.0458 |
| | (-3.01) | (0.84) |
| Income taxes | -0.00201 | 0.0783** |
| | (-0.15) | (2.06) |
| Employee SSC | -0.0275 | 0.0511* |
| | (-0.92) | (1.71) |
| Employer SSC | 0.0929*** | 0.0878*** |
| | (4.32) | (3.38) |
| EPLs on regular contracts | 0.0259 | -0.0449 |
| | (0.25) | (-0.34) |
| EPLs on temporary contracts | -0.138* | 0.222* |
| | (-1.84) | (1.90) |
| Replacement rate, 1st year | 0.0121* | -0.00814 |
| | (1.74) | (-1.06) |
| Benefit length | -0.633 | 0.855 |
| | (-0.97) | (0.79) |
| Active labor market policies | 0.00656 | -0.0430 |
| | (0.64) | (-1.56) |
| Time and country effects | yes | yes |
| Adjusted $R^2$ | 0.855 | 0.850 |
| Parameters | 40 | 40 |
| Observations | 143 | 143 |

Notes: This table shows the sensitivity of the results in Table 3.2 by replacing labor market institutions with their one period lagged values.
Nonlinear least squares estimation. The sample is restricted to those ages 15-64 inclusive.
t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation).
* p<0.10 ** p<0.05 *** p<0.01

Table 3.11 Test for Endogeneity. Restriction on Variations in Institutions

| | Dependent Variables | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| **Independent Variables** | $u_{ct}^{f}$ | $u_{ct}^{m}$ | $u_{ct}^{f}$ | $u_{ct}^{m}$ |
| **Impact of shocks ($\beta$):** | | | | |
| TFP shock | -0.127 | 0.0764 | 0.0232 | 0.127 |
| | (-1.43) | (0.54) | (0.22) | (1.09) |
| Real interest rate | 0.945*** | 1.339*** | 0.967*** | 1.155*** |
| | (7.98) | (10.68) | (8.64) | (8.82) |
| Labor demand shock | -0.475*** | -0.188*** | -0.613*** | -0.339** |
| | (-4.60) | (-4.02) | (-4.09) | (-2.22) |
| Lagged ECB unsystematic shock | 0.0797** | 0.0515 | 0.160*** | -0.0217 |
| | (2.22) | (1.21) | (2.80) | (-0.43) |
| **Interaction LMIs/shocks ($\gamma$):** | | | | |
| Union density | -0.00833 | -0.0267*** | -0.601*** | -0.936*** |
| | (-1.12) | (-3.41) | (-3.50) | (-5.09) |
| Union coverage | -0.0206** | -0.0327** | 0.0589** | 0.0933*** |
| | (-2.08) | (-2.53) | (2.18) | (2.97) |
| Coordination | -0.188*** | 0.0632 | 2.385*** | 2.416*** |
| | (-3.58) | (0.86) | (3.20) | (2.98) |
| Income taxes | 0.0524** | 0.117*** | 1.720*** | 2.767*** |
| | (2.18) | (3.22) | (3.44) | (5.23) |
| Employee SSC | 0.0207 | 0.0636** | 0.625*** | 0.991*** |
| | (0.70) | (2.18) | (3.58) | (5.37) |
| Employer SSC | 0.113*** | 0.0936*** | -0.897*** | -1.598*** |
| | (3.85) | (3.20) | (-3.06) | (-4.91) |
| EPLs on regular contracts | -0.0894 | -0.0423 | -0.663*** | -0.178 |
| | (-1.02) | (-0.36) | (-4.36) | (-1.19) |
| EPLs on temporary contracts | 0.0859 | 0.324** | 1.017** | 2.076*** |
| | (1.00) | (2.60) | (2.25) | (4.38) |
| Replacement rate, 1st year | -0.0356*** | -0.00738 | 0.156*** | 0.192*** |
| | (-3.64) | (-0.69) | (3.41) | (4.05) |
| Benefit length | -3.154*** | 0.738 | -1.123 | 17.20 |
| | (-3.08) | (0.68) | (.) | (.) |
| Active labor market policies | 0.0347** | -0.0562* | -0.927*** | -1.516*** |
| | (2.16) | (-1.86) | (-3.49) | (-5.21) |
| Time and country effects | yes | yes | yes | yes |
| Adjusted $R^2$ | 0.878 | 0.845 | 0.874 | 0.872 |
| Parameters | 40 | 40 | 40 | 40 |
| Observations | 154 | 154 | 154 | 154 |

Notes: This table shows the sensitivity test on endogeneity of institutions for the results in Table 3.2. Columns I and II present the re-estimation results of Equation (3.1) using the values of the institution measures in the first year of each 3-year interval. Columns III and IV present the re-estimation results of Equation (3.1) by fixing the institution measures to their values in the first year of the observation period, 2000.
Nonlinear least squares estimation. The sample is restricted to those ages 15-64 inclusive.
t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation).
* p<0.10 ** p<0.05 *** p<0.01

Table 3.12 Pairwise Correlations Across Labor Market Institutions

| | Union density | Union coverage | Coordination | Income taxes | Employee SSC | Employer SSC | EPLs regular | EPLs temporary | RR, 1st year | Benefit length | ALMPs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Union density | 1.00 | 0.08 | 0.40 | 0.69 | -0.24 | -0.11 | -0.35 | -0.16 | -0.19 | 0.27 | -0.07 |
| Union coverage | | 1.00 | 0.08 | 0.41 | 0.23 | 0.70 | 0.24 | 0.22 | 0.04 | 0.13 | 0.04 |
| Coordination | | | 1.00 | 0.41 | 0.22 | -0.17 | -0.38 | -0.52 | -0.29 | 0.52 | 0.30 |
| Income taxes | | | | 1.00 | -0.32 | 0.08 | -0.31 | -0.35 | -0.41 | 0.37 | 0.09 |
| Employee SSC | | | | | 1.00 | -0.05 | 0.29 | -0.09 | 0.33 | 0.05 | 0.31 |
| Employer SSC | | | | | | 1.00 | 0.11 | 0.46 | -0.12 | -0.15 | -0.40 |
| EPLs regular | | | | | | | 1.00 | 0.14 | 0.46 | -0.44 | 0.02 |
| EPLs temporary | | | | | | | | 1.00 | 0.36 | -0.38 | -0.30 |
| RR, 1st year | | | | | | | | | 1.00 | -0.16 | -0.01 |
| Benefit length | | | | | | | | | | 1.00 | 0.35 |
| ALMPs | | | | | | | | | | | 1.00 |

Table 3.13 Test for Multicollinearity

| | Union density | Union coverage | Coordination | Income taxes | Employee SSC | Employer SSC | EPLs regular | EPLs temporary | RR, 1st year | Benefit length | ALMPs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dependent Variable: $u_{ct}^{f}$** | | | | | | | | | | | |
| TFP shock | 0.152 | 0.0809 | 0.0932 | 0.0160 | 0.0310 | 0.271* | 0.0798 | 0.0759 | 0.0325 | 0.0962 | 0.0663 |
| | (1.05) | (0.58) | (0.64) | (0.12) | (0.25) | (1.72) | (0.57) | (0.54) | (0.26) | (0.68) | (0.48) |
| RIR | 0.747*** | 0.702*** | 0.763*** | 0.786*** | 0.702*** | 0.865*** | 0.736*** | 0.757*** | 0.809*** | 0.726*** | 0.765*** |
| | (9.29) | (7.90) | (7.51) | (9.25) | (7.53) | (9.40) | (8.81) | (8.60) | (9.68) | (8.28) | (8.23) |
| LD shock | -0.441*** | -0.467*** | -0.398*** | -0.413*** | -0.283** | -0.445*** | -0.383** | -0.431** | -0.204*** | -0.390*** | -0.369*** |
| | (-2.83) | (-3.06) | (-2.69) | (-3.18) | (-2.16) | (-3.55) | (-2.57) | (-2.46) | (-3.29) | (-2.82) | (-2.66) |
| ECB shock | -0.0347 | -0.758 | 1.290 | 0.475 | 0.544 | 0.220** | -29.08 | 1.219 | 0.895* | 0.147 | -0.0419 |
| | (-0.24) | (-0.35) | (0.39) | (1.49) | (1.31) | (2.38) | (.) | (0.32) | (1.72) | (0.16) | (-0.22) |
| Institution | -0.0141** | -0.00232 | 0.0209 | 0.0307** | -0.0513 | 0.0621*** | 0.00205 | -0.0272 | -0.0133** | 0.434 | 0.0246 |
| | (-2.36) | (-0.43) | (0.43) | (2.08) | (-1.40) | (5.09) | (1.20) | (-0.33) | (-2.06) | (0.49) | (1.22) |
| **Dependent Variable: $u_{ct}^{m}$** | | | | | | | | | | | |
| | Union density | Union coverage | Coordination | Income taxes | Employee SSC | Employer SSC | EPLs regular | EPLs temporary | RR, 1st year | Benefit length | ALMPs |
| TFP shock | 0.342** | 0.373** | 0.322** | 0.218 | 0.209 | 0.389** | 0.221 | 0.238 | 0.158 | 0.262* | 0.244* |
| | (2.31) | (2.24) | (2.30) | (1.50) | (1.52) | (2.26) | (1.54) | (1.64) | (1.16) | (1.78) | (1.76) |
| RIR | 0.992*** | 1.091*** | 1.103*** | 1.051*** | 0.955*** | 1.176*** | 1.003*** | 1.034*** | 1.112*** | 1.012*** | 0.896*** |
| | (11.79) | (9.76) | (10.45) | (11.87) | (9.84) | (11.83) | (11.08) | (11.24) | (12.90) | (11.55) | (9.39) |
| LD shock | -0.0406 | 0.0627 | 0.0203 | -0.0411 | 0.0137 | -0.0621 | -0.0301 | -0.0778 | -0.0864 | -0.0722 | 0.0939 |
| | (-0.25) | (0.40) | (0.21) | (-0.28) | (0.09) | (-0.43) | (-0.15) | (-0.45) | (-0.80) | (-0.48) | (0.79) |
| ECB shock | -0.181 | 0.157 | 0.403 | 1.235 | 0.540 | 0.0833 | 0.594 | 1.580 | 1.045 | 0.531 | 0.0631 |
| | (-1.17) | (0.39) | (1.29) | (0.93) | (1.25) | (0.62) | (1.05) | (0.59) | (1.61) | (0.72) | (0.74) |
| Institution | -0.0144*** | 0.00609* | 0.137** | 0.0154 | -0.0374 | 0.0419*** | -0.117 | -0.0461 | -0.0101** | 0.720 | -0.0549* |
| | (-2.66) | (1.70) | (2.07) | (1.01) | (-1.54) | (4.19) | (-1.38) | (-0.61) | (-2.02) | (0.98) | (-1.92) |

Notes: The table gives the coefficient of each shock variable when only one institution is involved in the estimation, as well as the institution which is involved and its shock-interaction coefficient. Nonlinear least squares estimation. The sample is restricted to those ages 15-64 inclusive.
t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation). * $p<0.10$ ** $p<0.05$ *** $p<0.01$

Table 3.14 Unemployment Rates by Gender and Age in the EA: 2000-2013 Average

| | Average unemployment rate | | | | | |
|---|---|---|---|---|---|---|
| **Country** | Female 15-24 | Female 25-54 | Female 55-64 | Male 15-24 | Male 25-54 | Male 55-64 |
| **Austria** | 8.77 | 4.44 | 3.50 | 9.20 | 4.29 | 4.65 |
| **Belgium** | 19.74 | 7.18 | 4.59 | 18.64 | 6.20 | 3.95 |
| **Finland** | 21.53 | 6.62 | 6.51 | 23.08 | 6.63 | 7.88 |
| **France** | 21.29 | 8.49 | 5.34 | 20.06 | 6.93 | 5.64 |
| **Germany** | 9.13 | 7.46 | 10.22 | 11.68 | 7.64 | 9.71 |
| **Ireland** | 12.46 | 6.14 | 4.60 | 18.17 | 8.08 | 5.61 |
| **Italy** | 30.59 | 9.60 | 3.63 | 24.96 | 6.04 | 4.19 |
| **Luxembourg** | 14.84 | 4.65 | 2.51 | 12.84 | 2.90 | 1.94 |
| **Netherlands** | 8.65 | 4.26 | 3.81 | 9.17 | 2.89 | 3.86 |
| **Portugal** | 21.65 | 9.11 | 6.22 | 17.42 | 7.26 | 7.74 |
| **Spain** | 32.62 | 15.88 | 11.40 | 28.76 | 11.49 | 9.59 |

Source: Eurostat, unemployment rates by sex, age and educational attainment level (%); OECD, LFS by sex and age.

Table 3.15 Regression Results for Unemployment Rates by Gender and Age

| | Dependent Variables | | | | | |
|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI |
| **Independent Variables** | $u_{ct}^{f}$ 15-24 | $u_{ct}^{f}$ 25-54 | $u_{ct}^{f}$ 55-64 | $u_{ct}^{m}$ 15-24 | $u_{ct}^{m}$ 25-54 | $u_{ct}^{m}$ 55-64 |
| **Impact of shocks ($\beta$):** | | | | | | |
| TFP shock | -0.0739 | -0.0421 | 0.0445 | 0.0952 | 0.0413 | -0.0394 |
| | (-0.35) | (-0.43) | (0.41) | (0.31) | (0.32) | (-0.32) |
| Real interest rate | 1.852*** | 0.834*** | 1.044*** | 2.846*** | 1.208*** | 1.253*** |
| | (7.46) | (8.07) | (9.25) | (10.56) | (10.63) | (10.88) |
| Labor demand shock | -0.584*** | -0.186*** | -0.297*** | -0.395*** | -0.161*** | -0.231*** |
| | (-2.65) | (-3.92) | (-3.45) | (-3.23) | (-3.25) | (-3.77) |
| Lagged ECB shock | 0.415** | 0.0864** | -0.0241 | 0.116 | 0.0195 | 0.0214 |
| | (2.51) | (2.35) | (-0.41) | (1.12) | (0.47) | (0.38) |
| **Interaction LMIs/shocks ($\gamma$):** | | | | | | |
| Union density | 0.00243 | -0.0245** | -0.0107 | -0.0214*** | -0.0242*** | -0.0145** |
| | (0.28) | (-2.59) | (-1.47) | (-2.79) | (-3.15) | (-2.09) |
| Union coverage | -0.00589 | -0.0409** | -0.0147* | -0.0152 | -0.0221** | -0.0270*** |
| | (-0.54) | (-2.60) | (-1.71) | (-1.44) | (-2.05) | (-2.68) |
| Coordination | -0.126* | -0.0238 | -0.0630 | 0.0140 | -0.000444 | -0.0205 |
| | (-1.69) | (-0.32) | (-1.18) | (0.21) | (-0.01) | (-0.36) |
| Income taxes | 0.0390 | 0.101** | 0.0384 | 0.0950*** | 0.0809** | 0.0682** |
| | (1.24) | (2.48) | (1.45) | (2.82) | (2.43) | (2.29) |
| Employee SSC | -0.0503 | 0.0146 | 0.0942*** | 0.0231 | 0.0427 | 0.0994*** |
| | (-1.43) | (0.41) | (3.58) | (0.80) | (1.53) | (4.00) |
| Employer SSC | 0.0879*** | 0.131*** | 0.0889*** | 0.0762*** | 0.0918*** | 0.105*** |
| | (2.63) | (3.62) | (3.79) | (2.95) | (3.57) | (4.46) |
| EPLs on regular contracts | 0.0451 | 0.111 | -0.131 | -0.0952 | -0.124 | -0.0764 |
| | (0.39) | (0.72) | (-1.59) | (-0.87) | (-1.09) | (-0.79) |
| EPLs on temporary contracts | -0.171 | 0.220 | -0.0257 | 0.132 | 0.257** | 0.169 |
| | (-1.63) | (1.54) | (-0.26) | (1.20) | (2.29) | (1.62) |
| Replacement rate, 1st year | -0.00631 | -0.0174** | -0.00986* | -0.00826 | -0.00846 | -0.00696 |
| | (-1.04) | (-2.40) | (-1.69) | (-1.25) | (-1.28) | (-1.19) |
| Benefit length | -2.938** | -1.346 | -1.564 | -1.053 | 0.172 | 0.588 |
| | (-2.50) | (-1.06) | (-1.48) | (-1.00) | (0.16) | (0.59) |
| Active labor market policies | 0.0424** | 0.0139 | 0.0206 | -0.0334 | -0.0361 | -0.00623 |
| | (2.03) | (0.51) | (1.15) | (-1.26) | (-1.37) | (-0.28) |
| Time and country effects | yes | yes | yes | yes | yes | yes |
| Adjusted $R^2$ | 0.874 | 0.875 | 0.815 | 0.860 | 0.844 | 0.824 |
| Parameters | 40 | 40 | 40 | 40 | 40 | 40 |
| Observations | 154 | 154 | 154 | 154 | 154 | 154 |

Notes: Nonlinear least squares estimation. t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation).
* p<0.10 ** p<0.05 *** p<0.01

Table 3.16 Unemployment Rates by Gender and Marital Status in the EA: 2000-2013 Average

| Country | Average unemployment rate | | | |
|---|---|---|---|---|
| | Female<br>Single / Widowed / Divorced | Female<br>Married / Union / Cohabiting | Male<br>Single / Widowed / Divorced | Male<br>Married / Union / Cohabiting |
| **Austria** | 6.25 | 3.82 | 6.66 | 3.29 |
| **Belgium** | 11.13 | 5.70 | 10.69 | 4.24 |
| **Finland** | 12.00 | 5.54 | 13.36 | 4.21 |
| **France** | 12.23 | 6.86 | 12.11 | 4.45 |
| **Ireland** | 9.03 | 4.76 | 13.50 | 5.62 |
| **Italy** | 14.99 | 7.87 | 12.50 | 3.96 |
| **Luxembourg** | 6.08 | 4.71 | 5.99 | 2.01 |
| **Netherlands** | 6.47 | 3.55 | 5.80 | 2.24 |
| **Portugal** | 13.06 | 8.24 | 13.27 | 5.76 |
| **Spain** | 15.62 | 20.09 | 9.10 | 18.94 |

Source: ILOSTAT, unemployment rate by sex, age and marital status (%) – Annual.

Table 3.17 Regression Results for Unemployment Rates by Gender and Marital Status

| Independent Variables | Dependent Variables I $u_{ct}^{f}$ Single / Widowed / Divorced | II $u_{ct}^{f}$ Married / Union / Cohabiting | III $u_{ct}^{m}$ Single / Widowed / Divorced | IV $u_{ct}^{m}$ Married / Union / Cohabiting |
|---|---|---|---|---|
| **Impact of shocks ($\beta$):** | | | | |
| TFP shock | -0.0768 | 0.121 | -0.0258 | 0.260*** |
| | (-0.85) | (1.12) | (-0.22) | (2.68) |
| Real interest rate | 0.718*** | 0.746*** | 1.000*** | 1.102*** |
| | (5.78) | (6.50) | (6.80) | (10.14) |
| Labor demand shock | -0.446*** | -0.171*** | -0.510*** | 0.110*** |
| | (-3.06) | (-3.13) | (-3.22) | (3.12) |
| Lagged ECB shock | 0.211*** | 0.0246 | 0.0551 | -0.0261 |
| | (2.67) | (0.93) | (0.97) | (-0.93) |
| **Interaction LMIs/shocks ($\gamma$):** | | | | |
| Union density | 0.000792 | -0.0502*** | -0.00724 | -0.0441*** |
| | (0.11) | (-4.07) | (-0.96) | (-5.54) |
| Union coverage | -0.00852 | 0.00927 | 0.00172 | 0.0723*** |
| | (-0.84) | (0.58) | (0.20) | (5.79) |
| Coordination | -0.209*** | -0.101 | -0.291*** | 0.232*** |
| | (-2.84) | (-1.11) | (-3.89) | (2.96) |
| Income taxes | 0.0552** | 0.114** | 0.0689** | -0.0327 |
| | (1.99) | (2.46) | (2.48) | (-1.16) |
| Employee SSC | -0.145** | -0.195** | -0.116** | -0.233*** |
| | (-2.33) | (-2.53) | (-2.11) | (-5.27) |
| Employer SSC | 0.0878*** | 0.0397 | 0.0598** | -0.0861*** |
| | (2.71) | (1.01) | (2.20) | (-2.65) |
| EPLs on regular contracts | 0.0652 | -0.191 | -0.103 | -0.715*** |
| | (0.53) | (-1.10) | (-1.03) | (-3.07) |
| EPLs on temporary contracts | 0.0719 | 0.650*** | 0.227* | 0.409*** |
| | (0.61) | (3.20) | (1.77) | (4.41) |
| Replacement rate, 1st year | -0.000752 | 0.00512 | 0.00571 | 0.00759* |
| | (-0.19) | (0.56) | (1.29) | (1.70) |
| Benefit length | -0.237 | 2.171 | 2.208* | 1.989* |
| | (-0.23) | (1.33) | (1.95) | (1.90) |
| Active labor market policies | 0.0312** | 0.0847*** | 0.0317* | -0.0550** |
| | (2.06) | (2.73) | (1.86) | (-2.59) |
| Time and country effects | yes | yes | yes | yes |
| Adjusted $R^2$ | 0.866 | 0.929 | 0.887 | 0.941 |
| Parameters | 39 | 39 | 39 | 39 |
| Observations | 140 | 140 | 140 | 140 |

Notes: Nonlinear least squares estimation. t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation).
* p<0.10 ** p<0.05 *** p<0.01

Table 3.18 Unemployment Rates by Gender and Education in the EA: 2000-2013 Average

| | Average unemployment rate | | | | | |
|---|---|---|---|---|---|---|
| **Country** | Female Basic | Female Intermediate | Female Advanced | Male Basic | Male Intermediate | Male Advanced |
| **Austria** | 8.80 | 4.25 | 2.95 | 10.43 | 4.48 | 2.30 |
| **Belgium** | 14.25 | 8.91 | 4.07 | 11.48 | 6.34 | 3.78 |
| **Finland** | 17.81 | 9.14 | 4.32 | 15.64 | 9.04 | 4.04 |
| **France** | 13.83 | 9.56 | 5.62 | 12.96 | 7.05 | 5.32 |
| **Germany** | 13.52 | 7.77 | 4.38 | 16.54 | 8.44 | 3.60 |
| **Ireland** | 11.30 | 8.04 | 4.38 | 14.45 | 9.66 | 4.43 |
| **Italy** | 14.01 | 10.04 | 7.16 | 8.89 | 6.59 | 4.16 |
| **Luxembourg** | 7.59 | 4.97 | 3.90 | 5.65 | 3.06 | 2.61 |
| **Netherlands** | 7.96 | 4.54 | 2.96 | 6.16 | 3.54 | 2.49 |
| **Portugal** | 10.64 | 10.54 | 7.28 | 8.73 | 7.98 | 5.74 |
| **Spain** | 22.62 | 17.52 | 11.41 | 16.49 | 11.82 | 7.69 |

Source: ILOSTAT, unemployment rate by sex, age and education (%) – Annual. ILOSTAT contains the statistics according to three levels of education: basic, intermediate and advanced, corresponding to primary and lower secondary education (levels 1-2); upper secondary and post-secondary non-tertiary education (levels 3 and 4); and tertiary education (levels 5-8) in the International Standard Classification of Education (ISCED) 2011, respectively.

Table 3.19 Regression Results for Unemployment Rates by Gender and Education

| | Dependent Variables | | | | | |
|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI |
| **Independent Variables** | $u_{ct}^{f}$ Basic | $u_{ct}^{f}$ Intermediate | $u_{ct}^{f}$ Advanced | $u_{ct}^{m}$ Basic | $u_{ct}^{m}$ Intermediate | $u_{ct}^{m}$ Advanced |
| **Impact of shocks ($\beta$):** | | | | | | |
| TFP shock | 0.00127 | -0.0900 | -0.0772 | 0.363*** | 0.211** | 0.0519 |
| | (0.01) | (-0.77) | (-1.02) | (2.63) | (2.35) | (0.75) |
| Real interest rate | 1.104*** | 0.972*** | 0.417*** | 1.212*** | 0.846*** | 0.610*** |
| | (6.81) | (7.52) | (4.82) | (7.34) | (7.35) | (10.14) |
| Labor demand shock | -0.260*** | -0.230*** | -0.216** | 0.193*** | 0.242*** | -0.123*** |
| | (-3.43) | (-3.56) | (-2.24) | (3.06) | (3.58) | (-3.31) |
| Lagged ECB shock | 0.138*** | 0.116** | 0.137* | -0.0224 | -0.0142 | -0.0257 |
| | (2.88) | (2.45) | (1.76) | (-0.41) | (-0.35) | (-1.01) |
| **Interaction LMIs/shocks ($\gamma$):** | | | | | | |
| Union density | -0.0270** | -0.0187* | 0.00183 | -0.0230** | -0.0123 | -0.0244*** |
| | (-2.43) | (-1.95) | (0.17) | (-2.35) | (-1.33) | (-3.13) |
| Union coverage | -0.0332* | -0.0375** | -0.0425** | 0.0419*** | 0.0273** | -0.0350*** |
| | (-1.93) | (-2.35) | (-2.16) | (3.11) | (2.50) | (-2.93) |
| Coordination | -0.0248 | -0.0645 | -0.118 | 0.378*** | 0.345*** | -0.0763 |
| | (-0.28) | (-0.84) | (-1.51) | (3.14) | (2.99) | (-1.27) |
| Income taxes | 0.129** | 0.108** | 0.00195 | -0.0892** | -0.125*** | 0.0677* |
| | (2.55) | (2.52) | (0.07) | (-2.29) | (-3.29) | (1.91) |
| Employee SSC | 0.0240 | 0.0227 | -0.0392 | -0.131*** | -0.132*** | 0.0385 |
| | (0.57) | (0.61) | (-0.84) | (-2.96) | (-3.21) | (1.34) |
| Employer SSC | 0.125*** | 0.114*** | 0.134** | -0.0123 | 0.0353 | 0.125*** |
| | (2.96) | (3.13) | (2.50) | (-0.31) | (0.95) | (4.64) |
| EPLs on regular contracts | -0.0712 | 0.171 | 0.204 | -0.839*** | -0.662*** | 0.0134 |
| | (-0.50) | (1.05) | (1.18) | (-2.77) | (-2.95) | (0.14) |
| EPLs on temporary contracts | 0.306* | 0.138 | -0.223* | -0.0920 | -0.210* | 0.111 |
| | (1.79) | (0.93) | (-1.86) | (-0.79) | (-1.87) | (1.00) |
| Replacement rate, 1st year | -0.0111 | -0.0180** | 0.00149 | 0.00108 | 0.000350 | -0.0000853 |
| | (-1.36) | (-2.41) | (0.27) | (0.20) | (0.09) | (-0.01) |
| Benefit length | -1.131 | -1.449 | 0.0755 | -0.638 | 0.540 | 0.116 |
| | (-0.81) | (-1.11) | (0.06) | (-0.48) | (0.51) | (0.11) |
| Active labor market policies | -0.0262 | -0.0111 | 0.0434* | -0.0443* | -0.0262 | 0.0152 |
| | (-0.81) | (-0.39) | (1.67) | (-1.66) | (-1.20) | (0.83) |
| Time and country effects | yes | yes | yes | yes | yes | yes |
| Adjusted $R^2$ | 0.841 | 0.856 | 0.829 | 0.844 | 0.846 | 0.875 |
| Parameters | 40 | 40 | 40 | 40 | 40 | 40 |
| Observations | 154 | 154 | 154 | 154 | 154 | 154 |

Notes: Nonlinear least squares estimation. t statistics in parentheses (Standard errors are estimated using robust Huber/White sandwich formation).
* p<0.10 ** p<0.05 *** p<0.01

# Conclusion

This PhD thesis studied the effects of macroeconomic shocks on unemployment rates, in the context of a single monetary policy regime in the EA. The analyses focused on the time period covering a whole business cycle, from the inception of the EA until the outbreak of the GFC and its recovery. By using a medium-scale New Keynesian DSGE model in Chapter 1 and empirical panel data methods in Chapters 2 and 3, we successively examined: 1) the heterogenous responses of unemployment rates to a common monetary policy shock in the EA countries; 2) the impact of the interactions between shocks and labor market institutions on unemployment, and 3) the impact of shocks, also interacted with labor market institutions, on gender unemployment and other demographic characteristics.

The main findings show that monetary policy shocks conducted by the ECB are the second largest exogenous force, after risk premium shocks, driving national unemployment rate fluctuations in the largest four EA countries, namely France, Germany, Italy and Spain, not only in the short run but also in the medium and long run. In terms of dynamic responses, the unemployment rates rise in response to the tightening of monetary policy, due to the contraction in output, but in a different way across these four sample countries: Spain is the most affected, in terms of both elasticity and persistence; in France the impact, maximum and persistence effects are, roughly, twice lower than in Spain while Germany and Italy fall in-between. Some labor market institutions do reveal a significant effect on shaping out the severity of shocks on the unemployment rate, particularly, higher tax wedges tend to amplify the impact of shocks on unemployment, while unemployment benefit generosity and pervasive unionization lead to a smaller effect of shocks on the unemployment rate (vice versa). Furthermore, the lagged ECB monetary policy shock has a strongly significant impact on the female unemployment rate (especially for young and less-educated women), but not on the male unemployment rate. The transmission effects of labor market institutions also manifest gender differences. The amplification effect of high tax wedges, such as income taxes or social security contributions from employers, applies to women to a greater extent, while the moderating effect of greater union density is found to only work on men and not on women. In light of the above summary, our findings imply the important role of unemployment benefits, tax wedges and trade unions in channeling the transmission of shocks to the labor market, which are all very closely linked to the national fiscal policies.

In terms of policy implications, we think that the main insight from this thesis relates to the debate in the EU about the need to move forward with a more common fiscal policy to make the EA more effective. Most economists agree today that some form of common fiscal policy would be beneficial for the functioning of the EA as it would complement the ECB's monetary policy in the event of both asymmetric shocks and area-wide crises (see Guttenberg 2020; Guttenberg and Hemker 2018; Obstfeld 2013; Tabellini 2015). There are still many open questions about what form a common fiscal policy should take: does the EA need a new institution to execute fiscal policy decisions, or should the focus of political energy be on getting the right policies and instruments in place? If the latter, how should the details set up? These are all interesting questions for the future. From the point of view of this thesis, our findings lead us to conclude in favor of institutional harmonization in the EA, including some fiscal measures on unemployment benefits, the tax system, etc.

Finally, we would like to emphasize that the setup of the New Keynesian DSGE model in Chapter 1 is based on a single country, which is abstract and unrealistic for the EA. This implies that potential extensions to our modelling work may need to build a multi-country DSGE model to capture cross-country heterogeneity within the EA, which is also one of the most challenging studies in the field of DSGE modeling.

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