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Debunking the Myth of Southern Profligacy. A DSGE Analysis of Business Cycles in the EMU's Big Four*

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Abstract

We investigate the drivers of EMU big fours' business cycles in a DSGE model. Our approach allows to disentangle the role of demand and technology shocks, where the latter may generate permanent consequences on national productivity levels. For the years before the financial crisis we cannot find evidence of a demand-driven boom in Spain and Italy relative to what happened in France and Germany. The aftermath of the sovereign bond crisis was characterized by a sequence of adverse permanent technology shocks both in Spain and in Italy. These latter results are consistent with recent theoretical developments that emphasize the adverse supply-side effects of a credit crunch.

Keywords: *Asymmetric Euro crisis, two-country DSGE, Bayesian estimation*

JEL codes: C11, C13, C32, E21, E32, E37

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1 Introduction

The creation of the European Monetary Union (EMU) in 1999 was heralded as the beginning of a new phase of prosperity and relatively fast growth, potentially leading to convergence between peripheral and core countries. The early EMU years seemed to confirm this prediction, but the sovereign bond crisis severely hit the "peripheral" members and raised concerns of a possible breakup of the Euro Area, due to the persistent growth gap between the core and the periphery. These patterns are well exemplified by output growth dynamics in the four largest EMU countries - France, Germany, Italy and Spain (Figure 1), which account for 79% of the Euro Area GDP. After the relatively favorable $1999-2006$ period, growth rates in Italy and Spain plunged and remained negative until the end of the sample. While the $2008-2009$ financial crisis was a generalized phenomenon which affected all developed economies, the sovereign bond crisis has been specific to the Eurozone, apparently rooted in the imbalances that accumulated in the pre-2008 period.

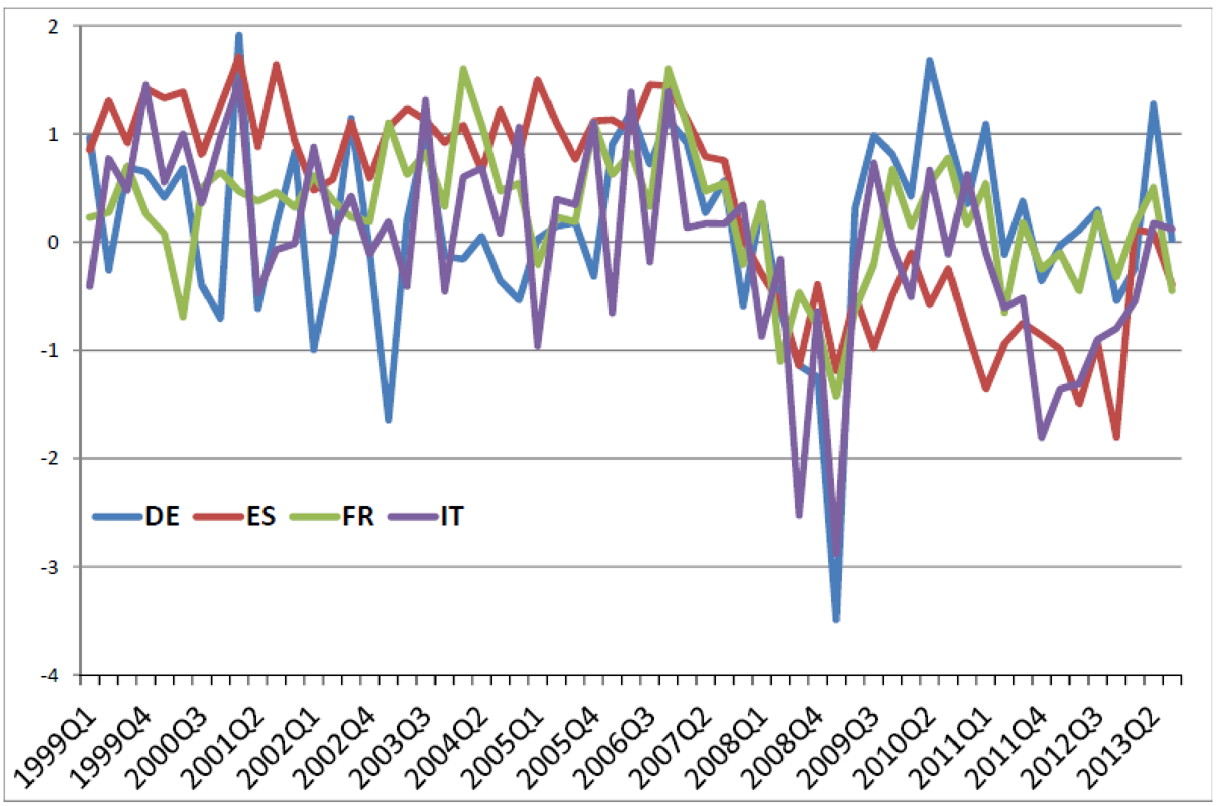

Figure 1: GDP growth - EMU largest economies

In peripheral countries the early EMU years had been characterized by relatively loose domestic credit conditions, and by real exchange rate appreciations. These phenomena were initially seen as part of the catching up process triggered by monetary integration (Blanchard and Giavazzi, 2002). After the onset of the 2010 sovereign bond crisis a "new view" has suggested that favorable credit conditions triggered a surge in consumers demand and, by falling short of stimulating productivity convergence, determined demand-driven erosion of competitiveness in these countries (Giavazzi and Spaventa, 2011; Sinn, 2011; Fernandez-Villaverde et al., 2013). The new view also implied that to get out of the crisis policymakers should seek internal devaluations, mainly through fiscal austerity programs and labor market reforms.

It should be noted, however, that the 2010 sovereign crisis was triggered by (potentially self-fulfilling) fear that a Grexit domino effect would cause EMU disintegration (De Grauwe and Ji, 2013). In the periphery this caused a severe credit crunch that might have produced the growth slowdown, in analogy with what is typically observed in consequence of "sudden stops" (Furceri and Mourougane, 2012; Benigno et al., 2015). Samarina et al. (2017) compute non-financial business and mortgage credit cycles that highlight important differences between the four largest EMU economies. For France Spain and Italy they document a large credit financial boom between 2005 and 2008, more pronounced for the business than for the mortgage sector. The subsequent post-2010 contraction mainly hit the business sector and was far less severe in France than in the other two countries. By contrast, there is no evidence of a contemporaneous credit boom/bust cycle in Germany.

Theoretical contributions have explored the supply-side effects of a credit crunch. Khan and Thomas (2013) show that financial shocks penalize firms characterized by relatively high productivity but relatively low net worth, thereby causing reductions in aggregate total factor productivity. Bassetto et al. (2014) argue that a credit crunch has a particularly severe effect on small firms production. Buera et al. (2015) obtain a similar result focusing on employment dynamics. This alternative view emphasizes that the supply-side effects of a credit crunch bear important policy implications. In fact, Laeven and Valencia (2013) find that firms exposed to external finance greatly beneficed from bank recapitalization plans and fiscal policies designed to stimulate domestic demand.

The paper investigates the drivers behind business cycle dynamics in EMU four largest economies. One may expect this model to answer two questions which are crucial to the definition of policies designed to restore growth in the southern economies. Was the pre-2007 relatively fast growth in the south driven by demand shocks or was there also some favorable productivity component? How can we explain the post-2010 dismal performance of these countries? Was it due to lack of domestic demand, including contractionary fiscal policies, or was it caused by a slowdown in the underlying rate of productivity growth?

We consider a number of country-specific technology and demand shocks. Technology shocks include standard temporary TFP shocks and shocks to the productivity growth trend, entailing for each country permanent variations in productivity levels relative to the rest of the Eurozone. These latter shocks are often neglected in empirical DSGE models. Non-policy demand shocks include "risk premium" shocks driving a wedge between the return on capital accruing to the households and the price of capital services paid by firms, and standard investment-specific shocks.

Our results challenge the view that loose domestic (private and/or public) demand conditions in the early EMU years are at the root of the Eurozone crisis. In spite of the expansionary credit cycle, we find no evidence of a large demand-driven boom in Italy or Spain before the financial crisis, while in this period favorable demand shocks played an important role in Germany and France. It is interesting to note that the hypothesis of a credit- (demand-) driven boom is also rejected by Chouard et al. (2014), who use a reduced-form equation of total factor productivity dynamics. As for fiscal policy, we cannot find evidence of an expansionary bias in discretionary public consumption in the southern economies. In fact the contribution of fiscal shocks in Spain is comparable to what we observe for France or Germany, whereas in Italy the fiscal shocks were larger but did not induce a systematic expansion.

Demand shocks remain crucial to explain the 2008 slump and the subsequent post-2010 modest recovery in Germany and, to a lesser extent, in France. Adverse permanent technology shocks explain the post-2008 severe output losses observed for Italy. The same conclusion applies to Spain after 2010. Thus, the severe output contractions in Italy and Spain should not be interpreted as the necessary correction of accumulated imbalances. They signal instead a North-South divide, determined by a permanent technology gap. This is broadly consistent with the view that the crisis is the consequence of the supply side effects of the banking crisis in the South. Ball (2014) estimates the effects of the financial crisis on potential output in a panel of OECD countries, including the four countries considered here. It is interesting to note that his ranking of the financial crisis effects fits very well our results. Potential output in Germany was virtually unscathed, France suffered a break in potential output growth of relatively limited importance, a severe disruption is observed for Italy and Spain.

The paper is organized as follows. Section 2 motivates our focus on permanent technology shocks highlighting the connections between our theoretical and empirical modelling strategies. Section 3 introduces the estimation strategy and section 4 presents the results. Finally, section 5 concludes.

2 Modelling strategy

Right from the outset, it is worth to emphasize the connections between our theoretical and empirical modelling strategies. The theoretical DSGE literature incorporating non-trivial financial frictions and a banking sector has been rapidly expanding since the outset of the financial crisis.[1] Unfortunately, empirical DSGE models (Brzoza-Brzezina and Kolasa, 2013; Suh and Walker, 2016) find that modelling financial frictions is essential for replicating fluctuations in financial variables, but the amplification mechanism caused by financial frictions has relatively weak effects of real variables and is not sufficient to improve over the statistical fit of the workhorse New Keynesian model, such as Smets and Wouters (2007).

It is also important to notice that recent empirical DSGE models of the financial crisis utterly neglect the potential role of permanent productivity shocks. Gerali et al. (2010) apply an HP filter to trending variables; others, such as Suh and Walker (2016) and Lindé, Smets and Wouters (2016) impose a deterministic trend. One standard justification for this approach is that the low frequency features of data series bear relatively negligible importance for empirical models that

[1] One common feature of the financial frictions modelled in the above mentioned contributions is that a credit crunch affects demand for consumption and investment goods, but it has no effect on the growth rate of productivity.

focus on the short-term behavior of the economy.

In sharp contrast with these studies, Sims (2011) emphasizes the importance of jointly considering the roles of the persistent but transitory productivity shocks of the RBC-DSGE literature and of the permanent shocks identified in the VAR literature (Galí, 1999). He shows that incorporating permanent technology shocks in an empirical DSGE model allows to achieve a better match of the empirical responses to technology shocks with fewer frictions than in standard empirical DSGE models.

We contribute to the existing literature identifying the distinct role played by demand factors and variations in productivity growth during the two crises. In the light of the apparent difficulty of improving the empirical performance of DSGE models by explicitly adding financial frictions, we have chosen to incorporate permanent technology shocks in an otherwise standard DSGE model, without dealing explicitly with the financial frictions, as Kollman et al. (2016).

Consistently with our results, they find that the relatively bad performance of the Euro Area reflects a combination of adverse aggregate demand and supply shocks, including permanent TFP shocks

In concluding this discussion it is important to stress the different approaches to the measurement of permanent TFP shocks relative to more conventional studies. The early RBC literature focused on persistent but transitory changes in the measured Solow residual as a source of technology shocks. This approach is criticized because the procyclical behavior of the Solow residual may be due to cyclical errors in measuring changes in capital utilization and/or in the intensity of work effort (Basu, 1996). As a consequence, Basu et al. (2006) advocate the adjustment of the Solow residual, controlling for imperfect competition and time varying utilization of capital and labor. Sims (2011) shows that the Basu et al. TFP measure incorporates both permanent and temporary but persistent shocks. Our approach is obviously different because we estimate temporary and permanent technology shocks jointly with a number of temporary demand and markup shocks, as it is typical of the empirical DSGE literature. Instead of being treated as a residual, in our framework technology shocks are identified on the grounds of their ability to explain permanent comovements of observed variables, including permanent variations of the capital labor ratio and of consumption levels. Our contributions is therefore quite distinct from earlier work on TFP in the Eurozone, such as Cette et al. (2016) and Gamberoni et al. (2016).

Our empirical strategy defines the theoretical characterization of a monetary union economy. As we discuss in section 3 below, we estimate a two-country monetary union model for each of the four countries. This option is preferred to the alternative of estimating a multi-country model for the whole Eurozone, which would be intractable.[2] We therefore assume that the monetary union is composed of the domestic economy (D, size s) and of the rest of the Euro Area economy (REA, size $1-s$). In what follows we describe the D economy, as the REA economy is characterized symmetrically. An asterisk identifies variables and parameters referring to the REA economy.

Each region produces both non-tradable and tradable goods. Following Rabanal (2009), there is no price discrimination across regions, i.e. the law of one price holds. The structure of the economy in each region is very close to Christoffel et al. (2008). Households supply factor inputs to monopolistic producers of intermediate goods and delegate wage setting decisions to monopolistic labor unions. Retail firms demand intermediate goods to assemble the final consumption and investment bundles under perfect competition. The model features standard nominal and real frictions, i.e. price and nominal wage stickiness modelled *à la* Calvo, investment adjustment costs, variable capacity utilization, external consumption habits.

There is a continuum of households indexed by i. As in Kollmann et al. (2016) we draw a distinction between a fraction $1-\theta$ of Ricardian households ($i=o$) and the remaining θ Non-Ricardian or rule-of-thumb households ($i=rt$). Non-Ricardian households do not have access to financial markets and consume all their disposable labor income in each period. Ricardian households participate in financial markets, trade government bonds, accumulate physical capital and own firms. In our framework introducing Non-Ricardian households is an admittedly rough-and-ready method to capture the impossibility for some households to exploit financial markets to smooth their consumption over the business cycle and also to better characterize the response of aggregate demand to public consumption shocks. De Bortoli and Galí (2017) show that this simple two-agent New Keynesian model (TANK) is a tractable framework that captures reasonably

[2] See Juillard et al. (2008) and Dees et al. (2014) for a discussion of the difficulties associated to estimating multi-country DSGE models of the size that would be required here.

well the main predictions of HANK models which are based on a detailed description of agents heterogeneity (Kaplan et al. 2016).[3]

The model incorporates an exogenous fiscal sector, including public consumption, tax rates on factor incomes, transfers and lump sum taxes. Factor incomes taxation and transfers are assumed constant and used to calibrate relative consumption between the two households groups, as in Coenen et al. (2013). Public consumption is one among the observables used to estimate the model and we assume that its cyclical pattern is driven by exogenous shocks whereas lump-sum taxation of Ricardian households ensures government solvency.

The technical Appendix provides a full description of the model. In what follows we focus on certain aspects of the model that are crucial to understand our results, i.e. characterization of preferences and shocks.

The representative firm producing intermediate goods uses the following production technology:

$$Y_t^{int} = \varepsilon_t^{a,int}[u_t^{int}K_t^{int}]^{\alpha_{int}}[z_t h_t^{int}]^{1-\alpha_{int}} - z_t\Phi_{int} \tag{1}$$

where Φ_{int} defines fixed costs of production, u_t^{int} is the degree of capacity utilization, K_t^{int} is the capital stock, h_t^{int} is the labor bundle:

$$h_t^{int} = \left\{ \left(\frac{1}{s}\right)^{\frac{\lambda_t^w}{1+\lambda_t^w}} \int_0^s \left[h_t^j\left(int\right)\right]^{\frac{1}{1+\lambda_t^w}} dj \right\}^{1+\lambda_t^w} \tag{2}$$

Firm int demand for labor type j is

$$h_t^j\left(int\right) = \left(\frac{W_t^j}{W_t}\right)^{-\frac{1+\lambda_t^w}{\lambda_t^w}} h_t^d \tag{3}$$

where W_t^j is type j nominal wage, W_t is the aggregate nominal wage index and h_t^d is the aggregate labor demand. Each household supplies the labor bundle that firms demand. In each labor market j, wage-setting decisions are delegated to a monopolistic union and households supply the amount

[3] It is well known that HANK models require non-trivial solution methods. Introducing a more detailed characterization of heterogeneity in our two-country medium scale estimated model would be an extremely difficult task.

of labor that firms demand at W_t^j.[4] The time-varying parameter λ_t^w allows to incorporate wage markup shocks:

$$\log\left(\lambda_t^w\right)=\left(1-\rho_w\right)\log\left(\lambda^w\right)+\rho_w\log\left(\lambda_{t-1}^w\right)+\eta_t^w \qquad \eta_t^w\sim N\left(0,\sigma_w^2\right). \tag{4}$$

$\varepsilon_t^{a,int}$ is a temporary technology shock, such that

$$\log\left(\varepsilon_t^{a,int}\right)=\left(1-\rho_{int}\right)\log\left(\varepsilon^{a,int}\right)+\rho_{int}\log\left(\varepsilon_{t-1}^{a,int}\right)+\eta_t^{int} \tag{5}$$

and $z_t=z_{t-1}g_{z,t}$ is a labour-augmenting non-stationary technology shifter where

$$\log\left(g_{z,t}\right)=\left(1-\rho_{g_z}\right)\log\left(g_z\right)+\rho_{g_z}\log\left(g_{z,t-1}\right)+\eta_t^{g_z} \tag{6}$$

allows to incorporate technology shocks with a permanent effect on the level of productivity.

Intermediate firms operate in the domestic tradable and non-tradable sectors, T and N respectively. They face downward sloping demand curves obtained from standard consumption bundles

$$Y_t^X=\left[\left(\frac{1}{s}\right)^{\frac{\lambda_t^{p,X}}{1+\lambda_t^{p,X}}}\int_0^s Q_t^X\left(x\right)^{\frac{1}{1+\lambda_t^{p,X}}}dx\right]^{1+\lambda_t^{p,X}} \qquad X=T,N,$$

where markup shocks, i.e. shocks to the elasticity of substitution across goods are assumed to follow an AR(1) process with i.i.d. Normal error term:

$$\log\left(\lambda_t^{p,X}\right)=\left(1-\rho_{p,X}\right)\log\left(\lambda_t^{p,X}\right)+\rho_{p,X}\log\left(\lambda_{t-1}^{p,X}\right)+\eta_t^{p,X} \tag{7}$$

The final consumption bundle is:[5]

$$C_t=\left[\gamma_c^{\frac{1}{e}}\left(C_t^T\right)^{\frac{e-1}{e}}+\left(1-\gamma_c\right)^{\frac{1}{e}}\left(C_t^N\right)^{\frac{e-1}{e}}\right]^{\frac{e}{e-1}} \qquad e>1 \tag{8}$$

[4] Following Galí et al. (2007) we assume that the fractions of Ricardian and non-Ricardian households is uniformly distributed across worker types. Since wage-setting decisions are centralized, this implies that households supply an identical amount of labor services in each labor market j.

[5] We postulate similar bundles for investment goods, see the Appendix for details.

where C_t^T is defined as:

$$C_t^T = \left[\varpi^{\frac{1}{\upsilon}}\left(C_t^H\right)^{\frac{\upsilon-1}{\upsilon}} + (1-\varpi)^{\frac{1}{\upsilon}}\left(C_t^F\right)^{\frac{\upsilon-1}{\upsilon}}\right]^{\frac{\upsilon}{\upsilon-1}} \qquad \upsilon > 1$$

Tradables incorporate domestic C_t^H and imported C_t^F tradable intermediate goods as inputs.

Household's i preferences $\varepsilon_t^c U_t^i\left(c_t^i, c_{t-1}, h_t^i\right)$ are characterized by non separability between consumption and labor effort and by consumption habits (Smets and Wouters, 2005, 2007; Albonico et al., 2016). To ensure that the model has a balanced growth path (BGP), consumption variables, $c_t^i = \frac{C_t^i}{z_t}$ and $c_t = \frac{C_t}{z_t}$, are normalized with the technology shifter z_t. The term ε_t^c is a preference shock affecting the subjective discount factor and evolving according to:

$$\log\left(\varepsilon_t^c\right) = (1-\rho_c)\log\left(\varepsilon^c\right) + \rho_c \log\left(\varepsilon_{t-1}^c\right) + \eta_t^c \qquad \eta_t^c \sim N\left(0, \sigma_c^2\right) \tag{9}$$

Ricardian households allocate their resources between consumption C_t^o, investment in physical capital I_t^o, in public bonds B_{t+1}^o that pay the nominally riskless rate R_t^{ECB} and in a portfolio of state-contingent securities, A_t, that allow Ricardian households in the two regions to engage in mutual risk sharing. Their budget constraint is:

$$\begin{aligned}(1+\tau^c) P_{C,t} C_t^o + P_{I,t} I_t^o + A_t + B_{t+1}^o \;&=\; A_{t-1} + R_{t-1}^{ECB} B_t^o + \left(1-\tau^l-\tau^{wh}\right) W_t h_t^o + D_t^o \\ &+ \left(1-\tau^k\right)\left[\frac{R_t^k}{\varepsilon_{t-1}^b} u_t^o - a\left(u_t^o\right) P_{I,t}\right] K_t^o + \tau^k \delta P_{I,t} K_t^o + T_t^o \end{aligned} \tag{10}$$

where τ^c, τ^l, τ^k, τ^{wh}, T^o, respectively denote consumption, labor and capital income tax rates, social contributions levied on labor incomes, and lump-sum taxes: $P_{C,t}$ and $P_{I,t}$ are the price indexes for consumption and investment goods bundles; R_t^k is the rental rate of capital, $a\left(u_t^o\right)$ defines variable capacity utilization costs, and ε_t^b is a risk premium shock that creates a wedge between the return on capital accruing to the households and the price of capital paid by firms.[6]

$$\log\left(\varepsilon_t^b\right) = (1-\rho_b)\log\left(\varepsilon^b\right) + \rho_b \log\left(\varepsilon_{t-1}^b\right) + \eta_t^b \qquad \eta_t^b \sim N\left(0, \sigma_b^2\right)$$

[6] A similar kind of shock is introduced in Ratto et al. (2009) and Amano and Shukayev (2012).

Physical capital accumulates as follows:

$$K_{t+1}^{o} = (1-\delta) K_t^o + \varepsilon_t^i \left[1 - S\left(\frac{I_t^o}{I_{t-1}^o}\right)\right] I_t^o$$

where δ is the depreciation rate and ε_t^i denotes an investment-specific technology shock:

$$\log\left(\varepsilon_t^i\right) = (1-\rho_i)\log\left(\varepsilon^i\right) + \rho_i \log\left(\varepsilon_{t-1}^i\right) + \eta_t^i \qquad \eta_t^i \sim N\left(0, \sigma_i^2\right)$$

The term $S\left(\frac{I_t^o}{I_{t-1}^o}\right)$ represents standard investment adjustment costs.

Public consumption is exogenous and stochastic:

$$\frac{g_t - g}{y} = \rho_G \frac{g_{t-1} - g}{y} + \eta_t^G \qquad \eta_t^G \sim N\left(0, \sigma_G^2\right) \tag{11}$$

where lower case letters stand for variables adjusted for growth, i.e. $g_t = G_t/z_t$, and g, y define steady state values.

As in Christoffel et al. (2008), the common monetary authority sets the nominal interest rate according to the following log-linear Taylor rule:

$$\begin{aligned} \hat{R}_t^{ECB} &= \phi_R \hat{R}_{t-1}^{ECB} + (1-\phi_R)\left(\phi_\pi \hat{\pi}_{t-1}^{EA} + \phi_y \hat{y}_t^{EA}\right) \\ &\quad + \phi_{\Delta\pi}\left(\hat{\pi}_t^{EA} - \hat{\pi}_{t-1}^{EA}\right) + \phi_{\Delta y}\left(\hat{y}_t^{EA} - \hat{y}_{t-1}^{EA}\right) + \hat{\varepsilon}_t^r \end{aligned} \tag{12}$$

where '$\hat{\ }$' denotes log deviations from steady state. $\pi_t^{EA} = \pi_{C,t}\left(\pi_{C,t}^*\right)^{1-s}$ is the Euro Area gross inflation rate and $y_t^{EA} = s y_t + (1-s) y_t^*$ is the Euro Area aggregate output. $\hat{\pi}_t^{EA}$ defines the deviation of inflation from steady state or target inflation.

2.1 Estimation strategy

The model is log-linearized around its steady state and then estimated using Bayesian techniques. Right from the outset, we have chosen to follow Smets and Wouters (2007) who do not adopt the standard practice of pre-filtering data to remove low frequency components. In our framework this is important because we are interested in identifying low frequency components, such as the permanent productivity shocks, and the short to medium term responses to such shocks. As pointed out in Canova (2014) cyclical fluctuations may arise in consequence of both permanent and transitory shocks.[7] Ferroni (2011) is also critical of Smets and Wouters (2007) who impose a deterministic trend when differencing trending observables. In fact their choice requires very strong a priori (deterministic nature) of the productivity growth process and imposes that all volatility is determined by transitory disturbances. In this regard, even if we estimate a BGP deterministic component for all trending variables, we also allow for the possibility that volatility is caused by a stochastic non-transitory component of productivity growth. Note that the stochastic component of productivity growth may vary across countries, so this is crucial to capture convergence/divergence productivity patterns. Moreover, we let the data speak about such patterns.[8]

We adopt a two-stage approach. In the first stage we estimate a closed economy model in order to obtain estimates for the deterministic productivity trend and for the parameters of the Central Bank policy rule, including the inflation objective.[9] All these estimated values are then imposed in the second stage, when we estimate the four two-country models.[10]

The data sample is 1996Q2-2013Q3, due to data availability and to the difficulty of estimating the model after 2013Q3, when monetary policy was *de facto* constrained by the zero lower bound.

[7] To further justify our choice, Canova (2014) shows that when the data generating process is characterized by transitory and permanent shocks, any frequency band will feature both the transitory and the permanent components of the model and permanent shocks might dominate volatility at business cycle frequencies.

[8] We do not consider here alternative approaches such as the ones proposed in Ferroni (2011), Canova (2014) and Canova and Ferroni (2011). These approaches tend to reduce the distortions in the parameter estimates with respect to the standard ones, however the introduction of parameters pertaining to the non-cyclical component of observable variables can increase identification problems and the choice of priors for these parameters and of which variables should be stationary or not seem to be arbitrary. Moreover, a departure of the data from the balanced growth path equilibrium which characterizes the model, in an open economy context, might result in a statistical artifact for a small data sample. Robustness checks in the spirit of Canova (2014), who introduces a flexible structure for taking into account cyclical and non-cyclical components (data and model based), are left for future research.

[9] Essentially the closed economy model is obatined by raising the share of the domestic economy to 1, so that the consumption and domestically produced bundles coincide. In other words, there is no distinction between traded and non-traded goods and any distinction between domestic and foreign residents falls.

[10] When we estimate the monetary policy parameters and the productivity growth rate in each model, we obtain slightly different results for these variables, but our conclusions concerning cross-country differences are confirmed. Results are available upon request.

2.1.1 First-stage estimates

For the first-stage estimates we use the Euro area short-term nominal interest rate and 7 variables referred to the Euro area: real GDP, real private consumption, consumer price inflation (log difference in the overall HICP index), real investments, real compensation per employee, total employment, government spending.

Measurement equations are introduced to ensure that the observable variables are consistent with the properties of the model's balanced-growth path and with the underlying assumption that all relative prices are stationary. Output, consumption, investments, wages and government spending are transformed in log differences, thus approximating their growth rates. Following Christoffel et al. (2008), total employment has been detrended with a linear trend, $g_e^{EMU} \cdot t$, estimated with simple OLS methods. The following measurement equation then incorporates the filtered variable $\ln e_t - g_e^{EMU} \cdot t$:

$$\ln e_t - g_e^{EMU} \cdot t = \hat{e}_t + \overline{e}$$

where $\overline{e}$ is an estimated constant. The auxiliary equation

$$\hat{e}_t = \frac{\beta}{1+\beta} E_t \hat{e}_{t+1} + \frac{1}{1+\beta} \hat{e}_{t-1} + \frac{(1-\xi_e)(1-\beta\xi_e)}{(1+\beta)\xi_e} \left(\hat{h}_t - \hat{e}_t \right) \tag{13}$$

relates the employment variable, $\hat{e}_t$, to the unobserved hours worked variable, $\hat{h}_t$. Parameter ξ_e determines the sensitivity of employment with respect to worked hours. For consumer price inflation the observation equation is:

$$\Delta \ln P_t = \pi_t + \overline{\overline{\pi}} \tag{14}$$

where $\overline{\overline{\pi}}$ is the estimated quarterly steady-state inflation rate.

The nominal interest rate is defined as:

$$\ln R_t^{ECB} = \hat{R}_t^{ECB} + \bar{R} \tag{15}$$

with $\bar{R}$ corresponding to the steady state nominal interest rate. For the remaining, non stationary variables, which are detrended by the employment trend as in Christoffel et al. (2008),[11] we assume the following measurement equation:

$$\Delta \ln Y_t = \hat{y}_t - \hat{y}_{t-1} + \overline{\gamma} + \hat{g}_{z,t} + g_e^{EMU} \tag{16}$$

where $\overline{\gamma} = 100(g_z - 1)$ and $\hat{g}_{z,t}$ respectively denote the estimated deterministic and stochastic growth trend components.[12]

This closed-economy model is estimated assuming interest rate, risk premium, investment-specific, price and wage markup, government spending, temporary and permanent productivity shocks.

2.1.2 Second-stage estimates

In the second stage we use 9 time series characterizing the specific domestic country, which consist in real GDP, real private consumption, consumer price inflation (log difference in the overall HICP index), real investments, real compensation per employee, total employment, government spending, nontradables inflation (log difference in the services HICP index, as in Kolasa, 2009) and nontradables GDP (proxied by services GDP, as in Rabanal, 2009). Nine additional observables are symmetrically defined for the rest of the Euro area. The Euro area short-term nominal interest rate completes the set of observables and its measurement equation is defined as in 15.

For each model, we estimate the employment trend coefficients g_e and g_e^*. Then, the employment measurement equations are defined as:

$$\begin{aligned} \ln e_t - g_e \cdot t &= \hat{e}_t + \overline{e} \\ \ln e_t^* - g_e^* \cdot t &= \hat{e}_t^* + \overline{e}^* \end{aligned}$$

[11] In Smets and Wouters (2007) these variables are expressed per capita by dividing with the population over 16. Our chice is motivated by the cross-country different long-run changes in participation and employment rates.

[12] For obvious reasons g_e^{EMU} does not affect the measurement equation for the real wage both in the first- and in the second-stage estimates.

where

$$\hat{e}_t = \frac{\beta}{1+\beta} E_t \hat{e}_{t+1} + \frac{1}{1+\beta} \hat{e}_{t-1} + \frac{(1-\xi_e)(1-\beta\xi_e)}{(1+\beta)\xi_e} \left(\hat{h}_t - \hat{e}_t\right) \tag{17}$$

$$\hat{e}_t^* = \frac{\beta}{1+\beta} E_t \hat{e}_{t+1}^* + \frac{1}{1+\beta} \hat{e}_{t-1}^* + \frac{(1-\xi_e^*)(1-\beta\xi_e^*)}{(1+\beta)\xi_e^*} \left(\hat{h}_t^* - \hat{e}_t^*\right) \tag{18}$$

As shown above, for each of the 4 models we consider an interest rate shock and, a set of country-specific shocks: two transitory sectoral TFP shocks, one shock to the productivity trend, a risk premium shock, an investment-specific shock, a preference shock, a government spending shock, price and wage markup shocks.

For sectoral inflation variables, the observation equations are:

$$\Delta \ln P_t = \pi_t + \overline{\overline{\pi}} \tag{19}$$

$$\Delta \ln P_t^* = \pi_t^* + \overline{\overline{\pi}} \tag{20}$$

where $\overline{\overline{\pi}}$ is set according to the first-stage estimates.

For the remaining non stationary variables the measurement equations are:[13]

$$\Delta \ln Y_t = \hat{y}_t - \hat{y}_{t-1} + \overline{\gamma} + \hat{g}_{z,t} + g_e \tag{21}$$

$$\Delta \ln Y_t^* = \hat{y}_t^* - \hat{y}_{t-1}^* + \overline{\gamma} + \hat{g}_{z,t}^* + g_e^* \tag{22}$$

were $\overline{\gamma}$ is retrieved from first-stage estimates. Note that we detect important differences in the g_e values estimated for the 4 countries, ranging between 0.139 for Germany and 0.53 for Spain (see Table 1). This, in turn, implies important changes in the dispersion of our observables. To gauge these effects in Figure 2 we plot the observables for GDP growth adjusted for the employment trend ($\Delta \ln Y_t - g_e$) which can be easily compared with the actual growth rates reported in Figure 1. It is easy to see that employment detrending reduces dispersion of GDP growth rates before the financial crisis and increases it afterwards.

[13] We allow for a measurement error in nontradables GDP equations.

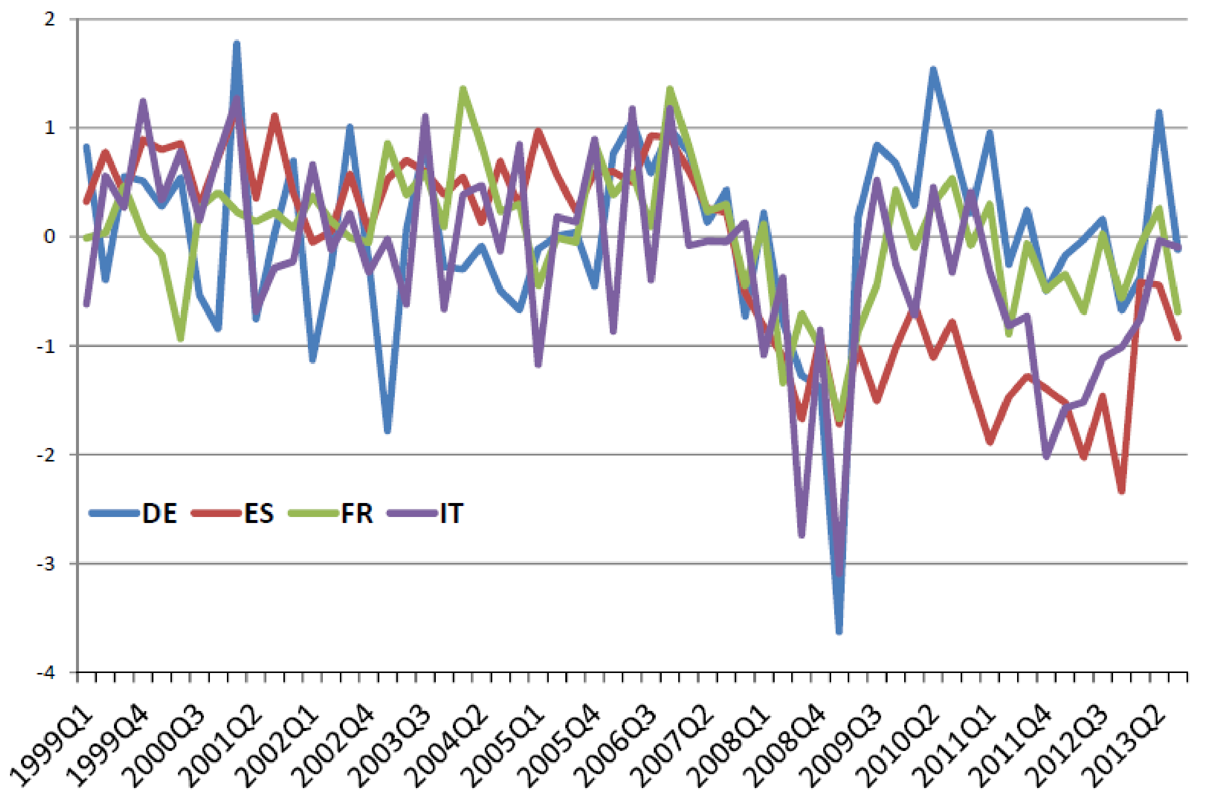

Figure 2: GDP growth (adjusted for employment trend) - EMU largest economies

For government expenditures we impose the following measurement equations:

$$\Delta \ln G_t = \frac{y}{g}\left(\hat{g}_t - \hat{g}_{t-1}\right) + \overline{\gamma} + \hat{g}_{z,t} + g_e \tag{23}$$

$$\Delta \ln G_t^* = \frac{y^*}{g^*}\left(\hat{g}_t^* - \hat{g}_{t-1}^*\right) + \overline{\gamma} + \hat{g}_{z,t}^* + g_e^* \tag{24}$$

where $\hat{g}_t$ is defined as $\frac{g_t - g}{y}$.

2.1.3 Calibration and priors

We calibrate a number of parameters at the same level for all EMU countries. Following Christoffel et al. (2008), the discount factor β is fixed at 0.9988, the steady-state depreciation rate δ is 0.025, the capital shares α_{int} are set at 0.3, the steady state net price and wage markups are fixed at 35% and 30% respectively, redistributive transfers are assumed to determine a steady state consumption ratio $c^{rt}/c^{o} = 0.8$.

Another set of parameters are calibrated using average sample data. For each of the four countries in Table 1 we report the country-size parameters s, the goods shares $(\gamma_c, \gamma_c^*, \gamma_i, \gamma_i^*, \varpi, \varpi^*)$, the constant tax and social contributions rates $\left(\tau^c, \tau^{c,*}\tau^l, \tau^{l,*}, \tau^k, \tau^{k,*}, \tau^l, \tau^{wf}\right)$, the steady state public-consumption- and debt-to-GDP ratios $\left(\frac{g}{y}, \frac{g^*}{y^*}, \frac{b}{y}, \frac{b^*}{y^*}\right)$.

Parameters s correspond to the HICP weights for each of the 4 countries. The shares of tradable consumption goods (γ_c, γ_c^*) correspond to sample-average shares of goods in the HICP basket. The shares of investment goods (γ_i, γ_i^*) are measured by the share of non-construction investments over total investment expenditures. The share of home produced goods in the tradable index ϖ is equal to one minus the average sample-period ratio between total bilateral imports and GDP. The rest of the Euro Area counterpart, ϖ^*, is obtained endogenously through the steady state. The constant tax rates are average sample ratios between the relevant revenue and tax-base series.[14] We use average sample ratios for calculating government-spending-to-GDP and debt-to-GDP ratios.[15] As pointed out above, parameters g_e^{EMU}, g_e and g_e^* are obtained from OLS estimates of $\ln e_t$.

The remaining parameters are estimated with Bayesian techniques. Priors, reported in Table 1 of the Online Appendix, are set in line with the literature on Euro Area models (see Smets and Wouters 2003, 2005; Christoffel et al. 2008; Rabanal 2009; Kolasa 2009). All the parameters priors are set symmetrically. In particular, parameters measuring the persistence of the shocks are assumed to be Beta distributed, with mean 0.5 and standard deviation 0.1 and the standard errors of the innovations are assumed to follow Gamma distributions, similarly to Rabanal (2009). The parameters governing price and wage setting, habits, utilization elasticity, interest rate smoothing and the steady state fraction of LAMP are also Beta distributed. The fractions of LAMP θ, θ^* are assumed to be Beta distributed with mean 0.4 and standard deviation 0.1, in line with the recent results obtained for the Euro Area by Albonico et al. (2014). The priors for the elasticity of substitutions in the consumption indices (e, υ) are set in line with Rabanal (2009) as Normal(1, 0.5) distributions.

In the closed economy model, we estimate the monetary authority's long-run (net) quarterly

[14] As a proxy for employees and employers social security contributions we assume that 1/3 of contributions are paid by the households while 2/3 of contributions are paid by firms, as in Christoffel et al. (2008).

[15] We derive the difference between aggregate transfers and taxes to GDP ratios as a residual from the steady state government budget constraint.

inflation objective $100\,(\bar{\pi}-1)$ assuming a prior mean of 0.5% (2% in annual terms), consistent with the ECB's quantitative definition of price stability. The trend growth rate of the economy is estimated with a Normal distribution with mean 0.6 (corresponding to 2.4% in annual terms) and 0.1 standard deviation. The parameters of the Taylor rule are normally distributed.[16] Risk aversion and the inverse of Frisch elasticity are Normally distributed, whereas the parameter defining investment adjustment costs is Gamma distributed.[17]

Table 1: Calibration of parameters

Parameters definition		***DE***	***FR***	***IT***	***ES***
β	discout factor	0.998			
δ, δ^*	depreciation rate	0.025			
α_N, α_H, $\alpha_{N,*}$ α_F	capital shares	0.3			
λ_p, λ_p^*	price markup	0.35			
λ_w, λ_w^*	wage markup	0.3			
$\frac{c^{rt}}{c^o}$, $\frac{c^{rt,*}}{c^{o,*}}$	consumption ratio	0.8			
s	country's size	0.294	0.205	0.183	0.109
γ_c	domestic share of tradable goods in consumption basket	0.624	0.611	0.616	0.644
γ_c^*	REA share of tradable goods in consumption basket	0.597	0.605	0.604	0.602
γ_i	domestic share of tradable goods in investment basket	0.43	0.460	0.48	0.37
γ_i^*	REA share of tradable goods in investment basket	0.49	0.472	0.47	0.48
ϖ	fraction of home-produced goods in the tradable index	0.91	0.958	0.897	0.902
τ_c	domestic consumption tax rate	0.215	0.277	0.232	0.187
τ_c^*	REA consumption tax rate	0.23	0.211	0.223	0.229
τ_l	domestic labor tax rate	0.303	0.226	0.402	0.199
τ_l^*	REA labor tax rate	0.229	0.262	0.222	0.262
τ_k	domestic capital tax rate	0.206	0.178	0.212	0.185
τ_k^*	REA capital tax rate	0.159	0.175	0.168	0.175
τ_{wh}	domestic payroll tax rate on wage income	0.127	0.142	0.149	0.108
τ_{wh}^*	REA payroll tax rate on wage income	0.131	0.126	0.125	0.132
τ_{wf}	domestic payroll tax rate on wage payments	0.254	0.285	0.298	0.216
τ_{wf}^*	REA payroll tax rate on wage payments	0.262	0.253	0.251	0.265
$\frac{b}{y}$	domestic debt to output ratio	0.912*4	0.687*4	1.091*4	0.569*4
$\frac{b^*}{y^*}$	REA debt to output ratio	0.669*4	0.772*4	0.679*4	0.777*4
$\frac{g}{y}$	domestic government spending to output ratio	0.186	0.229	0.189	0.180
$\frac{g^*}{y^*}$	REA government spending to output ratio	0.207	0.192	0.202	0.203
g_e	domestic employment trend	0.139	0.242	0.214	0.532
g_e^*	REA employment trend	0.257	0.220	0.226	0.181

[16] For the prior distributions of parameters estimated within the first stage, see Table 3.

[17] Where applicable, parameter calibrations and prior distributions are adopted in the estimated euro area-wide model.

3 Results

Our estimates of the policy rule parameters and of the productivity growth trend are reported in Table 2.

Table 2: Posterior mean estimates of parameters and shocks

Parameters		Prior distribution			Posterior	
		Shape	Mean	std dev.	Mean	90% HD
$\bar{\gamma}$	Quarterly deterministic trend	Norm	0.60	0.10	0.201	(0.11; 0.29)
$\bar{\pi}_*$	Quarterly inflation objective	Norm	0.50	0.10	0.623	(0.50; 0.75)
ϕ_r	Interest rate response to past interest rates	Beta	0.90	0.05	0.835	(0.80; 0.87)
ϕ_π	Interest rate response to inflation	Norm	1.70	0.10	1.743	(1.59; 1.90)
ϕ_y	Interest rate resp. to output	Norm	0.12	0.05	0.006	(0.00; 0.02)
$\phi_{\Delta y}$	Interest rate resp. to change in output	Norm	0.06	0.05	0.133	(0.11; 0.16)
$\phi_{\Delta \pi}$	Interest rate resp. to change in inflation	Norm	0.30	0.10	0.243	(0.18; 0.30)
LDD						-240.086

Table 3 shows the country-specific posterior mean estimates of structural parameters[18] obtained in the four countries second-stage estimates.[19]

We obtain fairly similar posterior estimates for the four countries, which are well identified. We observe important cross-country differences in the fraction of LAMP consumers, which is particularly large in Germany and small in Spain. This evidence can be rationalized following Kaplan et al. (2014) who suggest that θ is composed by "poor hand-to-mouth" consumers, who do not hold any type of assets, and "wealthy hand-to-mouth" consumers who cannot smooth consumption over the business cycle because their wealth is concentrated in illiquid assets, such as housing. For the countries considered here they estimate a similar ranking for the fraction of illiquid households, but cross-country differences are relatively smaller.

The elasticities of substitution e and υ have in general low posterior means. These low values are quite common in the literature that estimates open economy sticky price models because low elasticities are needed to explain higher volatility of relative prices than relative quantities (see Lubik and Schorfheide 2005, Rabanal and Tuesta 2006). Rabanal (2009) finds similar estimates for these parameters in Spain.

[18] Estimate results about shocks parameters are reported in Table 2 of the Online Appendix.

[19] Visual diagnostics of the estimation results are available upon request. The posterior distributions are computed considering 4 Monte Carlo Markov chains of 250,000 draws each, with 20% draws being discarded as burn-in draws. The average acceptance rate is comprised between 28 and 34 percent.

Table 3: Posterior mean estimates of parameters

	Parameters	DE	FR	IT	ES
e	Elasticity of subs. in the consump. index	0.194	0.175	0.347	0.222
		(0.056-0.325)	(0.047-0.295)	(0.127-0.552)	(0.064-0.372)
υ	Elasticity of subs. in the tradable consump. index	0.475	0.428	1.766	0.173
		(0.105-0.843)	(0.099-0.735)	(0.723-2.756)	(0.043-0.301)
σ	Intertemporal elasticity of substitution	2.508	2.678	2.441	1.880
		(2.013-3.001)	(2.117-3.222)	(1.942-2.952)	(1.444-2.350)
b	Degree of external habits	0.492	0.606	0.573	0.479
		(0.307-0.666)	(0.438-0.766)	(0.408-0.737)	(0.297-0.651)
ϕ_l	Inverse of Frisch elasticity	2.297	2.451	2.717	2.563
		(1.686-2.897)	(1.838-3.080)	(2.078-3.354)	(1.853-3.212)
θ	Fraction of LAMP	0.465	0.369	0.465	0.178
		(0.349-0.588)	(0.219-0.519)	(0.339-0.593)	(0.086-0.269)
γ_I	Degree of investment adjustment costs	5.002	5.309	4.555	4.986
		(3.986-5.979)	(4.420-6.245)	(3.720-5.419)	(4.235-5.661)
σ_u	Capacity utilization elasticity	0.361	0.307	0.423	0.262
		(0.288-0.435)	(0.222-0.398)	(0.350-0.504)	(0.168-0.346)
χ_p^N	Price index. to past inflation in non-trad. goods	0.681	0.880	0.868	0.882
		(0.505-0.855)	(0.797-0.966)	(0.771-0.967)	(0.804-0.964)
χ_p^H	Price index. to past inflation in tradable goods	0.340	0.365	0.270	0.309
		(0.203-0.468)	(0.226-0.499)	(0.151-0.381)	(0.183-0.427)
χ_p^F	Price index. to past inflation in imports	0.411	0.811	0.370	0.494
		(0.249-0.572)	(0.689-0.931)	(0.224-0.521)	(0.336-0.668)
ξ_p^N	Price stickiness in non-tradable goods	0.883	0.896	0.889	0.895
		(0.862-0.900)	(0.890-0.900)	(0.876-0.900)	(0.889-0.900)
ξ_p^H	Price stickiness in tradable goods	0.558	0.540	0.691	0.582
		(0.509-0.602)	(0.500-0.572)	(0.644-0.739)	(0.529-0.637)
ξ_p^F	Price stickiness in imports	0.565	0.637	0.436	0.550
		(0.510-0.621)	(0.587-0.690)	(0.387-0.472)	(0.496-0.606)
χ_w	Wage indexation to past inflation	0.712	0.743	0.787	0.757
		(0.537-0.910)	(0.595-0.891)	(0.640-0.937)	(0.622-0.895)
ξ_w	Wage stickiness	0.851	0.833	0.688	0.854
		(0.812-0.894)	(0.791-0.876)	(0.619-0.758)	(0.817-0.894)
ξ_e	Calvo employment	0.525	0.589	0.547	0.653
		(0.470-0.580)	(0.541-0.637)	(0.501-0.595)	(0.614-0.692)

3.1 Variance decompositions

The output variance decomposition (Table 4) highlights the different role played by supply and demand shocks in the four countries. Demand shocks played a relatively limited role in the souther countries. In Italy technology shocks and, to a lesser extent, public consumption shocks explain a relatively larger fraction of output growth volatility. Domestic (price) markup shocks were particularly important in Germany and Spain.

Table 4: Output variance decomposition

	DE	FR	IT	ES
Domestic Demand	35.94%	45.32%	24.26%	28.88%
Domestic Technology	53.66%	42.54%	46.08%	46.34%
Domestic Markup	4.69%	5.93%	5.35%	13.26%
Domestic Public consumption	2.37%	0.33%	21.15%	3.86%
Monetary policy	1.01%	1.75%	1.34%	0.93%
REA	2.33%	4.13%	1.81%	6.74%
Contributions of individual domestic shocks				
TFP Non tradables	15.89%	11.60%	21.13%	17.01%
TFP tradables	13.62%	20.09%	12.96%	15.38%
Permanent technology	24.14%	10.85%	12.00%	13.95%
Price markup	1.66%	1.57%	1.38%	4.50%
Wage markup	3.03%	4.36%	3.97%	8.76%

Turning to the inflation variance decomposition (Table 5), we see that a combination of technology and mark up shocks explains the bulk of inflation volatility in all countries.

Table 5: Inflation Variance decomposition

	DE	FR	IT	ES
Domestic Demand	9.22%	9.07%	12.14%	4.38%
Domestic TFP Non tradables	20.36%	6.34%	4.53%	14.97%
Domestic TFP tradables	46.88%	62.81%	36.18%	52.15%
Domestic permanent technology	3.68%	2.37%	20.32%	2.71%
Domestic Price markup	3.15%	0.61%	1.73%	0.86%
Domestic Wage markup	11.74%	10.29%	13.04%	20.98%
Domestic Public consumption	0.29%	0.00%	0.41%	0.10%
Monetary policy	1.19%	2.13%	4.17%	0.50%
REA	3.48%	6.38%	7.48%	3.35%

Finally, volatility of the public consumption ratio is explained by non-policy shocks in all countries but Italy, where fiscal discretion was the main source of volatility (Table 6).

Table 6: Governement spending over GDP variance decomposition

	DE	FR	IT	ES
Non-policy	77.06%	96.56%	28.36%	68.67%
Monetary policy	1.06%	1.91%	0.55%	0.76%
Government spending	21.89%	1.53%	71.09%	30.58%

All in all, the variance decompositions emphasize the limited role played by demand shocks in explaining the volatility of GDP growth and inflation in southern countries.

3.2 Historical decompositions

In this section, we present the historical decompositions for the growth rates of output, exchange rate, real wages index and public-consumption-to-GDP ratio (Figures 4, 6, 7 and 8, respectively). We address the key question whether exceedingly favorable demand conditions predated the financial crisis episodes or whether the sovereign bond crisis should be seen as a game changer that created a new economic environment within the Eurozone.

3.2.1 Output growth

To begin our discussion it may be helpful to look at the historical decomposition for the whole Eurozone, obtained from first-stage estimates (Figure 3). Demand shocks, including monetary and fiscal policies, were crucial to determine the pre-financial crisis growth acceleration. The financial crisis was mainly determined by a sequence of large non-policy demand shocks. Then, the post 2010 downturn is explained by a combination of markup, technology and non-policy demand shocks.

In Germany a sequence of favorable demand shocks supported growth in the 2003-2007 period, then there was a huge reversal in domestic demand shocks at the time of the 2007-2008 global crisis. Finally, the 2010- period was characterized by a reduction in volatility. For France we observe a similar pattern in the 2003-2007 period, when the favorable demand shocks were crucial to foster growth, but in the subsequent years technology shocks contributed more to the growth slowdown.

Results for Italy are quite different. First, in the 2003-2007 period we cannot detect a growth acceleration, and demand shocks remained subdued relative to Germany and France. Unlike these two countries, public consumption shocks in Italy played an important role, but there is no evidence of an expansionary bias. Second, since 2008 and particularly after 2010 adverse technology shocks became very important. Figure 5 presents the decomposition of technology shocks contributions: the post 2008 years are characterized by a sequence of adverse permanent shocks. Third, public consumption shocks were erratic and became almost irrelevant from 2010 onwards.

Output growth decomposition for Spain highlights some specific business cycle features. First, the pre-2008 high-growth period is characterized by a combination of favorable demand and technology shocks, where the latter were mainly characterized by permanent shocks. The global financial crisis period is marked by adverse demand shocks. Since 2010, the onset of the sovereign bond crisis is associated to a sequence of adverse permanent productivity shocks that were decisive to determine the growth slowdown. Relative to Italy, public expenditure shocks had a very limited influence on GDP growth, but after 2010 we observe an increase in their amplitude.

3.2.2 Real exchange rate growth

According to popular wisdom the early EMU years where characterized by exchange rate appreciations in the periphery. As a matter of fact, the Italian real exchange rate mainly depreciated prior to the crisis, and domestic demand conditions contributed to this outcome. Spain is the only country which was characterized by pre-financial crisis appreciation. Our decomposition highlights the overwhelming role played by technology shocks in determining this outcome.

3.2.3 Real wage growth

Demand driven wage increases have been singled out as the main culprit of competitiveness losses in the south of the Eurozone. In fact neither country was characterized by wage growth rates that systematically exceeded the corresponding wage growth rates for the rest of the Eurozone. Moreover, demand shocks played a limited role in determining wage dynamics in these two countries before the onset of the financial crisis. After 2010 technology shocks became the dominant force behind the observed slowdown in wage growth rates.

3.2.4 Public consumption ratios

As mentioned above, in Italy public consumption shocks were relatively more important up to 2010, but we cannot identify a tendency to implement undisciplined discretionary policies. After 2010 the public consumption ratio is remarkably more stable. Germany, Italy and Spain share a tendency to implement accommodative discretionary policies: shocks often drive the ratio in the same direction of non-policy shocks. In France the ratio is almost entirely determined by non-policy shocks.

3.2.5 Summing up

Our results cannot support the view that pre-2007 growth in the two southern countries was driven by a demand boom. Perhaps surprisingly, favorable demand conditions were relatively more important in France and in Germany. Competitiveness indicators, measured by real exchange rate and wage growth confirm this conclusion, as demand factors played a negligible role in determining these variables in Italy and Spain.

One striking result is that asymmetric shocks to the productivity trend play a non-negligible role in explaining the favorable performance of Spain before the crisis, and are major determinants of the turnaround in growth perspectives for the two southern countries after 2010.

Given the differential role of permanent technology shocks in the 4 countries, in Figure 9 for each country we plot the estimated productivity growth rates $\ln(g_{z,t})$ for the four countries. Results are striking. Productivity growth was below trend in Germany up until 2007 and became strongly positive since then. France experienced more favorable growth rates in the early EMU years and maintained a good performance after 2010. Evidence for Italy is particularly gloomy: productivity growth has fallen since 2002, and the situation worsened dramatically after 2010. Up until the 2008 financial crisis Spain experienced the fastest productivity growth rates, well above the balanced growth rate. Then productivity growth dramatically deteriorated after 2010.

One might wonder whether our results concerning the importance of permanent technology shocks might be due to model misspecification, possibly due to our choice to abstract from explicit modelling of financial frictions. To answer this question in Figure 10 we report the IRFs to a temporary shock to the productivity growth rate estimated for Spain. A temporary slowdown in productivity growth has a contractionary effect. Consumption is reduced, investment output and hours worked fall, along with the real wage and inflation. Relative to temporary contractionary shocks there are two key distinct features: the first is that Ricardian consumers now react to the permanent income reduction and their willingness to smooth consumption is therefore limited, the second is that the shock causes permanent adjustments in the long run. In fact neither effect could possibly materialize in DSGE models which account for banking frictions but neglect stochastic growth trends, such as the ones estimated in Brzoza-Brzezina and Kolasa (2013).

To conclude our discussion, note that the deflationary impact of the shock determines a real depreciation both in the short and in the long run. This last result allows to provide an alternative interpretation of the persistent real exchange rate appreciation observed for Spain before the financial crisis, in sharp contrast with the view that interprets it as the consequence of a demand boom.

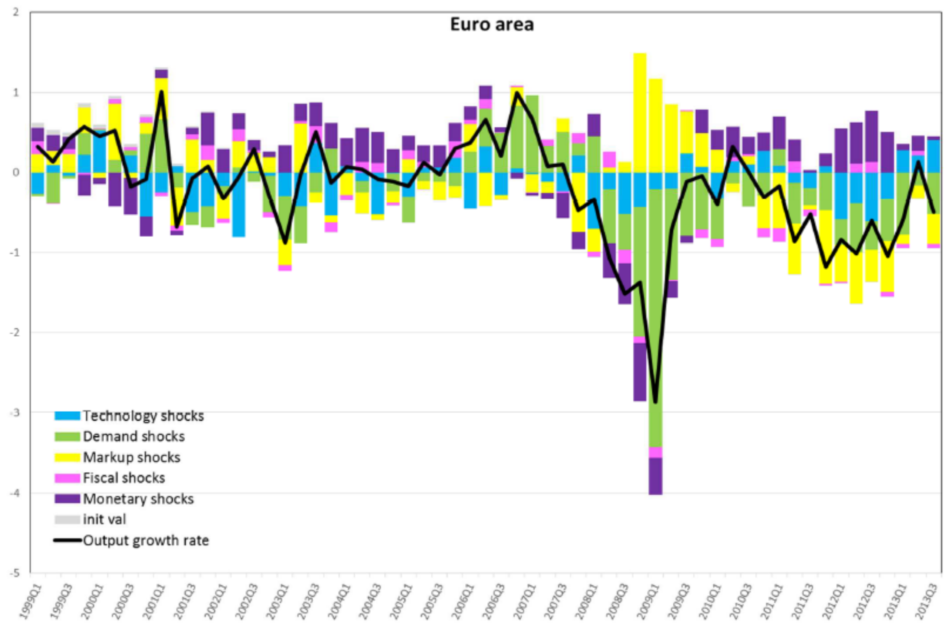

Figure 3: Historical decomposition of output growth in the Euro area.

Figure 4: Historical decomposition of output growth.

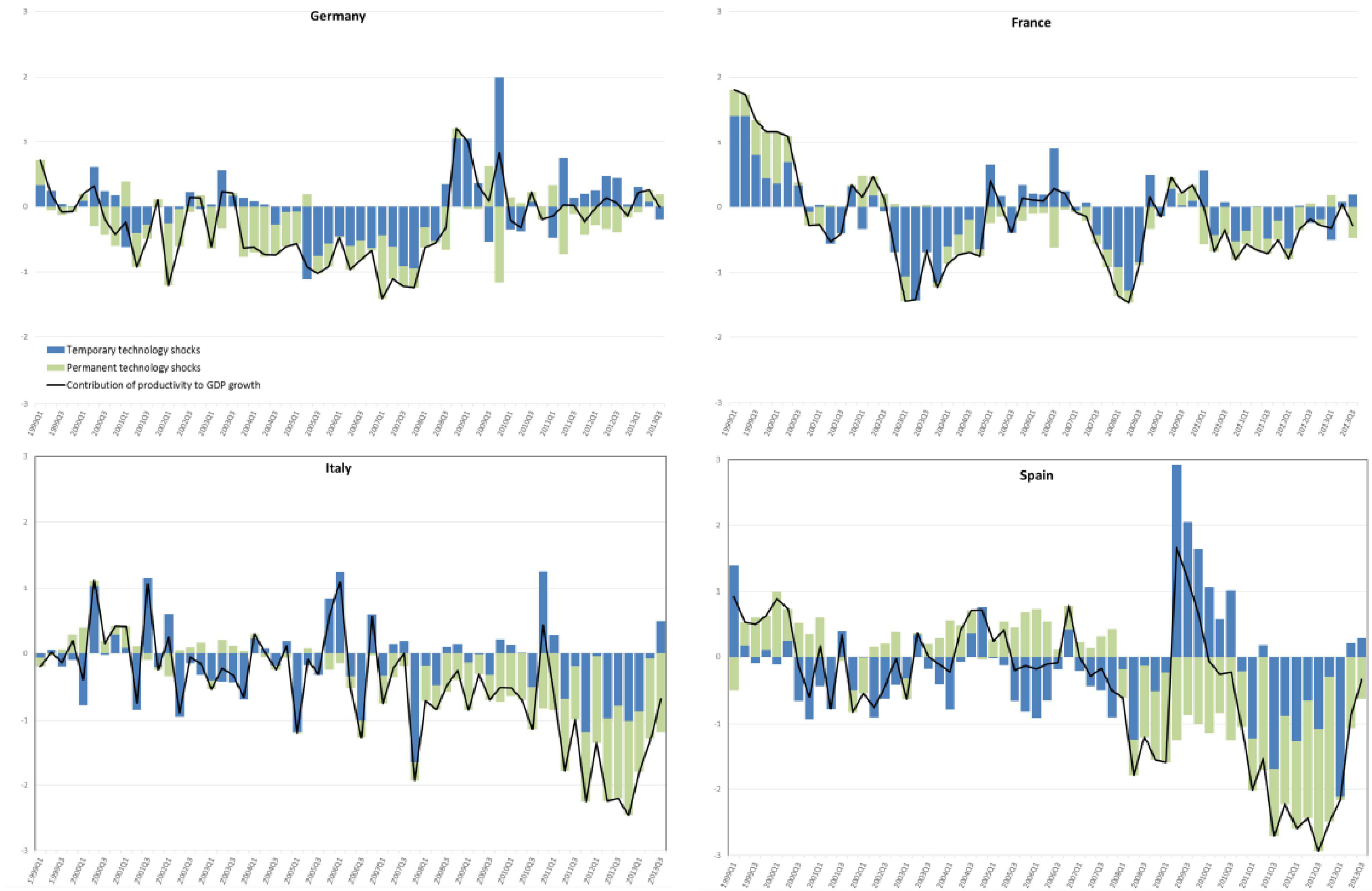

Figure 5: Contribution of productivity shocks to output growth.

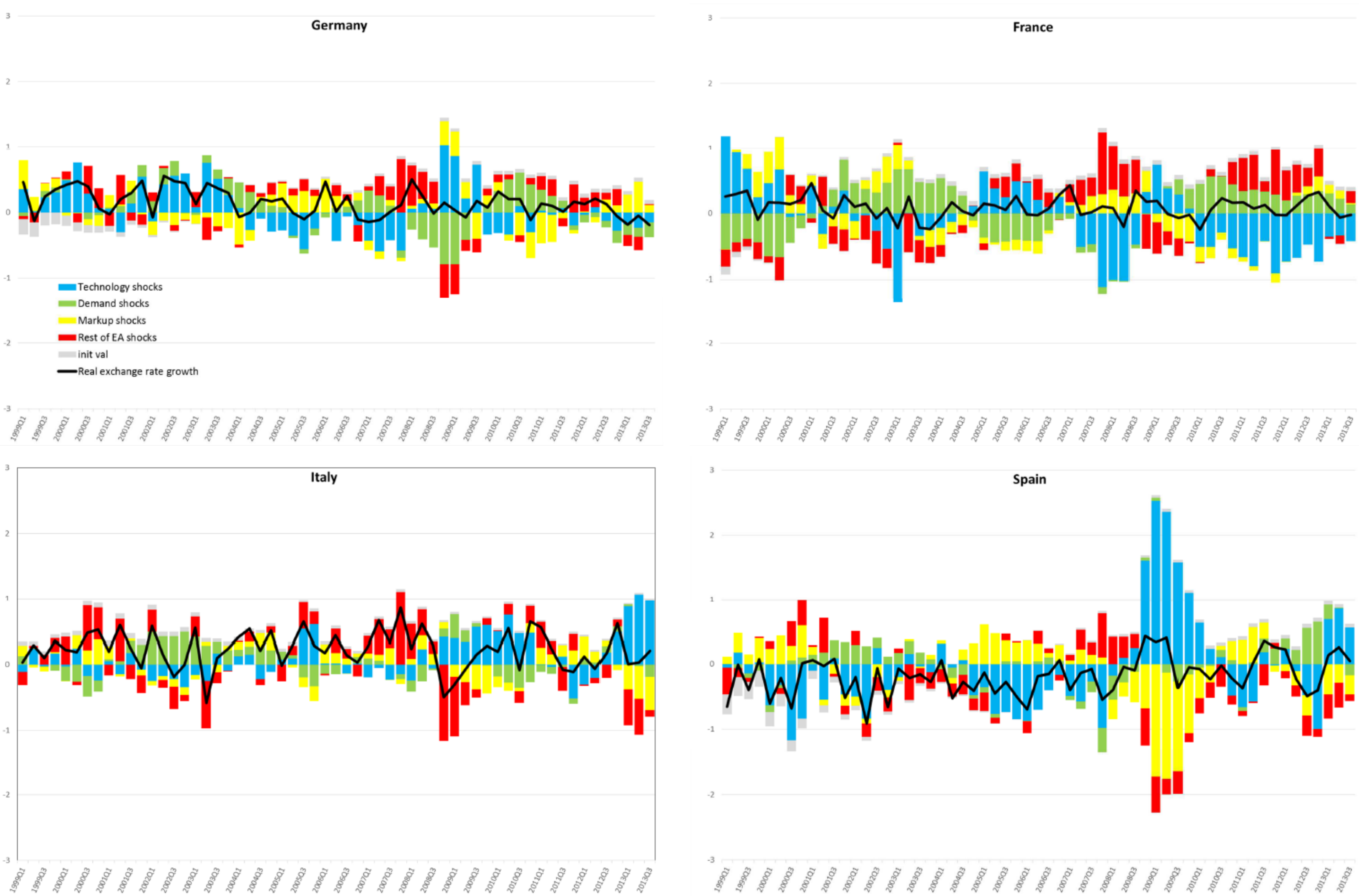

Figure 6: Historical decomposition of real exchange rate growth.

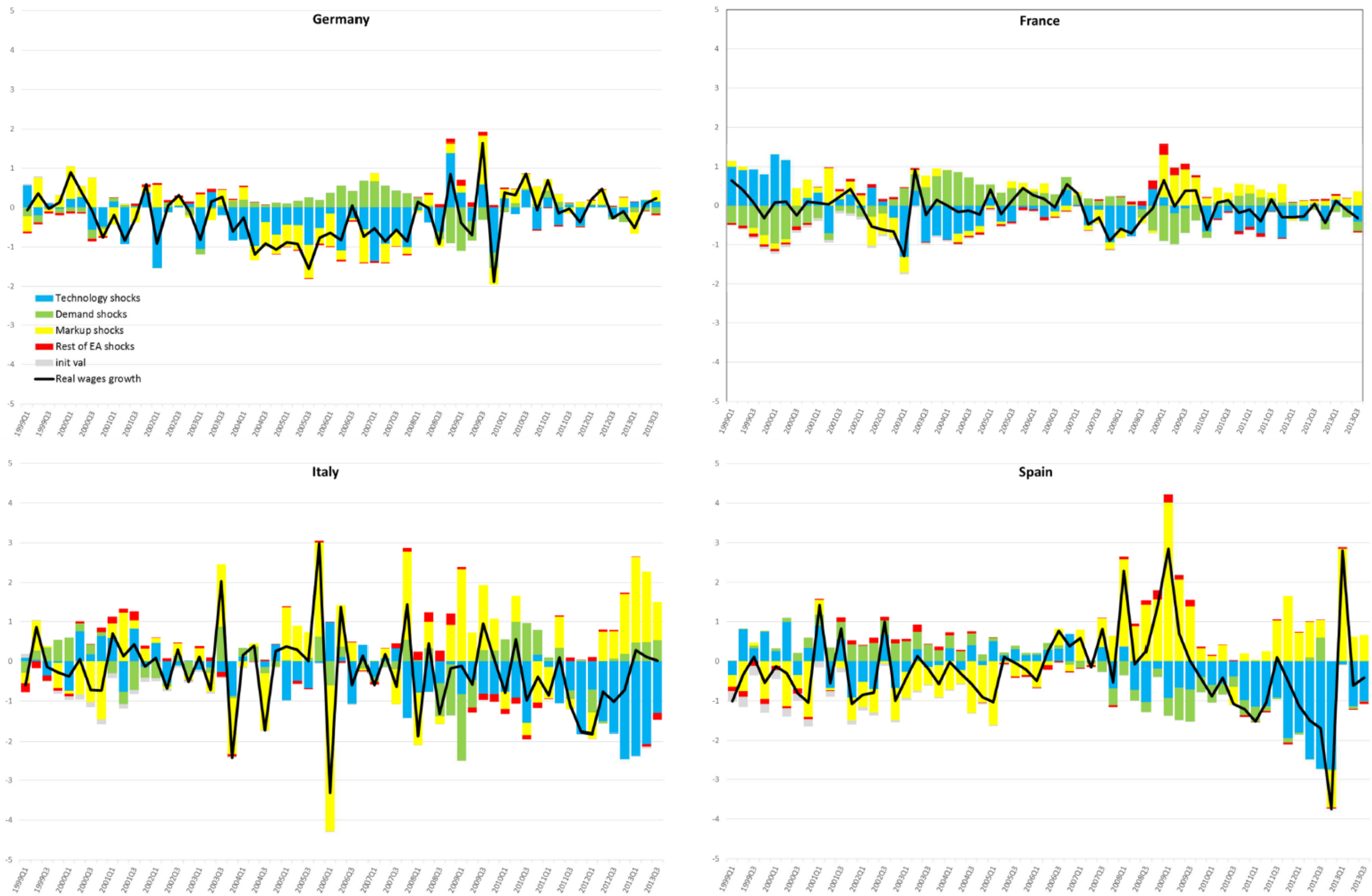

Figure 7: Historical decomposition of real wages growth.

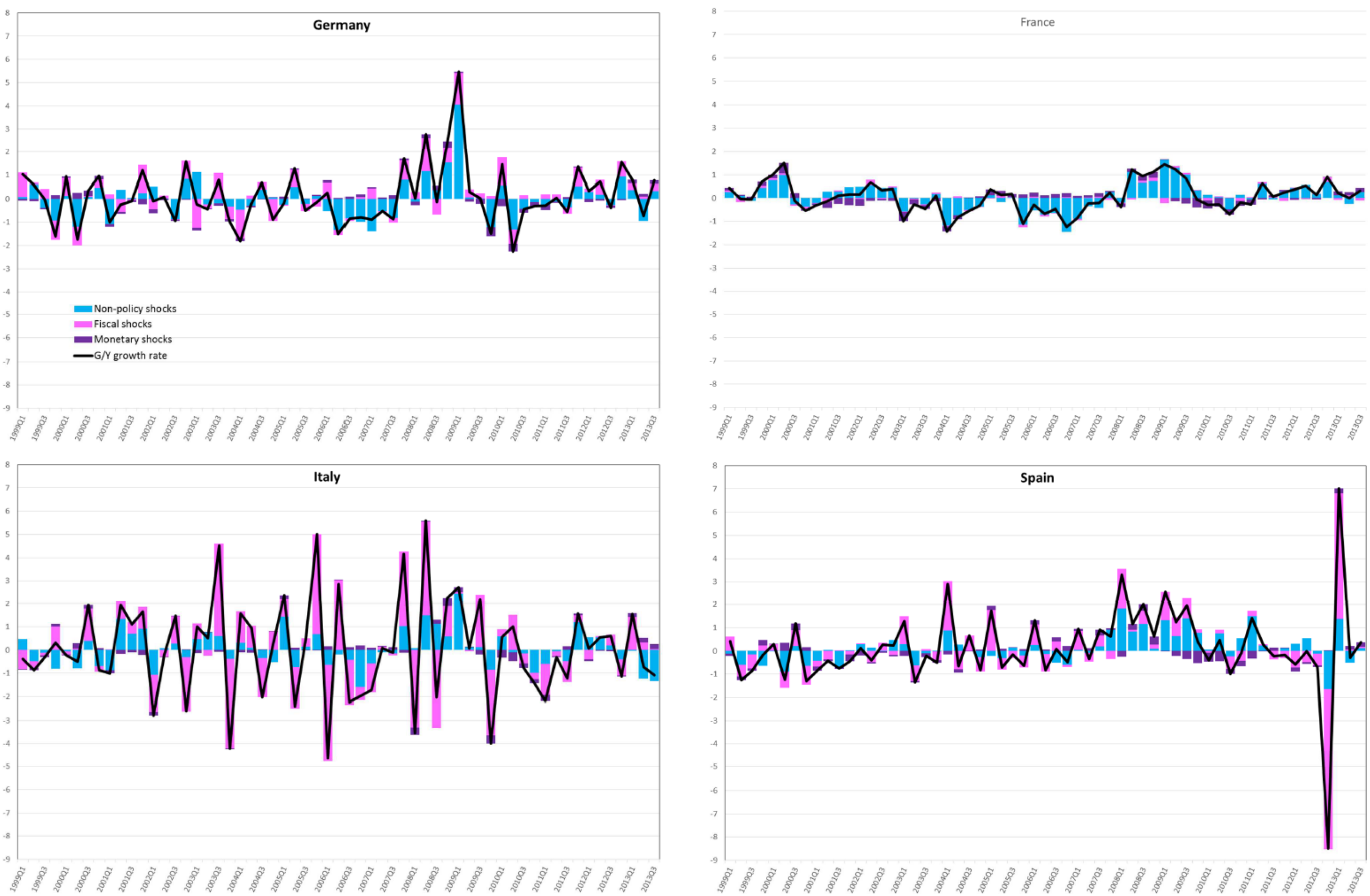

Figure 8: Historical decomposition of G/Y growth rate.

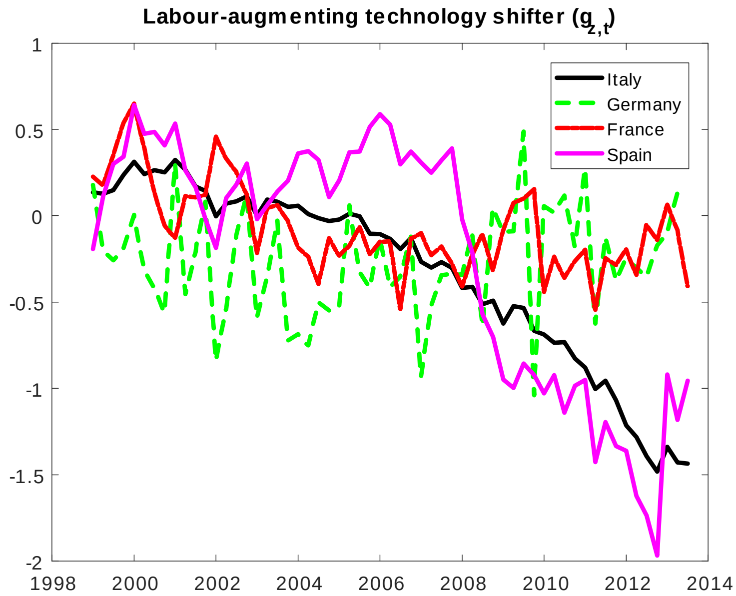

Figure 9: Estimated permanent technology shocks.

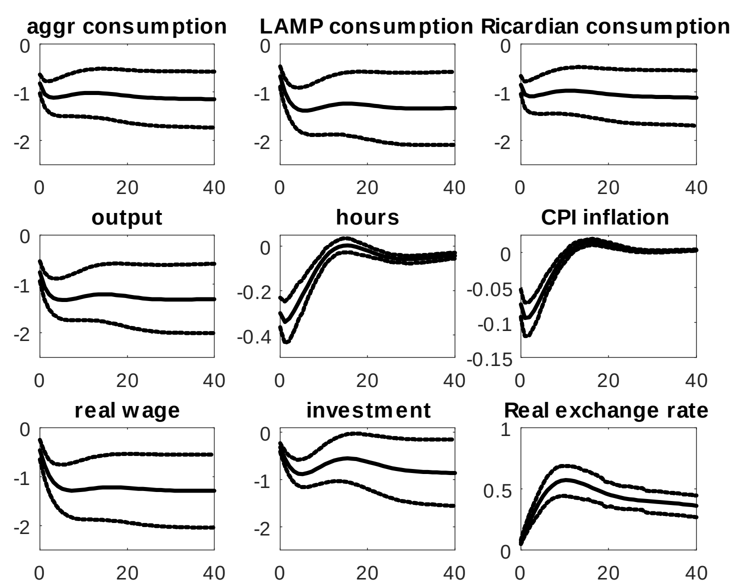

Figure 10: Impulse response functions to a negative permanent technology shock (Spain).

4 Conclusions

According to a popular wisdom, loose domestic credit conditions and undisciplined fiscal policies generated an illusory boom in the Eurozone southern economies, leading to competitiveness deterioration. These were the underlying factors that eventually led to sovereign bond crisis.

We cannot find support for this thesis in the cases of Spain and Italy, which account for 90% of the size of EMU southern economies. In fact, pre-2007 dynamics of growth and inflation in these two countries were not systematically stimulated by demand shocks. Further, the post-2010 severe output contraction experienced in these two countries was mainly determined by permanent adverse technology shocks. Thus the output losses experienced in these countries cannot be interpreted as a one-off price to pay in order to restore external competitiveness. Further, achieving cyclical recovery will not be sufficient to restore the relative income level that these countries had reached before the crisis.

To the extent that the slow down in productivity growth was the consequence of a credit crunch, our results suggest that macroeconomic policies should promote credit availability and favorable external financing conditions for innovative firms, and attempt to generate adequate domestic demand stimulus. In this regard it is interesting to note the relatively favorable growth performance of the Spanish economy in the last couple of years. In that country the government managed to free domestic banks from the burden of non-performing loans and was also allowed to escape the 3% deficit ceiling, whereas in Italy the solution to bank problems was delayed and the EMU rules limited fiscal flexibility due to the large stock of outstanding public debt.

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