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Working paper

Do Euro Area Countries Respond Asymmetrically to the Common Monetary Policy?

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Abstract

We investigate the possible existence of asymmetries among Euro Area countries reactions to the European Central Bank monetary policy. Our analysis is based on a Structural Dynamic Factor model estimated on a large panel of Euro Area quarterly variables. We find that, despite the single monetary policy has had the effect of reducing heterogeneity in impulse responses, member states still react asymmetrically in terms of prices and unemployment, while no difference appears in terms of output. These results are the consequence of country specific structures, rather than of European Central Bank policies.

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1 Introduction

Before the introduction of the common currency, every Euro Area (EA) member state's central bank had a different attitude towards the objectives of containing inflation and boosting economic growth (Clarida et al., 1998; Mihov, 2001). After 1999 the European Central Bank (ECB) took over national central banks and imposed a common monetary policy. Nowadays, all EA countries are subject to this single policy, but are still characterized by different economic structures, legislations, fiscal policies, and levels of public debt. Such a diversified environment makes the ECB decision process particularly challenging as member states' reaction to its policies might be different from country to country.

It is then natural to ask if there is any asymmetry in how single EA countries respond to the common monetary policy decided by the ECB. This is an important question both from the ECB and from member states' perspective. Indeed, while the ECB has to take into account possible asymmetries in order to avoid instabilities within the EA, member states have to consider their reaction to monetary policy before setting appropriate national policies.

The monetary transmission mechanism in the EA has been already investigated in the literature, both at the aggregate level (Monticelli and Tristani, 1999; Peersman and Smets, 2003; Cecioni and Neri, 2011) and among countries (Mojon and Peersman, 2003; Peersman, 2004) by means of Structural VAR (SVAR) models. In spite of some exceptions (Clements et al., 2001; Ciccarelli and Rebucci, 2006; Rafiq and Mallick, 2008), a substantial consensus is reached by these studies on excluding asymmetric effects of monetary policy across member states.

In this paper we use a different approach. We study how single EA countries respond to ECB decisions by estimating a Structural Dynamic Factor model estimated on a large panel of EA quarterly time series spanning the period from 1983 to 2007. We find that, although the introduction of the euro has changed the monetary transmission mechanism in the individual countries towards a more homogeneous response, EA countries react asymmetrically to the common monetary policy in terms of prices and unemployment, while no difference appears in terms of output. We conclude that these differences are the consequence of country specific structures rather than of ECB policies, and hence they should be addressed by means of national fiscal policies, regulation, and structural reforms.

Since the seminal contributions of Giannone et al. (2005), Bernanke et al. (2005), Stock and Watson (2005), and Forni et al. (2009), a factor approach has been used as an alternative to SVAR for macroeconomic analysis. One major advantage of factor models is to allow for dealing with very large panels of data without suffering from the curse of dimensionality. Moreover, due to strong co-movements among macroeconomic time series, factor models often provide a realistic representation of the data by assuming the existence of few common shocks as the main source of business cycle fluctuations. In the present context, this implies the possibility of disentangling EA-wide from country specific shocks: a desirable feature for analyzing ECB monetary policy, which, by definition, is common to all member states.

Recent literature employed factor models to analyze EA economies although, in general, with a different focus with respect to the present study. Sala (2003) studies the transmission of common monetary policy shocks across European countries but by estimating his model only on pre–euro data. Eickmeier and Breitung (2006) and Eickmeier (2009) conclude that heterogeneity across EA countries is mainly a result of idiosyncratic shocks. Favero et al. (2005) find homogeneous effects of monetary policy shocks on output gaps and inflation rates, while McCallum and Smets (2009) find heterogeneous responses in terms of real wage. Finally, Boivin et al. (2009) show that the common currency has contributed in shaping a greater homogeneity of the monetary policy transmission mechanism across countries.

Among these papers, the study most similar to ours is Boivin et al. (2009). However, while they are mainly interested in financial variables (bond yields, monetary aggregates, and exchange rates), our main focus is on variables of economic activity (GDP and its components, prices, and unemployment). Additionally, the empirical procedure of our study differs from Boivin et al. (2009) in the choice of treatment of structural breaks, and identification of monetary policy shocks. Hence, this paper contributes to the procedure used to estimate a structural dynamic factor model and to identify the impact of common monetary shocks on the economic activity of EA member states, and it also adds new evidence on possible cross-country asymmetries in the reaction to these shocks.

In the next section we outline the econometric methodology used in the empirical analysis. In section 3 we describe the dataset and the data transformation used, highlighting some stylized facts related to the existence of co-movements in the EA data. In section 4 we explain the identification strategy employed, while in section 5 we discuss country specific impulse responses of prices, output, consumption, investment, and unemployment to the common monetary policy shock. Finally, section 6 concludes.

2 Structural Dynamic Factor model

We consider here the Structural Dynamic Factor model firstly introduced by Giannone et al. (2005), Stock and Watson (2005), and Forni et al. (2009), which is a development of the model originally proposed by Stock and Watson (2002) and Bai (2003), and it is a particular case of the generalized dynamic factor model by Forni et al. (2000) and Forni and Lippi (2001). Similar models were also proposed by Sargent and Sims (1977), Geweke (1977), Chamberlain and Rothschild (1983), and Bernanke et al. (2005).

We assume that there exist two kind of sources of business cycle fluctuations in the national EA economies: (*i*) few structural shocks common to all countries and affecting the whole EA (e.g. monetary policy or oil shocks), and (*ii*) many idiosyncratic shocks (capturing for example country/regional/sectoral specific dynamics) having only marginal effects on the whole Area. Within this framework we consider a shock as common if it has a non-negligible effect over all EA economies, while we consider a shock as idiosyncratic if it affects only some countries or some sectors. This representation is indeed very realistic: think, for example, of a national shock having only limited, although maybe non-null, effects outside the country where it originated, or to sectoral-specific effects as in constructions or manufacturing.

Each stationary time series x_{it}, $i = 1, \ldots, n$ and $t = 1, \ldots, T$, where n is the number of variables and T is the sample length, is written as the sum of two mutually orthogonal unobservable components which account for the two sources of fluctuations: (*i*) the common component χ_{it} and (*ii*) the idiosyncratic component ξ_{it}. The common component χ_{it} is a linear combination of $r \leq n$ common factors f_{kt}, $k = 1, \ldots, r$, which are in turn driven by

$q \leq r$ common shocks u_{jt}, $j = 1, \ldots, q$.[1] Formally:

$$x_{it} = \chi_{it} + \xi_{it}, \tag{1}$$

$$\chi_{it} = \sum_{k=1}^{r} \lambda_{ik} f_{kt} = \boldsymbol{\lambda}_i' \mathbf{f}_t, \tag{2}$$

$$\mathbf{A}(L)\mathbf{f}_t = \mathbf{H}\mathbf{u}_t, \tag{3}$$

where $\boldsymbol{\lambda}_i$ is an r-dimensional vector of factor loadings, $\mathbf{A}(L)$ is an $r \times r$ matrix lag polynomial, $\mathbf{H}$ is an $r \times q$ matrix, $\mathbf{u}_t$, with $\mathbf{u}_t \sim iid(\mathbf{0}, \mathbf{I})$, is the q-dimensional vector containing the common shocks which are orthogonal also to the idiosyncratic components at any lead and lag. The idiosyncratic components can be mildly cross sectionally correlated, while, provided that stationarity is ensured, no assumption is made on their serial correlation properties.[2]

As proved by Forni et al. (2009), consistent estimation of (1)-(3), as both n and T go to infinity, and assuming both q and r are known, can be achieved in three steps. First, the factors f_{kt} and the corresponding loadings in (2) are estimated by means of principal components. Second, $\mathbf{A}(L)$ in (3) is estimated by running a VAR on the estimated factors. Finally, given the residuals obtained from the VAR estimation, the common shocks are estimated as the q largest principal components of the residuals, while $\mathbf{H}$ is estimated by projecting the residuals on the estimated shocks.[3]

From (1)-(3) we can write each observed macroeconomic variable as:

$$x_{it} = \sum_{j=1}^{q} b_{ij}(L) u_{jt} + \xi_{it} = \mathbf{b}_i(L)\mathbf{u}_t + \xi_{it},$$

where

$$\mathbf{b}_i(L) = \boldsymbol{\lambda}_i' \mathbf{A}^{-1}(L)\mathbf{H}, \tag{4}$$

are the impulse response functions of the common component of the i-th variable to the q common shocks. In this paper, we are just interested in the impulse response functions to the common shock representing the ECB monetary policy. Given its pervasive nature, the monetary policy shock is assumed to be one of the q common shocks u_{jt} and we denote it as u_t^{mp}. Without loss of generality, we assume the shock of interest to be the first one, so that the vector of common shocks is $\mathbf{u}_t = (u_t^{mp}, u_{2t}, \ldots, u_{qt})'$ and the impulse response functions (4) are written as

$$\mathbf{b}_i(L) = b_i^{mp}(L) + \sum_{j=2}^{q} b_{ij}(L),$$

and we focus only on the first term on the right hand side. However, it is well known that, unless additional restrictions are imposed, only the space spanned by the common factors is identified. As a consequence, impulse responses and common shocks in (4) are identified only up to multiplication by a $q \times q$ rotation matrix $\mathbf{R}$. In the present context, in order to achieve

[1] The literature has often referred to f_{kt} as the *static factors*, while to u_{jt} as *dynamic factors*. For a formal treatment of the model presented in this section see Forni et al. (2009).

[2] The literature refers to this model as the *approximate factor model* to be distinguish from the *exact factor model* which is characterized by cross-sectionally-dynamically uncorrelated idiosyncratic component, i.e. $\xi_{it} \sim iid(0, 1)$.

[3] Other estimation methods for model (1)-(3) have been proposed in Doz et al. (2011a,b).

identification, we impose economically meaningful restrictions as those in Forni et al. (2009), Forni and Gambetti (2010a), and Luciani (2012).[4]

Finally, in order to account for estimation uncertainty, we build confidence intervals using a bootstrap algorithm as in Bernanke et al. (2005) and Eickmeier (2009). At each iteration d, we bootstrap the estimated common shocks $\tilde{\mathbf{u}}_t^d$ and we generate new common factors as $\tilde{\mathbf{f}}_t^d = \widehat{\mathbf{A}}^{*-1}(L)\widehat{\mathbf{H}}\tilde{\mathbf{u}}_t^d$, where the * indicates that, as in Kilian (1998), we correct for the distortion induced by the VAR estimation on the common factors. We then estimate the parameters of equation (3) and identify the shocks as described in section 4, thus obtaining new bootstrapped impulse response functions.[5]

Collecting together all admissible impulse responses (the one on the sample and those on the bootstrap) gives a distribution of impulse responses from which we can get point estimates and confidence bands by computing the median and relevant percentiles.

2.1 Structural Dynamic Factor models in the Euro Area

EA economic history is characterized by two different institutional frameworks separated by the fixing of exchange rates in January 1999. These two exchange rate regimes are likely to have determined a structural break in the data around 1999:Q1. For this reason, we assume the existence of a structural break in our data and we take it into account by proceeding as follows:

1. we estimate the Structural Dynamic Factor model on a panel of 237 quarterly series from 1983:Q1 to 2007:Q4 in order to have consistent estimates of the space spanned by the common factors $\mathbf{f}_t$ and consequently of the space spanned by the common shocks $\mathbf{u}_t$;

2. we re-estimate the loadings $\boldsymbol{\lambda}_i$ for the pre-euro sample (1983:Q1-1998:Q4) and for the euro sample (1999:Q1-2007:Q4) separately;

3. we identify the monetary policy shock separately over the two subsamples.[6]

This procedure is justified on the basis of two results. On the one hand, Breitung and Eickmeier (2011) prove that in presence of a structural breaks, factor loadings $\boldsymbol{\lambda}_i$ may be inconsistently estimated. On the other hand, Stock and Watson (2002) demonstrate that the space spanned by the common factors $\mathbf{f}_t$ can still be estimated consistently if there is *limited time variation* in the loadings. The latter is a reasonable assumption in the context of EA, as the introduction of a single currency was indeed a gradual process which started in February 1992 with the Maastricht Treaty, and continued with the launching of the fixed exchange rate regime in January 1999 and the creation of the ECB, as established by the Treaty of Amsterdam effective since May 1999.

[4] Let $\mathbf{R}$ be a rotation matrix such that $\mathbf{R}\mathbf{R}' = \mathbf{I}$, and let $\mathbf{c}_i(L) = \mathbf{b}_i(L)\mathbf{R}$, and $\boldsymbol{\epsilon}_t = \mathbf{R}'\mathbf{u}_t$, then the model $x_{it} = \mathbf{c}_i(L)\boldsymbol{\epsilon}_t + \xi_{it}$ is observationally equivalent to model (1)-(3). As in SVARs, structural shocks and impulse response functions are unique up to an orthogonal transformation (i.e. a rotation) and structural analysis in the present context becomes analogous to the standard structural analysis in VARs.

[5] As demonstrated by Bai and Ng (2006), when $N \gg T$ the estimated factors can be treated as if they are directly observed rather than estimated, and hence inference on impulse responses can be conducted by ignoring the idiosyncratic component.

[6] Since Weber et al. (2011) find that the transmission mechanism of monetary policy was similar before 1996 and after 1999 but different during the transition period 1996-1998, as a robustness check we perform our analysis on the subsample 1983-1996 rather than 1983-1998. Results are identical to the one obtained with our benchmark specification, and are available in a complementary appendix to this paper.

Given their relevance for our analysis, we need to formally test these assumptions on the behavior of the common factors and their loadings. In order to do so, we first run a CUSUM Square test on the common factors (Brown et al., 1975) and find no significant structural change (figure 1). Then, we run the structural break test of Breitung and Eickmeier (2011) on the factor loadings, which indicates structural break on January the 1st 1999 for all the series of interest (table 1). These results are consistent with Canova et al. (2012) and Breitung and Eickmeier (2011).

2.2 Testing for asymmetries

In order to evaluate the presence of significant differences across impulse responses we should test the null-hypothesis of no differences. Olivei and Tenreyro (2010) propose a procedure to test for differences among impulse responses in VAR models. Their test consists in computing differences among observed impulse responses and then compare them with a distribution of distances obtained from data simulated from two different VARs. Unfortunately, this test is unfeasible in our case. Indeed, while Olivei and Tenreyro (2010) aim at comparing impulse responses of the same variable, but estimated from two different (VAR) models, we are interested in comparing responses of different variables, but estimated from the same (factor) model. Hence, in our case we should be able to simulate data from a factor model in which all impulse responses are equal. Building such a distribution would lead to a degenerate distribution in which all distances among impulse responses are zero, i.e. a useless distribution for making inference.

Therefore, in order to have an approximate measure of asymmetries, we rely on a simple procedure with a clear intuitive meaning. In particular, for each bootstrap, we compute the difference between the individual country response and the Euro Area response. These gives us a distribution of differences between impulse responses. We consider the difference non significant if zero is contained within the confidence bands.[7] A similar procedure is used also by Fielding and Shields (2011).

3 Model setup

3.1 Data and data treatment

Data include EA aggregates, main macroeconomic variables for single EA member states, and key indicators for the United Kingdom, the United States, and Japan. The database contains 9 aggregate EA variables: GDP, CPI, short and long term rates, monetary aggregates (M1 and M3), unit labor cost, real effective exchange rate, and the dollar/euro exchange rate. These aggregate variables are taken either from Eurostat, or from ECB, and, when necessary, they are backdated by using data from the Area Wide Model Database (Fagan et al., 2001).

We then have 35 variables for Germany, Italy, and the Netherlands, 34 for France and Spain, and 31 for Belgium. Variables included for these countries are: interest rates, monetary aggregates, real effective exchange rate, an index of stock prices, GDP and its expenditure components, unemployment rate, unit labor costs, GDP deflator, producer price index, CPI together with its disaggregated categories, retail sales, and number of cars sold. In addition, we also include CPI, GDP, and interest rates for smaller EA countries (Finland, Greece, Ireland, Luxembourg, and Portugal), and for UK, US, and Japan, as well as the spot oil price.

[7] We would like to thank an anonymous referee for suggesting us this testing procedure.

Summing up, our datasets consists of 237 quarterly time series covering the period 1983Q1–2007Q4.[8] The complete list of variables, sources, and the transformations used is available in Appendix A.

A comment is necessary on the way we transform data in order to make them stationary. According to Uhlig (2009), the co-movements found by Boivin et al. (2009) in a similar dataset, are actually the result of the autocorrelation induced in the transformed data. As a consequence, the existence of a factor structure, based on co-movements among series, would be just a by-product of data treatment. In order to cope with this critique, and compared with Boivin et al. (2009), we adopt a different set of transformations. As in Stock and Watson (2005) and Forni and Gambetti (2010c), we take second differences of the log of both prices and monetary aggregates, first differences of interest rates, and, when needed, growth rates are computed on a quarterly basis.[9] We label this kind of transformations as *heavy*, in contrast with *light* transformations used by Boivin et al. (2009). In the latter case interest rates are kept in levels, the first difference of log of prices and monetary aggregates is taken, and, most importantly, growth rates are computed on a yearly basis.

With reference to Uhlig (2009) critique, our choice of *heavy* transformations is justified by table 2, where we report selected percentiles of the distribution of the absolute value of univariate autocorrelations when considering *light vs. heavy* transformations. The median autocorrelation from lags 1 to 4 is between 0.36 and 0.15 in the *heavy* case, while it is between 0.86 and 0.28 in the *light* case. Similar results hold also for other percentiles.

3.2 Number of common shocks and factors

After transforming data, we rely on specific tests and information criteria for determining the number of common factors r and common shocks q. The latter is estimated by means of the test proposed by Onatski (2009), which suggests $q \in \{4, 5\}$ (table 3) and the criterion by Hallin and Liška (2007) suggesting $q \in \{2, 3\}$. We choose as our baseline specification $q = 4$, i.e. the average of these results.[10]

One possible way of fixing the number of common factors is to choose r such that the variance explained by the factors is equal to the variance explained by the chosen q shocks. This heuristic method suggests 13 factors (see table 5). An alternative is to resort to the criterion provided by Bai and Ng (2002), and its refinement by Alessi et al. (2010), both suggesting either 9 or 14 factors. We choose as our baseline specification $r = 12$, i.e. the

[8] The sample starts in 1983 because of two main reasons. First, not all the series in the database, especially at the single European country level, are available before 1983. Second, although EA data at the aggregate level are available since 1970 at a quarterly frequency, by comparing alternative aggregation methods, Bosker (2006) shows that differences in EA artificial data are prominent before 1983 especially for inflation and interest rates, while vanishing thereafter.

[9] It is worth to note that, within the literature on money demand in the EA (Papademos and Stark, 2010, and reference therein), it is common practice to treat monetary aggregates as $I(2)$ variables. Furthermore, Beyer (2009) and Dreger and Wolters (2010), among others, show that inflation is an important determinant in describing a stable long run money demand equation for the EA, thus indicating that money growth and inflation are cointegrated, and therefore $I(1)$ variables.

[10] It is also worth noting that four common shocks is a parameterization considered plausible in the literature. In particular, in her discussion of Boivin et al. (2009), Reichlin (2009) rises some doubts about their choice of seven common shocks by arguing that a smaller number of common shocks would be much more plausible: “when macroeconomists think of common shocks, they mention productivity, money, time preference, or government, and it is difficult to think of many other candidates” (p. 130).

average of what the mentioned criteria suggest.[11]

In table 4 we show the share of variance accounted for by the estimated common component. When looking at the post-1999 sample, we find that 91% of aggregate GDP and 90% of aggregate CPI fluctuations are imputable to the common component. These values decrease if we look at country specific GDP, CPI, and unemployment rate, but are still considerably high in the majority of the cases, notwithstanding the heterogeneity and large dimension of the dataset at hand. Indeed, the variance of the common component is more than 60% of total GDP fluctuations for all countries but Belgium (59%), Finland (54%), Portugal (45%), Ireland (12%), and Greece (44%), while it is more than 70% of total CPI fluctuations for all countries but Finland (60%), Portugal (70%), and Greece (54%), and more than 50% of total unemployment fluctuations for all countries but Belgium (47%) and Italy (36%). When averaging common variances across all 237 considered variables, we have that the common component account for 51% of the total fluctuations.

The existence of cross-country heterogeneity in the co-movements both justifies our approach (co-movements imply a factor structure), and motivates our research question (heterogeneity suggests asymmetric reactions).

4 Identification of the monetary policy shock

We identify the monetary policy shock by means of sign restrictions (Faust, 1998; Canova and de Nicolò, 2002; Uhlig, 2005), an identification strategy also used in the context of factor models by Eickmeier (2009) and Forni and Gambetti (2010b,c). Specifically, at each iteration we draw a vector of $q(q-1)/2$ angles $\boldsymbol{\omega}$ from a uniform distribution on $[0, 2\pi)$, which, by means of Givens transform, are used to construct an orthogonal matrix $\mathbf{R}(\boldsymbol{\omega})$ of dimension $q \times q$. We then compute the associated impulse responses and if they satisfy a prescribed set of sign restrictions (to be specified below) we accept the draw, otherwise we discard it. We stop this procedure once K draws are accepted.

We rely on the following assumptions imposed only on EA variables for the first two lags: after a contractionary monetary policy shock the short term interest rate, the real effective exchange rate, and the dollar/euro exchange rate increase, while GDP, CPI, and M1 decrease. These restrictions, which are theoretically consistent with a typical IS-LM model of an open economy, are commonly accepted in the literature (Peersman, 2005; Farrant and Peersman, 2006). Moreover, the choice of imposing restrictions only on the EA variables makes the identification scheme agnostic on the responses of single countries (see also Eickmeier, 2009, for a similar identification scheme).

In order to compute impulse responses and the related confidence intervals, we use the procedure described in section 2 with 500 bootstrap draws. To keep computations feasible, for each of the $500 + 1$ samples we save $K = 10$ rotation matrices. Then, for each sample we select just one rotation matrix as suggested by Fry and Pagan (2011).[12]

[11] Other criteria, not used in this paper, to determine q or r are in Bai and Ng (2007), Amengual and Watson (2007), Onatski (2010), and Kapetanios (2010). Results for the criteria by Bai and Ng (2002), Hallin and Liška (2007), and Alessi et al. (2010), as well as robustness analysis for for $q = \{3, 5\}$ and $r = \{9, 13\}$, are available in a complementary appendix to this paper.

[12] Fry and Pagan (2011) point out that for each sample the distribution of the $\mathbf{R}(\boldsymbol{\omega})$ that satisfies the sign restrictions represents model uncertainty. However, when computing impulse responses with confidence bands what matters is sampling uncertainty, not model uncertainty. Hence they suggest selecting for each sample just one rotation, namely the one which produces the impulse response closest to the median response.

An alternative strategy to identify monetary policy is to adopt a recursive identification scheme, i.e. the Cholesky decomposition as in Boivin et al. (2009) and Forni and Gambetti (2010a). Although recently criticized (Canova and Pina, 2005; Carlstrom et al., 2009; Uhlig, 2009; Castelnuovo, 2011, 2012a), this is the simplest, and perhaps, still, the most diffused identification scheme in SVAR literature (Christiano et al., 1999; Peersman and Smets, 2003; Weber et al., 2011). The main problem of this identification scheme is that it relies on zero short-run restrictions which are too binding and not necessarily based on economic theory. Differently, by using sign restrictions, we are imposing restrictions often used implicitly in empirical analysis to validate the results, and consistent with macroeconomic models. However, if the shock of interest explains a marginal fraction of the forecast error of the variables of interest, the outcome of the exercise conducted with sign restrictions should also be taken cautiously (for a Monte Carlo experiment, see Paustian, 2007; Castelnuovo, 2012b). For these reasons, in Appendix B we show also results obtained with Cholesky identification.

5 Results

In this section we present impulse response functions to a monetary policy shock. The shock is normalized so that on impact it raises EA short term rate of 50 basis points, we thus report impulse responses of selected variables both at the aggregate level, and at the country level. In figures 2-7 we show the impulse responses of CPI, GDP, together with consumption and investment, and unemployment rate. Each figure contains the impulse responses, together with 68% confidence bands, estimated both on the pre-euro sample (grey solid line, and shaded area), and on the euro-sample (black solid and dashed lines).

Figure 2 shows impulse responses for the aggregate EA variables used in the identification of the monetary policy shock and it should be considered just as validation of our identification strategy. In both samples, output, prices, and the monetary aggregate M1 respond negatively, while the short term rate and exchange rates respond positively.[13] When comparing pre-euro with euro sample impulse responses of aggregate CPI and GDP, we find that the introduction of the common currency amplified the response of CPI, while reducing the reaction of GDP. This result is consistent with an increase in prices' flexibility due to greater competition between EA industries.[14]

We then move to the analysis of country specific variables. In figure 8 we show results of the test on the asymmetries introduced in section 2.2. In each plot of figure 8 the grey/black straight line is the median difference between the response of a given country and the response of a benchmark country, while the shaded area/dashed lines is/are the 68% confidence bands estimated on the pre-euro/euro sample. If at horizon h the zero is contained within the confidence bands, it means that the impulse response of a given country and that of a benchmark country are not statistically different at horizon h. In panels (a) and (b) the benchmark

[13]Although the magnitude of the estimated responses may seem *too* large, it is in fact in line with the literature (Monticelli and Tristani, 1999; Sala, 2003; Eickmeier, 2009). Detailed information on the magnitude of the impulse responses estimated by the literature cited in this paper can be found in the complementary appendix.

[14]It may be argued that, since before 1999 there was no common monetary policy, the relevant comparison would be between pre–1999 Bundesbank monetary policy, and post–1999 ECB monetary policy (Sala, 2003). Hence, as a robustness check we estimated our model by imposing in the pre–1999 sample the identifying restrictions on the German short term interest rate. Results are near identical to the one obtained with our benchmark specification, and are available in a complementary appendix to this paper.

country is the EA, while in panels (c), (d), and (e) the benchmark country is Germany,

The goal is to understand whether there are asymmetries in the transmission mechanism of the common monetary policy to EA countries before and after 1999, and to understand which was the effect, if any, of the common monetary policy on the existing asymmetries.

5.1 Cross-country differences before 1999

Prices. Four countries out of ten (Finland, Italy, Portugal, and Greece) exhibit a positive reaction (figure 3). In addition to the four countries just mentioned, also the impulse responses of France, Belgium, and the Netherlands are statistically different from those of the EA (figure 3.a) thus showing a high degree of pre-euro heterogeneity in prices.

GDP. All countries, but Greece, react as predicted by economic theory (figure 4). The unconventional response of Greece seems to be related with the low percentage of variance of Greek GDP explained by the common component (see table 4). Indeed, it should be noted that Greece was not part of the European Monetary System, as it only joined it in stage II, i.e. in 1999. When testing for asymmetries (figure 8.b) we find that also the reactions of Germany, the Netherlands, Italy, Spain, Ireland, and Portugal are statistically different than those of the EA thus showing a high degree of heterogeneity pre-euro in output.

Consumption. All countries display the expected negative path (figure 5). However, when testing for asymmetries (figure 8.c) some differences emerge since both France and the Netherlands react significantly less than Germany, while Italy and Spain react significantly more.

Investment. All countries react as predicted by economic theory (figure 6) and all react significantly differently than Germany (figure 8.d).

Unemployment Rate. Unemployment in Germany, France, the Netherlands, and Belgium follows a similar hump–shaped path, while impulse responses for Spain and Italy are different (figure 7). However, when testing for asymmetries (figure 8.e) we find that also France, and the Netherlands, react in a significantly different way than Germany.

5.2 Cross-country differences after 1999

Prices. We can divide EA countries in three groups (see figure 3). In the first, we have countries for which we observe the expected negative response to the common monetary policy shock: Germany, France, the Netherlands, and Finland. In the second group, we have countries for which we estimate a *mute* response (i.e. not significantly different from zero): Ireland, Belgium, Spain, Italy, and Greece. Finally, the third group is composed of a single country for which we estimate a positive response, namely Portugal (see also Sala, 2003; Eickmeier, 2009). If we consider these results with reference to pre-euro impulse responses, the introduction of a common currency appears to have had a positive role in shaping homogeneity across countries CPIs. Table 4 provides an explanation of this switch in terms of explained variances of the common components: the higher this number, the more impulse responses are homogeneous. However, significant asymmetries persist between the EA and Finland, Italy, Portugal and Greece (figure 8.a), with Finland reacting more than the EA, and Italy, Portugal, and Greece reacting less. The response of the Mediterranean countries seem likely to be the consequence of price rigidities and of lack of competition.

GDP. Impulse responses are quite similar across countries (figure 4). With respect to the pre-euro sample, the response of Greek GDP has now the expected negative sign. Overall, the introduction of the euro has helped in reducing asymmetries. However, small differences are still present between the EA and the Netherlands, Ireland, and Portugal (figure 8.b). While Ireland and Portugal GDP fluctuations are mainly idiosyncratic (table 4), the strong reaction of Dutch GDP seems to be driven by consumption.

Consumption. The Netherlands and Italy display the deepest reaction in consumption with a minimum of roughly -5% and -3% respectively (figure 5), a result also found by Reichlin (2009) in the case of Italy. The response of Netherlands consumption is likely due to the particular dynamics of the series which has nothing to do with monetary policy. Indeed, from 1999 to 2003 the year on year consumption growth trended downward as a consequence of firms' and households' balance sheets adjustments, weak profits, and lower purchasing power of households. Germany, Belgium and Spain also show a significant contraction in consumption up to -1%, while the response is mute for France. The introduction of the euro has slightly reduced asymmetries for Italy and Spain (figure 8.c).

Investment. The reaction of investment is more homogeneous with the main exception of Germany for which a contraction up to -9% is observed (figure 6). This result is likely due to the dynamics of the German construction sector, as the housing market was characterized by a post-reunification boom-bust cycle in residential investment (Knetsch, 2010). This anomalous response of Germany implies significant differences with respect to all other countries (figure 8.d), which, however, have all similar responses.

Unemployment Rate. As in the pre-euro sample, all countries but Italy and Spain show similar reactions (figure 7). However, asymmetries are reduced between Germany and France and the Netherlands (figure 8.e). More in detail, on the one hand Spanish unemployment rate experiments a stronger boost than other countries, on the other hand, Italian unemployment seems not to respond to a common monetary policy shock. The first finding suggests large elasticity of Spanish labor market to monetary policy shocks likely due to the high share of fixed term contracts in the labor market (see for example Güell and Petrongolo, 2007). In contrast, the mute response of Italian unemployment is the consequence of a rigid labor market which seems not to be related at all to the business cycle as confirmed from the low correlation (-0.07) between changes in unemployment rate and GDP growth.[15]

6 Discussion and conclusions

In this paper we ask the following question: is there any asymmetry in how single EA countries respond to the common monetary policy decided by the ECB?

In order to answer we estimate a Structural Dynamic Factor model on a large panel of EA quarterly time series spanning the period from 1983 to 2007. The dataset incorporates data on the aggregate EA as well as country-specific key economic variables, such as gross domestic product, inflation, unemployment, consumption, investment, and many others.

We find that, although the introduction of the euro has changed the monetary transmission mechanism in the individual countries towards a more homogeneous response, differences

[15] Correlations for other countries are: Belgium -0.27, France -0.36, Germany -0.29, the Netherlands -0.26, and Spain -0.34.

still remain between North and South Europe in terms of prices and unemployment. Due to their idiosyncratic nature, these differences can hardly be controlled by means of the common monetary policy, rather they should be addressed by means of national fiscal policies, regulation, and structural reforms. Indeed, while before 1999 CPI responses were highly asymmetric, the introduction of the euro and of the single monetary policy, and the consequent increase in integration and competition within the EA, made prices more flexible thus responding more homogeneously to changes in interest rate. The remaining asymmetries are observed in the Mediterranean countries, which historically have less flexible prices and lack of market competition. Similarly, the asymmetries in labor markets seem to be the result of structural and socio-economic characteristics of single countries. This is the case for example with the rigid labor market structure in Italy, which makes Italian unemployment rate completely non-reactive unresponsive to the single monetary policy.

In conclusion, EA countries react asymmetrically to the common monetary policy in terms of prices and unemployment, while no difference appears in terms of output. While the post-1999 reduction in asymmetries is consistent with the aims of the ECB (see Boivin et al., 2009), the remaining differences are beyond the scope of monetary policy, and they should be addressed by means of national reforms. As demonstrated by the recent/current public debt crisis, and by the skyrocketing of government bond spreads, these differences pose a threat to the region's stability: addressing them is fundamental for the future of Europe, and it should be a priority if economic cohesion is to be achieved.

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Tables

Table 1: TESTING FOR STRUCTURAL BREAK IN THE FACTOR LOADINGS:
Breitung and Eickmeier Test

	BG	FR	GE	IT	NL	ES	FI	GR	IE	PT	EA
Consumer Price Index	63.44	71.35	72.50	55.46	60.86	63.32	41.56	37.75	48.56	57.69	80.68
Gross Domestic Product	81.41	74.14	76.29	54.57	58.66	79.83	70.87	30.82	39.30	45.10	88.59
Consumption	70.35	55.96	65.19	66.52	34.19	56.59					
Investment	49.91	66.55	52.65	51.76	48.81	68.91					
Unemployment Rate	66.52	55.61	34.15	47.61	54.45	48.21					

This table show the LM Statistic for the null of no structural break in the factor loadings on January the 1st 1999. This statistic is asymptotically distributed as a χ^2 random variable with r (number of factors degrees of freedoms. The 10%, 5%, and 1% critical values are 18.5493, 21.0261, and 26.2170 respectively.

Table 2: THE DISTRIBUTION OF AUTOCORRELATIONS
Light vs. Heavy

Percentile				*Lag*				
light	1	2	3	4	5	6	7	8
5	0.65	0.40	0.12	0.03	0.03	0.04	0.02	0.02
25	0.81	0.57	0.32	0.11	0.13	0.12	0.09	0.07
50	0.86	0.67	0.47	0.28	0.23	0.22	0.19	0.16
75	0.90	0.78	0.65	0.51	0.43	0.36	0.32	0.29
95	0.95	0.87	0.78	0.70	0.64	0.58	0.54	0.51
heavy	1	2	3	4	5	6	7	8
5	0.08	0.02	0.01	0.01	0.01	0.01	0.01	0.01
25	0.24	0.09	0.06	0.07	0.06	0.04	0.04	0.04
50	0.36	0.18	0.15	0.15	0.14	0.11	0.10	0.10
75	0.54	0.32	0.27	0.25	0.23	0.18	0.18	0.16
95	0.90	0.74	0.59	0.50	0.39	0.35	0.30	0.33

Percentiles of the distribution of univariate autocorrelation functions when computing *light* transformations as in Boivin et al. (2009) or *heavy* transformations, i.e. by replacing yearly with quarterly growth rates and taking first differences of interest rates and second differences of the log of prices and monetary aggregates.

Table 3: DETERMINING THE NUMBER OF COMMON SHOCKS:
Onatski Test

q_0 *vs.* q_1	1	2	3	4	5	6	7	8
0	0.029	0.050	0.069	0.088	0.104	0.121	0.135	0.151
1		0.271	0.487	0.626	0.321	0.372	0.421	0.465
2			0.608	0.677	0.262	0.321	0.372	0.421
3				0.390	0.195	0.262	0.321	0.372
4					0.108	0.195	0.262	0.321
5						0.947	0.923	0.343
6							0.623	0.257
7								0.142

This table shows p-values of the null of q_0 common shocks against the alternative of $q_0 < q \leq q_1$ common shocks. The Discrete Fourier Transformation of the data is computed for $\omega_j = 2\pi s_j/T$, with $s_j \in [2, ..., 20]$, thus to includes waves between 1 and 12 years.

Table 4: COMOVEMENTS IN THE EURO AREA
Explained Variance

Country	*GDP*		*CPI*		*UR*	
	83-98	99-07	83-98	99-07	83-98	99-07
Euro Area	0.85	0.91	0.79	0.90	-	-
Germany	0.71	0.76	0.69	0.80	0.48	0.69
France	0.74	0.78	0.49	0.82	0.55	0.60
Netherlands	0.31	0.73	0.73	0.75	0.54	0.58
Belgium	0.66	0.59	0.55	0.81	0.58	0.47
Finland	0.63	0.54	0.31	0.60	-	-
Italy	0.42	0.66	0.70	0.82	0.50	0.36
Spain	0.38	0.66	0.62	0.90	0.67	0.57
Portugal	0.67	0.45	0.51	0.70	-	-
Ireland	0.39	0.12	0.33	0.72	-	-
Greece	0.20	0.44	0.18	0.54	-	-

For each country we report the variance explained by the common component of GDP, CPI, and Unemployment Rate (UR). For each variable the first column refers to the 1983:Q1-1998:Q4 (pre-euro) sample, and the second column to the 1999:Q1-2007:Q4 (euro) sample. Values are given on a scale between 0 (no contribute of the common component) and 1.

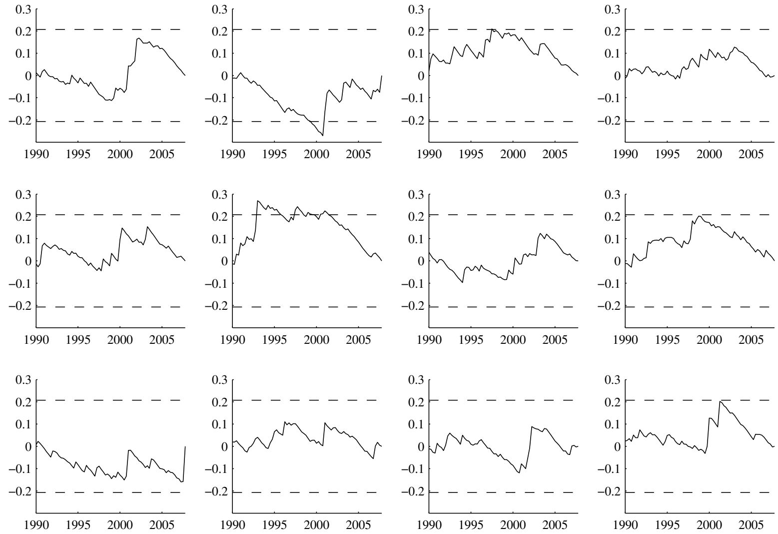
Table 5: CUMULATED EXPLAINED VARIANCE:
Number of Factors

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
q	0.21	0.34	0.43	0.51	0.58	0.64	0.68	0.73	0.76	0.79	0.82	0.84	0.86	0.88
r	0.09	0.16	0.23	0.27	0.31	0.34	0.37	0.40	0.42	0.45	0.47	0.49	0.51	0.53

The table shows the percentage of overall variance explained by the first q common shocks estimated with the method of dynamic principal components as in Forni et al. (2000), and the first r static factors estimated by static principal components. Variance is measured on a scale between 0 and 1.

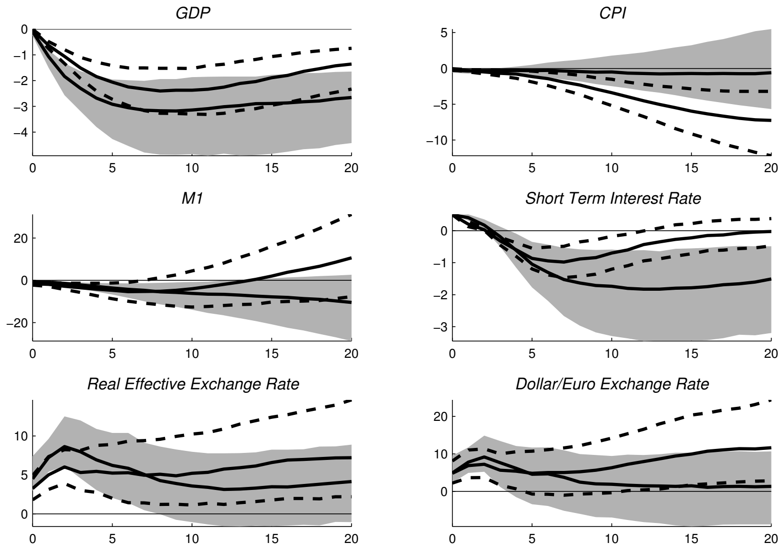
Figures

Figure 1: CUSUM Square Test on the Static Factors



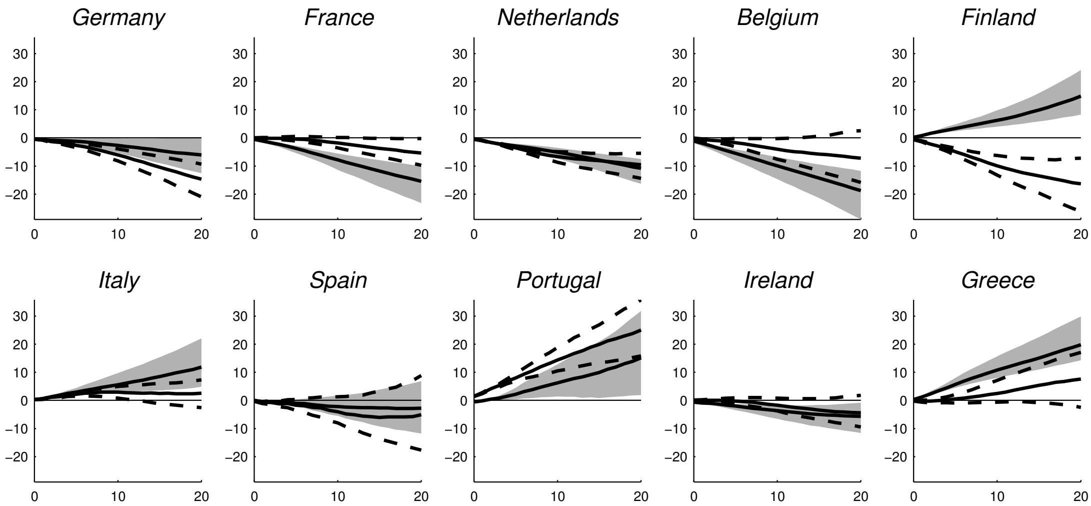
Solid line is the CUSUM Square statistic of (Brown et al., 1975), while the dashed lines are the 90% confidence bands computed using critical values as given in Durbin (1969) and Edgerton and Wells (1994).

Figure 2: Impulse Responses to a Monetary Policy Shock
Euro Area Aggregates



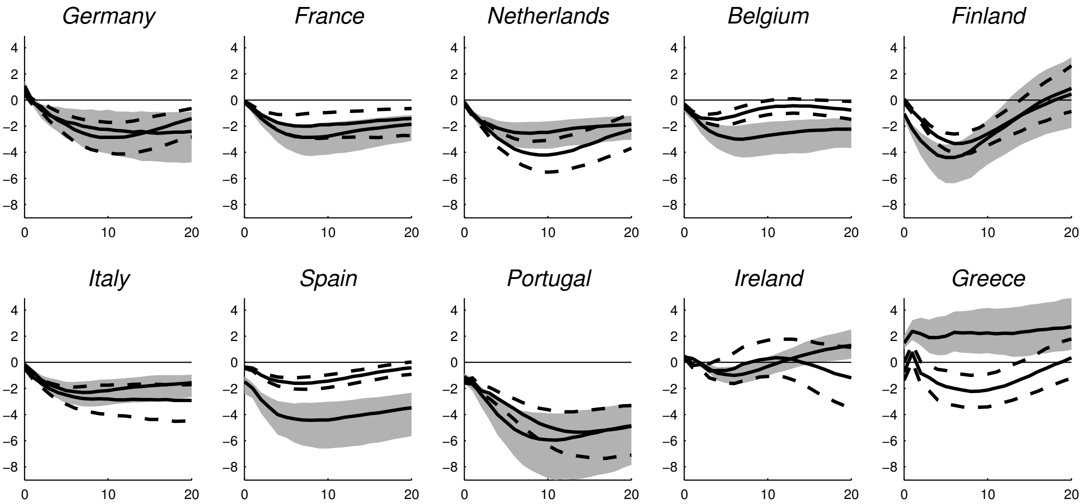
Solid line is the estimated impulse responses for the 1999:Q1-2007:Q4 (euro) subsample with 68% bootstrap confidence band (dashed). Shaded area is the 68% confidence band for the 1983:Q1-1998:Q4 (pre-euro) subsample.

Figure 3: Impulse Responses to a Monetary Policy Shock
Consumer Price Index



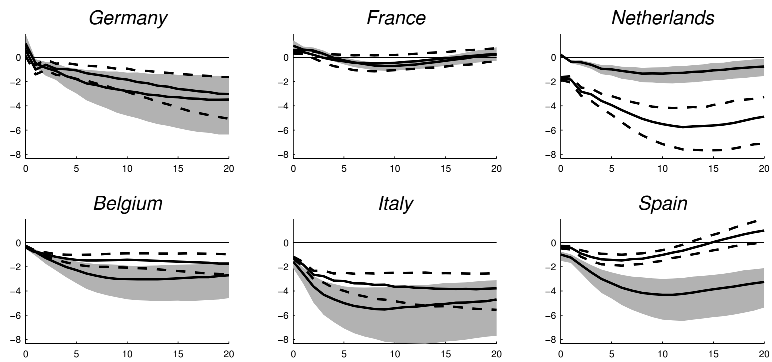
Solid line is the estimated impulse responses for the 1999:Q1-2007:Q4 (euro) subsample with 68% bootstrap confidence band (dashed). Shaded area is the 68% confidence band for the 1983:Q1-1998:Q4 (pre-euro) subsample.

Figure 4: Impulse Responses to a Monetary Policy Shock
Gross Domestic Product



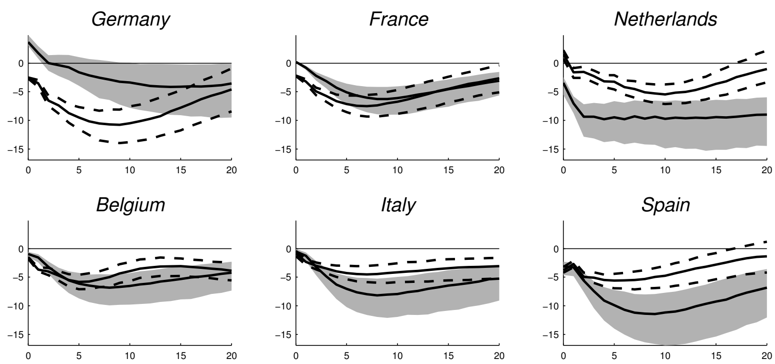
Solid line is the estimated impulse responses for the 1999:Q1-2007:Q4 (euro) subsample with 68% bootstrap confidence band (dashed). Shaded area is the 68% confidence band for the 1983:Q1-1998:Q4 (pre-euro) subsample.

Figure 5: Impulse Responses to a Monetary Policy Shock
Consumption



Solid line is the estimated impulse responses for the 1999:Q1-2007:Q4 (euro) subsample with 68% bootstrap confidence band (dashed). Shaded area is the 68% confidence band for the 1983:Q1-1998:Q4 (pre-euro) subsample.

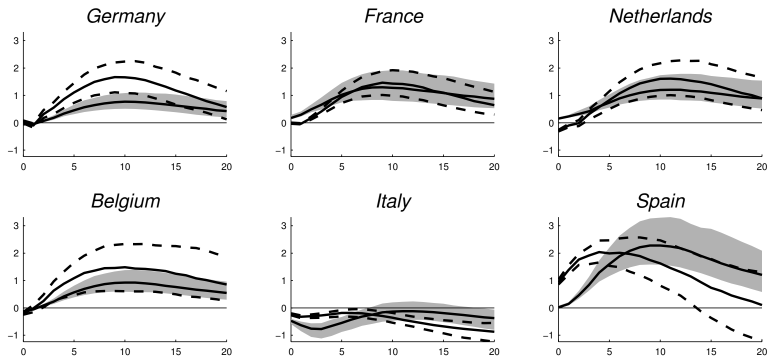
Figure 6: Impulse Responses to a Monetary Policy Shock
Investment



Solid line is the estimated impulse responses for the 1999:Q1-2007:Q4 (euro) subsample with 68% bootstrap confidence band (dashed). Shaded area is the 68% confidence band for the 1983:Q1-1998:Q4 (pre-euro) subsample.

Figure 7: Impulse Responses to a Monetary Policy Shock

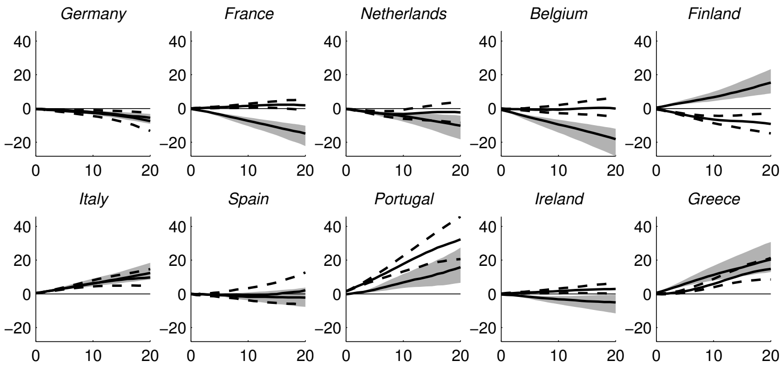
Unemployment Rate



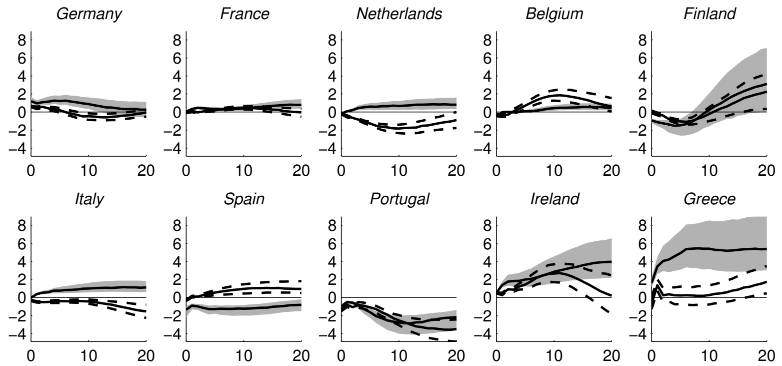
Solid line is the estimated impulse responses for the 1999:Q1-2007:Q4 (euro) subsample with 68% bootstrap confidence band (dashed). Shaded area is the 68% confidence band for the 1983:Q1-1998:Q4 (pre-euro) subsample.

Figure 8: Quantifying Asymmetries
Distance from benchmark country

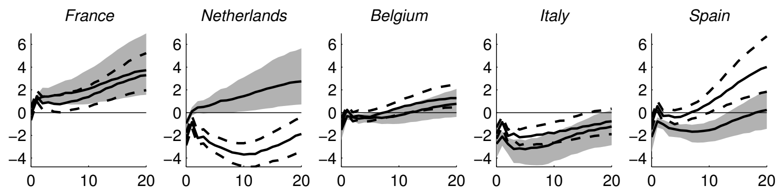
(a) *Consumer Price Index*



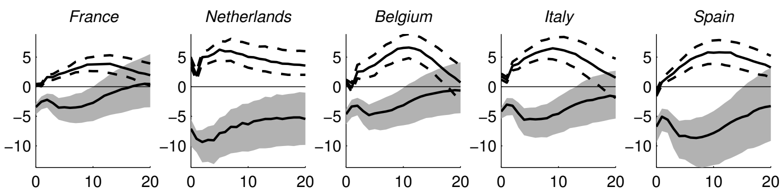
(b) *Gross Domestic Product*



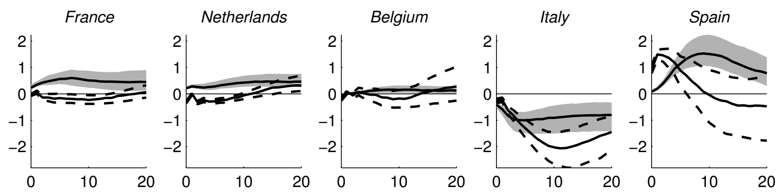
(c) *Consumption*



(d) *Investments*



(e) *Unemplyment Rate*



In each plot, the grey/black straight line is the median difference between the response of a given country and the response of a benchmark country, while the shaded area/dashed lines is/are the 68% confidence bands estimated on the pre-euro/euro sample. If at horizon h the zero is contained within the confidence bands, it means that the impulse response of a given country and that of a benchmark country are not statistically different at horizon h. In panels (a) and (b) the benchmark country is the EA, while in panels (c), (d), and (e) the benchmark country is Germany,

Appendix A The Euro Area dataset

Belgium

N	dsmnemonic	Variable	Source	Unit	F.	SA	T
1	BGOCFGDPD	GDP (REAL)	OEO	2004Mil€	Q	1	3
2	BGOCFPCND	PRIVATE CONSUMPTION EXPENDITURE (REAL)	OEO	2004Mil€	Q	1	3
3	BGOCFINVD	GFCF (REAL)	OEO	2004Mil€	Q	1	3
4	BGOCFEGSD	EXPORTS OF GOODS & SERVICES (REAL)	OEO	2004Mil€	Q	1	3
5	BGOCFIGSD	IMPORTS OF GOODS & SERVICES (REAL)	OEO	2004Mil€	Q	1	3
6	BGOCFDGDE	GDP - IPD	OEO	2004=100	Q	1	4
7	BGOCFDCNE	PRIVATE CONSUMPTION - IPD	OEO	2004=100	Q	1	4
8	BGOCFDINE	GROSS DOMESTIC FIXED CAPITAL FORMATION - IPD	OEO	2004=100	Q	1	4
9	BGOCFEPCE	EXPORTS OF GOODS AND SERVICES - IPD	OEO	2004=100	Q	1	4
10	BGOCFIPCE	IMPORTS OF GOODS & SERVICES - IPD	OEO	2004=100	Q	1	4
11	BGOSLI12O	PASSENGER CAR REGISTRATIONS	MEI	Thous.	M	1	3
12	BGOBS076Q	BTS: MANUFACTURING, Capacity Utilization Judg.	MEI	%	Q	1	2
13	BGOCFEMPO	EMPLOYMENT	OEO	Thous.	Q	1	3
14	BGOCFUNRQ	UNEMPLOYMENT RATE	OEO	%	Q	1	2
15	BGOULC..T	UNIT LABOUR COSTS - TOTAL (TREND)	MEI	2005=100	Q	0	3
16	BGOULCC.T	U.L.C. - CONSTRUCTION (ISIC F) (TREND)	MEI	2005=100	Q	0	3
17	BGOULCM.T	U.L.C. - MANUFACTURING (ISIC D) (TREND)	MEI	2005=100	Q	0	3
18	BGOULCS.T	U.L.C. - MARKET SERVICES (ISIC GK) (TREND)	MEI	2005=100	Q	0	3
19	BGOULCF.T	U.L.C. - FINANCIAL & BUSINESS SERVICES (ISIC JK)(TR)	MEI	2005=100	Q	0	3
20	BGOCC011	REAL EFFECTIVE EXCHANGE RATES	MEI	2005=100	M	0	3
21	BGOSLI15G	TOTAL RETAIL TRADE (VOLUME)	MEI	2005=100	M	1	3
22	BGOPP017F	PPI MANUFACTURED GOODS	MEI	2005=100	M	2	4
23	BGOCP049F	CPI - HARMONISED	MEI	2005=100	M	2	4
24	BGOCP042F	CPI All items non-food non-energy	MEI	2005=100	M	2	4
25	BGOCP041F	CPI Energy	MEI	2005=100	M	2	4
26	BGOCFISTR	INTEREST RATE - SHORT TERM	OEO	%	Q	0	2
27	BGOCFILTR	INTEREST RATE - LONG TERM	OEO	%	Q	0	2
28	BGOSP001F	BEL SHARE PRICES ALL SHARES †	MEI	2005=100	M	0	3
29	BGOLC007E	HOURLY EARNINGS MALES: INDUSTRY(DISC.)	MEI	2005=100	Q	1	3
30	BGM1....A	M1 (EXCL. CURR IN CIRC.) CURN ‡	NCB	Mil€	M	2	4
31	BGM3....A	M3 (EXCL. CURR IN CIRC.) CURN ‡	NCB	Mil€	M	2	4

† Series backdated by data in Eickmeier (2009)
‡ Series backdated by Eurostat "DS-070950 Former series for euro area countries on monetary aggregates and credit"

France

N	dsmnemonic	Variable	Source	Unit	F.	SA	T
32	FROCFGDPD	GDP (REAL)	OEO	2000Mil€	Q	1	3
33	FROCFPCND	PRIVATE CONSUMPTION EXPENDITURE (REAL)	OEO	2000Mil€	Q	1	3
34	FROCFINVD	GFCF (REAL)	OEO	2000Mil€	Q	1	3
35	FROEX003D	Government final consumption expenditure	MEI	2000Mil€chd	Q	1	3
36	FROCFEGSD	EXPORTS OF GOODS & SERVICES (REAL)	OEO	2000Mil€	Q	1	3
37	FROCFIGSD	IMPORTS OF GOODS & SERVICES (REAL)	OEO	2000Mil€	Q	1	3
38	FROCFDGDE	GDP - IPD	OEO	2005=100	Q	1	4
39	FROCFDCNE	PRIVATE CONSUMPTION - IPD	OEO	2005=100	Q	1	4
40	FROCFDINE	GROSS DOMESTIC FIXED CAPITAL FORMATION - IPD	OEO	2005=100	Q	1	4
41	FROCFEPCE	EXPORTS OF GOODS AND SERVICES - IPD	OEO	2005=100	Q	1	4
42	FROCFIPCE	IMPORTS OF GOODS & SERVICES - IPD	OEO	2005=100	Q	1	4
43	FROSLI05O	TOTAL CAR REGISTRATIONS	MEI	Thous.	M	1	3
44	FROBS076Q	BTS: MANUFACTURING, Capacity Utilization Judg.	MEI	%	Q	1	2
45	FROCFEMPO	EMPLOYMENT	OEO	Thous.	Q	1	3
46	FROCFUNRQ	UNEMPLOYMENT RATE	OEO	%	Q	1	2
47	FROULC..T	UNIT LABOUR COSTS - TOTAL (TREND)	MEI	2005=100	Q	0	3
48	FROULCC.T	U.L.C. - CONSTRUCTION (ISIC F) (TREND)	MEI	2005=100	Q	0	3
49	FROULCM.T	U.L.C. - MANUFACTURING (ISIC D) (TREND)	MEI	2005=100	Q	0	3
50	FROULCS.T	U.L.C. - MARKET SERVICES (ISIC G K) (TREND)	MEI	2005=100	Q	0	3
51	FROULCF.T	U.L.C. - FINANCIAL & BUSINESS SERVICES (ISIC J K)(TR)	MEI	2005=100	Q	0	3
52	FROCC011	REAL EFFECTIVE EXCHANGE RATES	MEI	2005=100	M	0	3
53	FROSLI15G	TOTAL RETAIL TRADE (VOLUME)	MEI	2005=100	M	1	3
54	FROPP017F	PPI Manufactured products	MEI	2005=100	M	2	4
55	FROCP049F	CPI - HARMONISED	MEI	2005=100	M	2	4
56	FROCP042F	CPI NON FOOD NON ENERGY	MEI	2005=100	M	2	4
57	FROCP019F	CPI Food	MEI	2005=100	M	2	4
58	FROCP041F	CPI ENERGY	MEI	2005=100	M	2	4
59	FROCP054F	CPI Rent	MEI	2005=100	M	2	4
60	FROCFISTR	INTEREST RATE - SHORT TERM	OEO	%	Q	1	2
61	FROCFILTR	INTEREST RATE - LONG TERM	OEO	%	Q	1	2
62	FROSP001F	FRA SHARE PRICES SBF 250	MEI	2005=100	M	0	3
63	FROLC007E	HOURLY WAGE RATE: INDUSTRY(DISC.)	MEI	2005=100	Q	1	3
64	FRM1....A	M1 (NATIONAL CONTRIBUTION TO M1)	NCB	Mil€	M	2	4
65	FRM3....A	M3 (NATIONAL CONTRIBUTION TO M3)	NCB	Mil€	M	2	4

Germany

N	dsmnemonic	Variable	Source	Unit	F.	SA	T
66	BDOCFGDPD	GDP (REAL)	OEO	2000Mil€	Q	1	3
67	BDOCFPCND	PRIVATE CONSUMPTION EXPENDITURE (REAL)	OEO	2000Mil€	Q	1	3
68	BDOCFINVD	GFCF (REAL)	OEO	2000Mil€	Q	1	3
69	BDOEX003D	GOVERNMENT FINAL CONSUMPTION EXPENDITURE	MEI	2000Mil€chd	Q	1	3
70	BDOCFEGSD	EXPORTS OF GOODS & SERVICES (REAL)	OEO	2000Mil€	Q	1	3
71	BDOCFIGSD	IMPORTS OF GOODS & SERVICES (REAL)	OEO	2000Mil€	Q	1	3
72	BDOCFDGDE	GDP - IPD	OEO	2000=100	Q	1	4
73	BDOCFDCNE	PRIVATE CONSUMPTION - IPD	OEO	2000=100	Q	1	4
74	BDOCFDINE	GROSS DOMESTIC FIXED CAPITAL FORMATION - IPD	OEO	2000=100	Q	1	4
75	BDOCFEPCE	EXPORTS OF GOODS & SERVICES - IPD	OEO	2000=100	Q	1	4
76	BDOCFIPCE	IMPORTS OF GOODS & SERVICES - IPD	OEO	2000=100	Q	1	4
77	BDOSLI05O	TOTAL CAR REGISTRATIONS	MEI	Thous.	M	1	3
78	BDOBS076Q	BTS: MANUFACTURING, Capacity Utilization Judg.	MEI	%	Q	1	2
79	BDOCFEMPO	EMPLOYMENT	OEO	Thous.	Q	1	3
80	BDOCFUNRQ	UNEMPLOYMENT RATE	OEO	%	Q	1	2
81	BDOULC..T	UNIT LABOUR COSTS - TOTAL (TREND)	MEI	2005=100	Q	0	3
82	BDOULCC.T	U.L.C. - CONSTRUCTION (ISIC F) (TREND)	MEI	2005=100	Q	0	3
83	BDOULCM.T	U.L.C. - MANUFACTURING (ISIC D) (TREND)	MEI	2005=100	Q	0	3
84	BDOULCS.T	U.L.C. - MARKET SERVICES (ISIC GK) (TREND)	MEI	2005=100	Q	0	3
85	BDOULCF.T	U.L.C. - FINANCIAL & BUSINESS SERVICES (ISIC JK)(TR)	MEI	2005=100	Q	0	3
86	BDOCC011	Real Effective Exchange Rate	MEI	2005=100	M	0	3
87	BDOSLI15G	TOTAL RETAIL TRADE (VOLUME)	MEI	2005=100	M	1	3
88	BDOPP017F	PPI Manufacturing Industry	MEI	2005=100	M	2	4
89	BDOCP049F	CPI - HARMONISED	MEI	2005=100	M	2	4
90	BDOCP042F	CPI Non-food non-energy	MEI	2005=100	M	2	4
91	BDOCP019F	CPI Food + alcohol-free drinks (excl rest) / Index publicati	MEI	2005=100	M	2	4
92	BDOCP041F	CPI - ENERGY (EXCL. GASOLINE BEFORE 1991)	MEI	2005=100	M	2	4
93	BDOCP053F	CPI Housing - rental services	MEI	2005=100	M	2	4
94	BDOCFISTR	INTEREST RATE - SHORT TERM	OEO	%	Q	1	2
95	BDOCFILTR	INTEREST RATE - LONG TERM	OEO	%	Q	1	2
96	BDOSP001F	SHARE PRICES CDAX	MEI	2005=100	M	0	3
97	BDOLC007E	HOURLY EARNINGS: MANUFACTURING	MEI	2005=100	Q	1	3
98	BDM1....A	M! - GERMAN CONTRIBUTION TO EURO M1	NCB	Bil€	M	2	4
99	BDM3....A	M3 - GERMAN CONTRIBUTION TO EURO M3	NCB	Bil€	M	2	4

Italy

N	dsmnemonic	Variable	Source	Unit	F.	SA	T
100	ITOCFGDPD	GDP (REAL)	OEO	2000Mil€	Q	1	3
101	ITOCFPCND	PRIVATE CONSUMPTION EXPENDITURE (REAL)	OEO	2000Mil€	Q	1	3
102	ITOEX004D	GFCF	MEI	2000Mil€chd	Q	1	3
103	ITOEX003D	GOVERNMENT FINAL CONSUMPTION EXPENDITURE	MEI	2000Mil€chd	Q	1	3
104	ITOCFEGSD	EXPORTS OF GOODS & SERVICES (REAL)	OEO	2000Mil€	Q	1	3
105	ITOCFIGSD	IMPORTS OF GOODS & SERVICES (REAL)	OEO	2000Mil€	Q	1	3
106	ITOCFDGDE	GDP - IPD	OEO	2000=100	Q	1	4
107	ITOCFDINE	GROSS DOMESTIC FIXED CAPITAL FORMATION - IPD	OEO	2000=100	Q	1	4
108	ITOCFDCNE	PRIVATE CONSUMPTION - IPD	OEO	2000=100	Q	1	4
109	ITOCFEPCE	EXPORTS OF GOODS & SERVICES - IPD	OEO	2000=100	Q	1	4
110	ITOCFIPCE	IMPORTS OF GOODS & SERVICES - IPD	OEO	2000=100	Q	1	4
111	ITOSLI05O	TOTAL CAR REGISTRATIONS	MEI	Thous.	M	1	3
112	ITOBS076Q	BTS: MANUFACTURING, Capacity Utilization Judg.	MEI	%	Q	1	2
113	ITOCFEMPO	EMPLOYMENT	OEO	Thous.	Q	1	3
114	ITOCFUNRQ	UNEMPLOYMENT RATE	OEO	%	Q	1	2
115	ITOULC..T	UNIT LABOUR COSTS - TOTAL (TREND)	MEI	2005=100	Q	0	3
116	ITOULCC.T	U.L.C. - CONSTRUCTION (ISIC F) (TREND)	MEI	2005=100	Q	0	3
117	ITOULCM.T	U.L.C. - MANUFACTURING (ISIC D) (TREND)	MEI	2005=100	Q	0	3
118	ITOULCS.T	U.L.C. - MARKET SERVICES (ISIC GK) (TREND)	MEI	2005=100	Q	0	3
119	ITOULCF.T	U.L.C. - FINANCIAL & BUSINESS SERVICES (ISIC JK)(TR)	MEI	2005=100	Q	0	3
120	ITOCC011	REAL EFFECTIVE EXCHANGE RATE - CPI BASED	MEI	2005=100	M	0	3
121	ITRETTOTF	IT RETAIL SALES NADJ	X	X	M	2	3
122	ITOPP017F	PPI(DISC.)	MEI	2005=100	M	2	4
123	ITOCP049F	CPI - HARMONISED	MEI	2005=100	M	2	4
124	ITOCP042F	CPI - EXCLUDING FOOD & ENERGY	MEI	2005=100	M	2	4
125	ITOCP019F	CPI - FOOD	MEI	2005=100	M	2	4
126	ITOCP041F	CPI - ENERGY	MEI	2005=100	M	2	4
127	ITOCP057F	CPI - HOUSING	MEI	2005=100	M	2	4
128	ITOCFISTR	INTEREST RATE - SHORT TERM: 3 MONTH EURIBOR	OEO	%	Q	0	2
129	ITOCFILTR	INTEREST RATE - LONG TERM: 10 YR TREASURY BONDS	OEO	%	Q	0	2
130	ITOSP001F	SHARE PRICES - ISE MIB STORICO	MEI	2005=100	M	0	3
131	ITOLC007E	HOURLY WAGE RATE : INDUSTRY(DISC.)	MEI	2005=100	M	1	3
132	ITM1....A	M1 - ITALIAN CONTRIBUTION TO EURO M1	NCB	Mil€	M	2	4
133	ITM3....A	M3 - ITALIAN CONTRIBUTION TO EURO M3	NCB	Mil€	M	2	4

Netherlands

N	dsmnemonic	Variable	Source	Unit	F.	SA	T
134	NLOCFGDPD	GDP (REAL)	OEO	2001Mil€	Q	1	3
135	NLOCFPCND	PRIVATE CONSUMPTION EXPENDITURE (REAL)	OEO	2001Mil€	Q	1	3
136	NLOCFINVD	GFCF (REAL)	OEO	2001Mil€	Q	1	3
137	NLOCFEGSD	EXPORTS OF GOODS & SERVICES (REAL)	OEO	2001Mil€	Q	1	3
138	NLOCFIGSD	IMPORTS OF GOODS & SERVICES (REAL)	OEO	2001Mil€	Q	1	3
139	NLOCFDGDE	GDP - IPD	OEO	2001=100	Q	1	4
140	NLOCFDCNE	PRIVATE CONSUMPTION - IPD	OEO	2001=100	Q	1	4
141	NLOCFDINE	GROSS DOMESTIC FIXED CAPITAL FORMATION - IPD	OEO	2001=100	Q	1	4
142	NLOCFEPCE	EXPORTS OF GOODS & SERVICES - IPD	OEO	2001=100	Q	1	4
143	NLOCFIPCE	IMPORTS OF GOODS & SERVICES - IPD	OEO	2001=100	Q	1	4
144	NLOSLI12O	PASSENGER CAR REGISTRATIONS	MEI	Thous.	M	1	3
145	NLOBS076Q	BTS: MANUFACTURING, Capacity Utilization Judg.	MEI	%	Q	1	2
146	NLOCFEMPO	EMPLOYMENT	OEO	Thous.	Q	1	3
147	NLOCFUNRQ	UNEMPLOYMENT RATE	OEO	%	Q	1	2
148	NLOULC..T	U.L.C. - TOTAL (TREND)	MEI	2005=100	Q	0	3
149	NLOULCC.T	U.L.C. - CONSTRUCTION (ISIC F) (TREND)	MEI	2005=100	Q	0	3
150	NLOULCM.T	U.L.C. - MANUFACTURING (ISIC D) (TREND)	MEI	2005=100	Q	0	3
151	NLOULCS.T	U.L.C. - MARKET SERVICES (ISIC GK) (TREND)	MEI	2005=100	Q	0	3
152	NLOULCF.T	U.L.C. - FINANCIAL & BUSINESS SERVICES (ISIC JK)(TR)	MEI	2005=100	Q	0	3
153	NLOCC011	REAL EFFECTIVE EXCHANGE RATES	MEI	2005=100	M	0	3
154	NLOSLI15G	TOTAL RETAIL TRADE (VOLUME)	MEI	2005=100	M	1	3
155	NLOPP017F	PPI MANUFACTURING	MEI	2005=100	M	2	4
156	NLOCP049F	CPI - HARMONISED	MEI	2005=100	M	2	4
157	NLOCP042F	CPI ALL ITEMS NON FOOD-NON ENERGY	MEI	2005=100	M	2	4
158	NLOCP019F	CPI FOOD	MEI	2005=100	M	2	4
159	NLOCP041F	CPI ENERGY	MEI	2005=100	M	2	4
160	NLOCP053F	CPI RENT INCL. IMPUTED RENT	MEI	2005=100	M	2	4
161	NLOCFISTR	INTEREST RATE - SHORT TERM	OEO	%	Q	0	2
162	NLOCFILTR	INTEREST RATE - LONG TERM	OEO	%	Q	0	2
163	NLOSP001F	SHARE PRICES ALL SHARES INDEX	MEI	2005=100	M	0	3
164	NLOLC007E	HOURLY WAGE RATE MANUFACTURING(DISC.)	MEI	2005=100	M	1	3
165	NLM1....A	M1	NCB	Mil€	M	2	4
166	NLM3....A	M3	NCB	Mil€	M	2	4

Spain

N	dsmnemonic	Variable	Source	Unit	F.	SA	T
167	ESOCFGDPD	GDP (REAL)	OEO	2000Mil€	Q	1	3
168	ESOCFPCND	PRIVATE CONSUMPTION EXPENDITURE (REAL)	OEO	2000Mil€	Q	1	3
169	ESOCFINVD	GFCF (REAL)	OEO	2000Mil€	Q	1	3
170	ESOCFEGSD	EXPORTS OF GOODS & SERVICES (REAL)	OEO	2000Mil€	Q	1	3
171	ESOCFIGSD	IMPORTS OF GOODS & SERVICES (REAL)	OEO	2000Mil€	Q	1	3
172	ESOCFDGDE	GDP - IPD	OEO	2000=100	Q	1	4
173	ESOCFDCNE	PRIVATE CONSUMPTION - IPD	OEO	2000=100	Q	1	4
174	ESOCFDINE	GROSS DOMESTIC FIXED CAPITAL FORMATION - IPD	OEO	2000=100	Q	1	4
175	ESOCFEPCE	EXPORTS OF GOODS & SERVICES - IPD	OEO	2000=100	Q	1	4
176	ESOCFIPCE	IMPORTS OF GOODS & SERVICES - IPD	OEO	2000=100	Q	1	4
177	ESOSLI12O	PASSENGER CAR REGISTRATIONS	MEI	Thous.	M	1	3
178	ESOBS076Q	BTS: MANUFACTURING, Capacity Utilization Judg.	MEI	%	Q	1	2
179	ESOCFEMPO	EMPLOYMENT	OEO	Thous.	Q	1	3
180	ESOCFUNRQ	UNEMPLOYMENT RATE	OEO	%	Q	1	2
181	ESOULC..T	UNIT LABOUR COSTS - TOTAL (TREND)	MEI	2005=100	Q	0	3
182	ESOULCC.T	U.L.C. - CONSTRUCTION (ISIC F) (TREND)	MEI	2005=100	Q	0	3
183	ESOULCM.T	U.L.C. - MANUFACTURING (ISIC D) (TREND)	MEI	2005=100	Q	0	3
184	ESOULCS.T	U.L.C. - MARKET SERVICES (ISIC GK) (TREND)	MEI	2005=100	Q	0	3
185	ESOULCF.T	U.L.C. - FINANCIAL & BUSINESS SERVICES (ISIC JK)(TR)	MEI	2005=100	Q	0	3
186	ESOCC011	REAL EFFECTIVE EXCHANGE RATES	MEI	2005=100	M	0	3
187	ESOPP017F	PPI Manufacturing - proxy PPI All Items	MEI	2005=100	M	2	4
188	ESOCP049F	CPI - HARMONISED	MEI	2005=100	M	2	4
189	ESOCP042F	CPI/NONFOOD/NONENERGY	MEI	2005=100	M	2	4
190	ESCPFDTBF	ES CPI - FOOD AND NON-ALCOHOLIC BEVERAGES NADJ	X	2006=100	M	2	3
191	ESOCP041F	CPI ENERGY	MEI	2005=100	M	2	4
192	ESOCP057F	CPI RENT	MEI	2005=100	M	2	4
193	ESOCFISTR	INTEREST RATE - SHORT TERM	OEO	%	Q	0	2
194	ESOCFILTR	INTEREST RATE - LONG TERM	OEO	%	Q	0	2
195	ESSHRPRCF	MADRID S.E - GENERAL INDEX	MEH	31/12/85=100	M	0	3
196	ESOLC007E	HOURLY EARNINGS: INDUSTRY EXCL. CONSTR. (DISC.)	MEI	2005=100	Q	1	3
197	ESM1....A	M1 - SPANISH CONTRIBUTION TO EURO M1 †	NCB	Mil€	M	2	4
198	ESM3....A	M3 - SPANISH CONTRIBUTION TO EURO M3 †	NCB	Mil€	M	2	4

† Series backdated by Eurostat "DS-070950 Former series for euro area countries on monetary aggregates and credit"

Other Countries

N	Country	dsmnemonic	Variable	Source	Unit	Freq	SA	T
199		FNOCFGDPD	GDP (REAL)	OEO	2000Mil€	Q	1	3
200	Finland	FNOCP049F	CPI - HARMONIZED	MEI	2005=100	M	2	4
201		FNOCFISTR	INTEREST RATE - SHORT TERM	OEO	Percentage	Q	0	2
202		FNOCFILTR	INTEREST RATE - LONG TERM	OEO	Percentage	Q	0	2
203		GROCFGDPD	GDP (REAL)	OEO	1995Mil€	Q	1	3
204	Greece	GROCP049F	CPI - HARMONIZED	MEI	2005=100	M	2	4
205		GROCFISTR	INTEREST RATE - SHORT TERM	OEO	Percentage	Q	0	2
206		IROCFGDPD	GDP (REAL)	OEO	2004Mil€	Q	1	3
207	Ireland	IROCP049F	CPI - HARMONIZED	MEI	2005=100	M	2	2
208		IRI60B..	MONEY MARKET RATE	IFS	Percentage	M	0	2
209		IROCFILTR	INTEREST RATE - LONG TERM	OEO	Percentage	Q	0	2
210	Luxembourg	LXOCFGDPD	GDP (REAL)	OEO	2000Mil€	Q	1	3
211		LXOCP049F	CPI - HARMONIZED	MEI	2005=100	M	2	4
212		PTOCFGDPD	GDP (REAL)	OEO	2000Mil€	Q	1	3
213	Portugal	PTOCP049F	CPI - HARMONIZED	MEI	2005=100	M	2	4
214		PTOCFISTR	INTEREST RATE - SHORT TERM	OEO	Percentage	Q	0	2
215		PTOCFILTR	INTEREST RATE - LONG TERM	OEO	Percentage	Q	0	2
216		UKOCFGDPD	GDP (REAL)	OEO	2003Mil.£	Q	1	3
217	United	UKOCP049F	CPI - HARMONIZED	MEI	2005=100	M	2	4
218	Kingdom	UKOCFISTR	INTEREST RATE - SHORT-TERM	OEO	Percentage	Q	0	2
219		UKOCFILTR	INTEREST RATE - LONG-TERM	OEO	Percentage	Q	0	2
220		JPOCFGDPD	GDP (REAL)	OEO	2000Mil¥	Q	1	3
221	Japan	JPCPIGLAF	CPI: GENERAL	MIAC	2005=100	M	2	4
222		JPOCFISTR	INTEREST RATE - SHORT TERM	OEO	Percentage	Q	0	2
223		JPOCFILTR	INTEREST RATE - LONG TERM	OEO	Percentage	Q	0	2
224		USOCFGDPD	GDP (REAL)	OEO	2000Mil$	Q	1	3
225	United	USOCP009F	CPI ALL ITEMS	MEI	2005=100	M	2	4
226	States	USOCFISTR	INTEREST RATE - SHORT-TERM	OEO	Percentage	Q	0	2
227		USOCFILTR	INTEREST RATE - LONG-TERM	OEO	Percentage	Q	0	2
228		EAESNGDPD	GDP †	EUR	Bil€2000chd	Q	1	3
229		EMCP....F	CPI - HARMONISED‡	EUR	2005=100	M	2	4
230	Euro	EMESEFI3R	3-MONTH INTEREST RATES (AVERAGE) †	EUR	Percentage	M	0	2
231	Area	EMESEFIGR	LONG TERM GOVERNMENT BOND YIELDS †	EUR	Percentage	M	0	2
232		EKEBLBCSE	UNIT LABOUR COSTS - TOTAL ECONOMY †	ECB	2000=100	Q	1	3
233		EMECBM1.A	MONEY SUPPLY: M1 (EP)	ECB	Bil€	M	2	4
234		EMECBM3.A	MONEY SUPPLY: M3 (EP)	ECB	Bil€	M	2	4
235		EMECBEXGR	REAL EFFECTIVE EXCHANGE RATE †	ECB	1990=100	Q	0	3
236	World	USESXECU	US DOLLAR TO ECU (MEAN)	EUR	$/€	M	0	3
237		UKI76AAZA	MARKET PRICE - UK BRENT	IFS	$	M	0	3

† Series backdated by using the AWM database data
‡ DS calculated before 1990

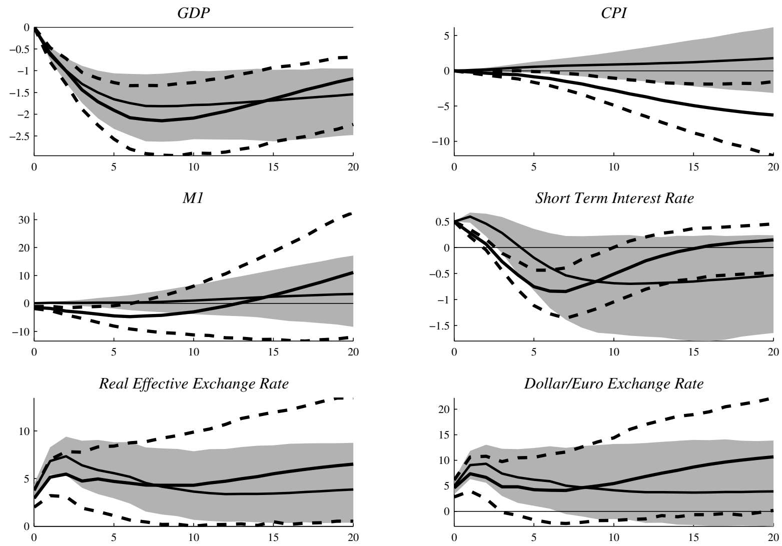
List of Abbreviations

Source		Transformations		Seasonally Adjustement	
NCB -	National Central Bank	1	none	0	Not Seasonally Adjusted
MEI	OECD Main Economic Indicators	2	Δ	1	Seasonally Adjusted
OEO	OECD Economic Outlook	3	$\Delta \log$	2	SA with dummy variables regression
ECB	European Central Bank	4	$\Delta\Delta \log$		
IFS	IMF International Financial Statistics	5	log		
EUR	Eurostat				
MEH	Ministerio de Economia y Hacienda				
MIAC	Ministry of Internal Affairs and Communications				

Appendix B Robustness analysis: Cholesky identification scheme

Following Forni and Gambetti (2010a), let $\mathbf{B}^{(q)}(L)$ be the $q \times q$ sub-matrix of $\mathbf{B}(L)$ corresponding to the impulse responses of EA aggregate GDP, CPI, short term rate, and real effective exchange rate. The *Cholesky Identification scheme* consists in identifying the monetary policy shock by selecting the rotation matrix $\mathbf{R}$ such that $\mathbf{B}^{(q)}(0)$ is lower triangular. That is, we assume that output and prices do not react contemporaneously to monetary policy shocks. This is a standard recursive scheme, with the monetary policy shock being the third shock (see Forni and Gambetti, 2010a, for a similar identification scheme using US data).

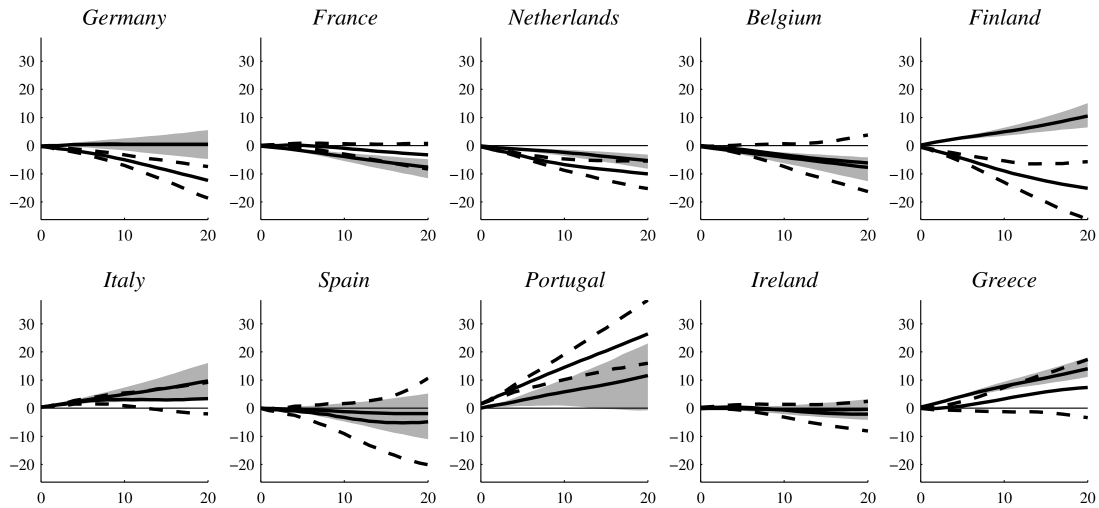
Figure B1: Impulse Response Functions
Cholesky Identification Scheme
EA Aggregates



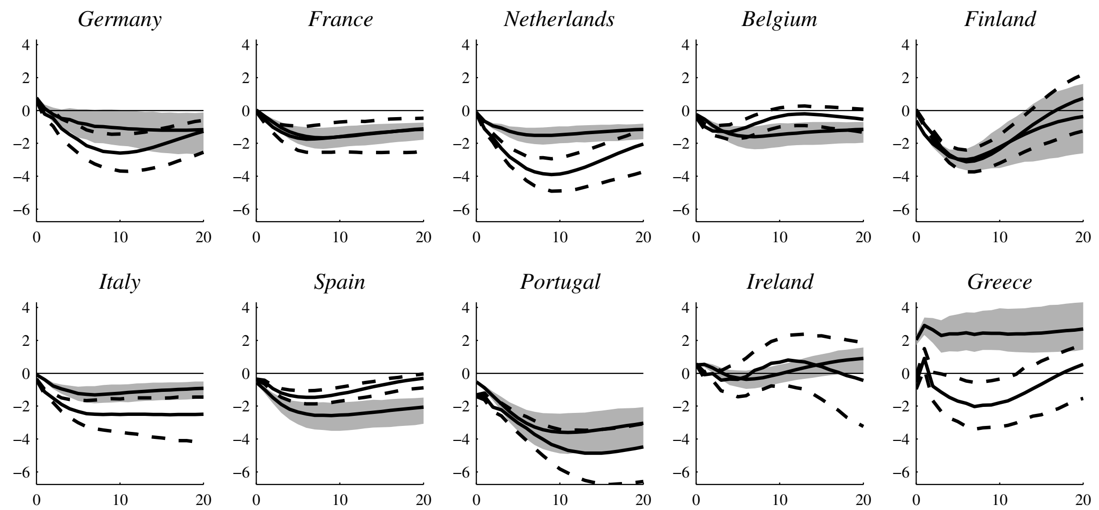
Solid line is the estimated impulse responses for the 1999:Q1-2007:Q4 (euro) subsample with 68% bootstrap confidence band (dashed). Shaded area is the 68% confidence band for the 1983:Q1-1998:Q4 (pre–euro) subsample.

Figure B2: Impulse Response Functions
Cholesky Identification Scheme

(a) *Consumer Price Index*



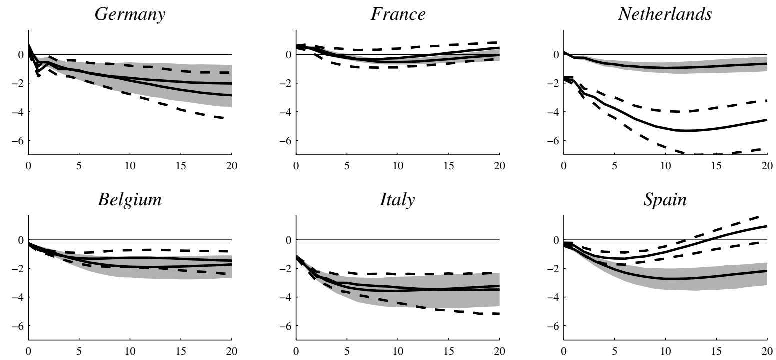
(b) *Gross Domestic Product*



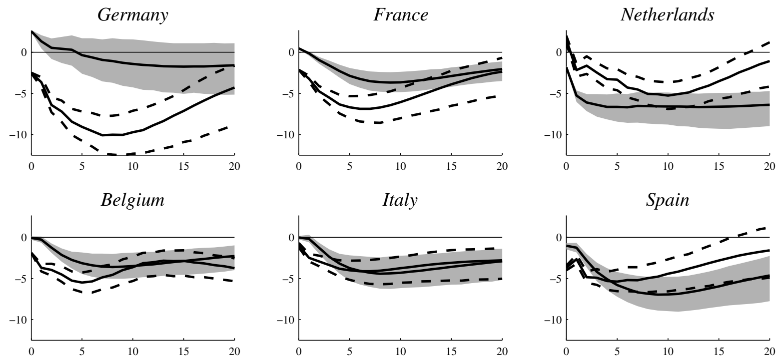
Solid line is the estimated impulse responses for the 1999:Q1-2007:Q4 (euro) subsample with 68% bootstrap confidence band (dashed). Shaded area is the 68% confidence band for the 1983:Q1-1998:Q4 (pre–euro) subsample.

Figure B3: Impulse Response Functions
Cholesky Identification Scheme

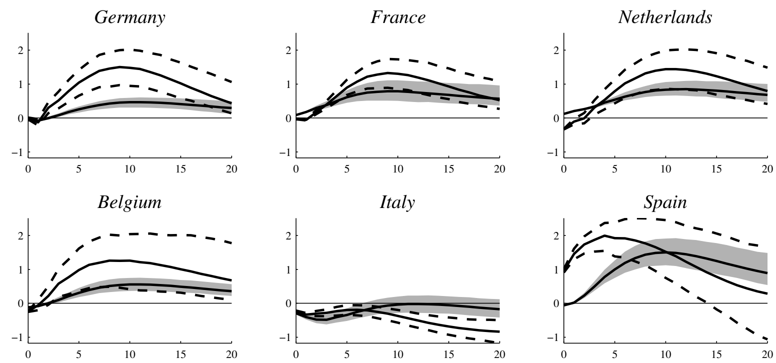
(a) *Consumption*



(b) *Investments*



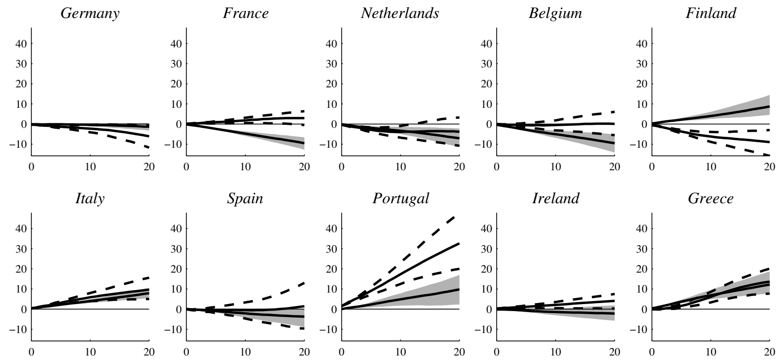
(c) *Unemplyment Rate*



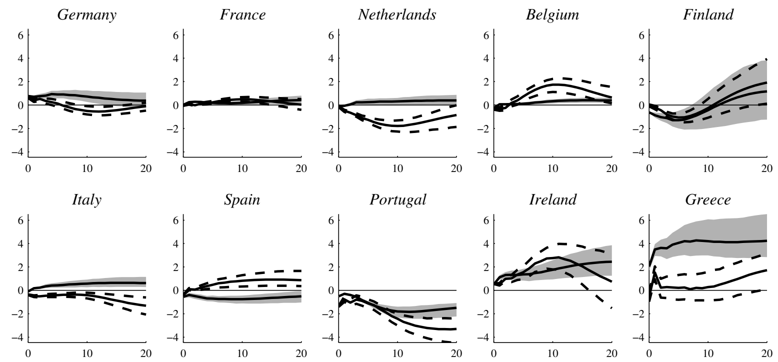
Solid line is the estimated impulse responses for the 1999:Q1-2007:Q4 (euro) subsample with 68% bootstrap confidence band (dashed). Shaded area is the 68% confidence band for the 1983:Q1-1998:Q4 (pre–euro) subsample.

Figure B4: Quantifying Asymmetries
Cholesky Identification Scheme

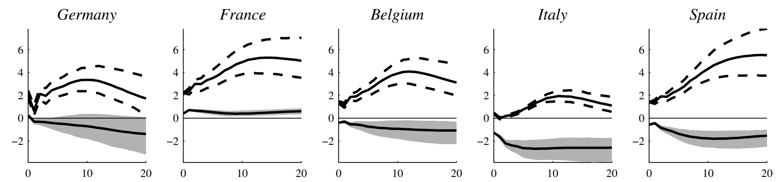
(a) *Consumer Price Index*



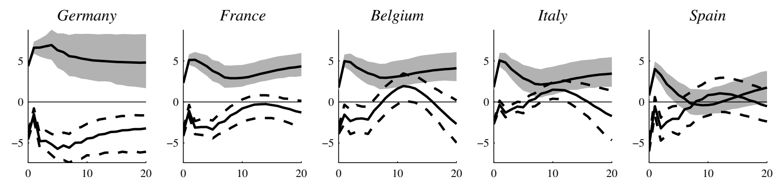
(b) *Gross Domestic Product*



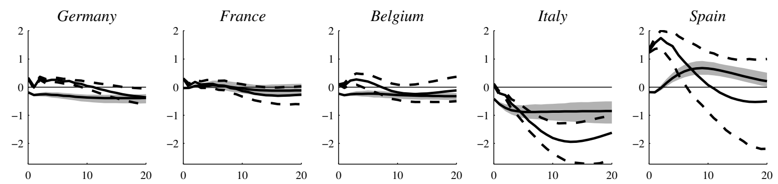
(c) *Consumption*



(d) *Investments*



(e) *Unemplyment Rate*



In each plot, the grey/black straight line is the median difference between the response of a given country and the response of a benchmark country, while the shaded area/dashed lines is/are the 68% confidence bands estimated on the pre-euro/euro sample. If at horizon h the zero is contained within the confidence bands, it means that the impulse response of a given country and that of a benchmark country are not statistically different at horizon h. In panels (a) and (b) the benchmark country is the EA, while in panels (c), (d), and (e) the benchmark country is Germany,