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Financial and fiscal interaction in the Euro Area crisis: This time was different

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ABSTRACT

This paper highlights the anomalous characteristics of the Euro Area 'twin crises' by contrasting the aggregate macroecosnomic dynamics in the period 2009–2013 with the business cycle fluctuations of the previous decades. We report three novel stylised facts. First, the contraction in output was marked by an anomalous downfall in private investment and an increase in households' savings, while consumption and unemployment followed their historical relation with GDP. Second, households' and financial corporations' debts, and house prices deviated from their pre-crisis trends, while non-financial corporations' debt followed historical regularities. Third, the jumps in the public deficit-GDP and debt-GDP ratios in 2008–2009 were unprecedented and so was the fiscal consolidation that followed. Our analysis points to the financial nature of the crisis as a likely explanation for these facts. Importantly, the 'anomalous' increase in public debt is in large part explained by extraordinary measures in support of the financial sector, which show up in the stock-flow adjustments and reveal a keyinteraction between the fiscal and the financial sectors.

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1. Introduction

This paper analyses the anomalous characteristics in the responses of a rich set of fiscal, financial and macroeconomic variables to the macroeconomic shocks that generated the 2008 and 2012 prolonged recessions, as compared to the business

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cycle regularities of the previous decades. In particular, we focus and provide novel results on the anomalous debt-deficit dynamics that characterised the aftermath of the financial crisis. Our approach is to model the Euro Area as a single economy and the twin crises – the 2008 financial crisis and the 2012 sovereign debt crisis – as a potentially unique event. This to account for the highly integrated economic and financial features of the Euro Area, and for the possibly common chain of events linking the two recessions.

Our analysis contributes to the literature on the special nature of financial crises as opposed to regular recessions. Much of the existing empirical literature in this area has investigated the path of a handful of macroeconomic variables by using a single regression approach, in which financial crises are identified by using a narrative dummy or a quantitative index (e.g., among others, Reinhart et al., 2012; Jordà et al., 2013, and Romer and Romer, 2017). A stylised fact emerging from this strand of research is that recessions that are associated to financial crises tend to be deeper, longer, and characterised by prolonged cycles of deleveraging which weigh on the economy.

Differently from this approach, we focus on the fallout of a single financial crisis but provide a landscape view over the economy by adopting a rich multivariate Vector Autoregression (VAR) model with real, nominal and financial variables to capture the interdependence of business and financial cycles.[2] Our Euro Area-wide VAR model makes use of historical quarterly time series data from 1983 to 2013 to jointly model the dynamic interaction of (i) macro aggregates – real GDP, consumption, private investment, unemployment; (ii) inflation, long- and short-term interest rates; (iii) several fiscal indicators – spending, taxes, transfers, public investment and interest payments; (iv) different spreads; (v) credit aggregates; (vi) house prices.[3] Including in our model a rich set of fiscal aggregates and rates capturing the monetary policy stance is potentially of great importance in examining the policy mix historically adopted in the Euro Area before and after the crisis. In fact, as firstly shown by Leeper (1991), it is important to model the joint behaviour of the monetary and fiscal authorities in explaining macroeconomic outcomes (see Leeper and Leith, 2016, for a review of the extensive research on the issue). Moreover, expanding the econometric information to incorporate both flow and stock variables such as household, financial and non-financial corporation households', financial and non-financial corporations' leverage helps identify the potential role of balance sheet adjustments. Similarly to us, Brunnermeier et al. (2017) propose a multivariate VAR approach to distinguish the several channels of interaction between financial variables and the macroeconomy and to control for the response of policy variables.

In joint modelling the evolution of financial and macro variables and the underlying cycles, we have to deal with a number of issues. First, trends and low frequency components are difficult to capture empirically, due to the inherent low number of observations (see Sims, 2000). More specifically, the limited lag order of VAR models may fail to correctly capture the financial cycles, that are thought to have much lower frequency than (and associate weakly with) the traditional business cycle (see, e.g. Borio, 2014). We try to address these issues by enriching our econometric information set and by adopting macroeconomic priors providing credibility to the idea of independent stochastic trend components. Also, we explicitly analyse and assess the plausibility the implicit trends retrieved by our model. Second, VAR-based estimates allow to take into account general equilibrium effects but do not accommodate for non-linearities, which are implicit, for example, in the debt accumulation equation (see, for example, Favero and Giavazzi, 2007 for a discussion on this point). To handle this issue we follow Favero and Giavazzi (2007) and adopt a VARX framework, where public debt can affect all variables but its dynamics is reconstructed externally as a cumulated sum of the deficit implied by the evolution of fiscal aggregates inside the model. This approach, beyond providing robustness to our analysis, also allows to highlight how the measure of public debt resulting from the cumulative sum of public deficit can differ from the actual public debt, due to stock-flow adjustments. In fact, the latter can be large in periods of financial distress given the size of financial transfers which are accounted for as debt but did not originate from fiscal deficits (for a discussion of the significance of this measure, see Alt and Lassen, 2006).

Our model provides three sets of empirical results. First, we perform a model-based counterfactual exercise by estimating the model for the period 1983–2007 (pre-crisis sample) and computing forecasts for 2008–2013, based on the pre-crisis parameters and conditional on the realised (observed) paths of nominal GDP and inflation. In computing conditional forecasts, we adopt the methodology proposed in Giannone et al. (2010) and detailed in Bańbura et al. (2015). This exercise can be interpreted as a test for the statement 'this time is different'. In fact, conditional on the prolonged drop in output triggered by the 2008 crisis (and the related path of inflation), it allows to uncover the differences between the conditional and the realised paths of the other variables examined and highlights potential anomalous responses as compared to the historical pattern observed in recessions.[4] Results provide us with a unified assessment of previously reported stylised facts, across many variables and also with new insights on the financial-fiscal interaction during and after the crisis.

Second, using results from the first exercise, we then study how two measures of public debt – the cumulative sum of the deficit and the observed debt incorporating stock-flow adjustments – deviated from its predicted measure conditional

[2] We adopt a Large Vector Autoregression (VAR) model with Bayesian priors that can incorporates a rich set of variables capturing monetary, fiscal, financial and real economic conditions, by efficiently coping with the dimensionality problem (De Mol et al., 2008; Bańbura et al., 2010). In our empirical specification, we adopt two sets of standard macroeconomic priors: Minnesota priors (Litterman, 1980; 1986) and sum-of-coefficients priors (Doan et al., 1984). The strength of these priors is optimally set using the hierarchical approach proposed by Giannone et al. (2015).

[3] The fiscal variables come from an updated version of a unique quarterly database for the Euro Area, described in Paredes et al. (2009).

[4] A similar approach has been used in recent works by Giannone et al. (2014) and Colangelo et al. (2017) in studying the response of monetary policy to the crisis.

on the collapse in output. If the observed path of any variable is found to be significantly different from what observed in its 'stressed' scenario, we conclude that there is a departure from previous cyclical experiences. This exercise is at the core of our paper, and highlights a novel set of results concerning the anomalous dynamics in fiscal variables, following the financial crisis.

Third, we study how the realised paths of the variables of interest deviated from the unconditional forecast and the implicit trends recovered by the model. This exercise provides a gauge on how much (or how little) correlation exists in the data between macro and financial variables. It also provides useful information on pre-crisis trends.

Our approach does not recover the nature of the shocks that caused the deep recessions, nor allows to infer causal relationships among the variables. Indeed, while our findings provide new evidence on what happens after financial crises, they only convey suggestive evidence of any causal impact of financial distress onto the economy. Also, importantly, the approach does not disentangle the complex causal relation between the exceptional fiscal and monetary policies undertaken and the macroeconomic performances observed. This limitation is common to the rest of the literature that has studied financial crises by adopting a treatment variable (and not exogenous events) defined in terms of anomalous credit conditions with respect to an historical norm.[5]

Our results confirm, as reported by extant literature, that households', financial corporations' debts and house prices are weakly associated to the economic cycle in the pre-crisis sample, possibly due to two decades of leveraging. In the post-crisis sample, they markedly deviated from their pre-crisis trends, as a consequence of the deleveraging. On the background of this deleveraging, our analysis provides three novel stylised facts. First, the contraction in output was marked by an anomalous deep and persistent downfall in private investment and an increase in households' savings beyond historical regularities; conversely, consumption and unemployment followed their historical relation with GDP. Interestingly, the contraction in private investment was at least initially counterbalanced by an increase in public investment – this marking a difference in the aggregate behaviour of private and public investment. Second, house prices contracted, and households' and financial corporations' debt adjusted more than in previous business cycle recessions, while deviating from their pre-crisis trends; non-financial corporations debt instead followed historical regularities. Finally, and importantly, the jumps in the fiscal deficit-GDP and debt-GDP ratios in 2008–2009 were unprecedented and so was the fiscal consolidation that followed. Notably, the 'anomaly' in public deficit is in large part explained by extraordinary measures in support of the financial sector, which show up in the stock-flow adjustments and reveals a key interaction between the fiscal and the financial sectors. Our analysis points to the financial nature of the crisis as a likely explanation for these facts.

Related literature. This paper is related to the recent literature investigating the behaviour of the economy in the aftermath of deep recessions and financial crises. A narrative approach in dating crises is commonly used in the literature, as for example in the influential book of Reinhart and Rogoff (2009b) and in a series of articles (e.g. Reinhart and Rogoff, 2009a; Reinhart and Rogoff, 2014). This approach has been pioneered by Caprio and Klingebiel (1996), and then extended by a number of important works, as for example Bordo et al. (2001), Cerra and Saxena (2008), Claessens et al. (2009), Claessens et al. (2010), Gourinchas and Obstfeld (2012), Schularick and Taylor (2012), Jordà et al. (2013), Laeven and Valencia (2014), and Bordo and Haubrich (2017). Most of these studies adopt a single regression approach to investigate the path of a handful of macroeconomic variables following a crisis, identified by using a narrative dummy or a quantitative index. A common finding in this literature is that recessions accompanied by financial crises tend to be more severe, while recoveries are particularly slow compared to deep recessions. Hoggarth et al. (2002), and Laeven and Valencia (2013) compare the path of output following crises with projections of pre-crisis trends. These studies find that output often falls far below the pre-crisis path, but that there is substantial dispersion across episodes.

Slightly different results are reported by Bordo and Haubrich (2017), who find that the slow recovery pattern in the US is true only in the 1930s, the early 1990s and after the 2008 financial crisis. Romer and Romer (2017) refine the narrative approach employing OECD accounts of financial crises to classify financial distress on a relatively fine scale. They find that the average decline in output following a financial crisis is statistically significant and persistent, but only moderate in size, with effects that are highly variable across major episodes.

In focussing on a rich set of fiscal variables we also connect to the literature which studies the impact of prolonged periods of exceptionally high public debt onto economic growth. Reinhart et al. (2012), basing their analysis on a cross-section of countries, have suggested that high public debt overhang has a negative effect on growth. Jordá et al. (2013), focussing on a cross-section of recessions for different countries, show that this negative effect is only at work when recessions are associated to financial crises. Furthermore, by incorporating some measure of interest rates spread we relate to Krishnamurthy and Muir (2017), who investigate credit spreads as a possible indicator of financial disturbances, and finds a substantial correlation between this statistical measure of financial distress and common crisis chronologies.

Finally, this paper may provide relevant insights to the debate about the post crisis slump in the Euro Area and the ongoing discussion on the reform of the economic governance of the European Monetary Union (EMU).[6] The policy debate has emphasised, for example, that the fiscal framework of the Euro Area induces pro-cyclicality of fiscal policy in response

[5] It is important to stress that, given our approach, we cannot discriminate amongst competing explanations. In particular we cannot determine whether the uncovered anomalous features were due to the 'depth' of the drop in output (and hence the activation of non-linearities and hysteresis effects), to the financial nature of the crisis, or to a sudden permanent change in the underlying trends.

[6] The European Economic Review has devoted a special issue to the debate on the persistent post-crisis slump and on the resulting fiscal and monetary policy challenges (see EER, 2016).

to large macro-shocks. When monetary policy is constrained at the zero-lower bound this implies an inadequate policy mix and depresses aggregate demand excessively (see, for example, Corsetti et al., 2019). In the light of this debate, our results lend support to proposals for reform of the Euro Area governance that would allow a slower fiscal consolidation in case of large negative shocks, by distinguishing between the cyclical component of the government fiscal balance, and the part that is explained by policy stabilisation interventions (see Corsetti, 2015a,b).

2. Fiscal and financial facts

In this section we report some background facts providing suggestive evidence on the financial nature of the crisis. First, we document the anomalous pattern of term and sovereign spreads in the Euro Area, and show that they suggest the activation of different types of financial stress at different points of the crisis. Second, we provide evidence of the fact that the anomalous accumulation of public debt during the last crisis in the Euro Area as a whole is related to the crisis in the financial sector of the core countries of the area. While this observation cannot fully determine the fiscal or financial nature of the crisis, it provides some interesting facts about the sources of deterioration of the fiscal position of the Euro Area.

Let us first turn to some potential indicators of financial frictions. We select two variables as proxies: the spread between the ten-year interest rate on government bonds and the three month Euribor (term spread) and the spread between the ten year interest rates on Italian debt and German debt (sovereign spread). We use the sovereign spread as an indicator of risk associated with the risk of disintegration of the EMU, the so-called 'redenomination' risk. To this aim we consider Italy rather than a country that lost access to the market during the crisis like Greece, Portugal or Ireland. Fig. 1 plots these variables.

The left-hand chart includes the entire sample and is dominated by the decline of the sovereign spread in preparation of the euro, while it does not show a cyclical behaviour. Conversely, the term spread has a typical anti-cyclical dynamics, raising in recessions and then normalising with a lag. The chart on the right is a zoom of the recent years, with shaded areas indicating CEPR dated recessions. A simple message is apparent: the dominant friction in the 2008–09 recession was the steepening of the term spread affecting all countries, while in the second was the cross-country spread revealing periphery countries stress. In other words, the Euro Area economy in the period 2008–2013 was subject to two different sources of risks: term risk and sovereign risk. The former characterises the first recession, the latter, the second.

Let us now report some key facts about fiscal deficit of the Euro Area as a whole. Fig. 2 focuses on the three recessions in our sample with starting dates in 1980, 1991, and 2008. In the left panel it reports public debt to GDP ratios and in the right one the deficit to GDP ratio. For each episode the debt and deficit variables are set equal to 100 at the beginning of the recession. The horizontal axis indicates quarters after that date.

Following each recession, the deficit to GDP ratio increases due to the decline of GDP (the denominator), the decline in tax income and the effect of fiscal stabilisers on public expenditure. The 2008 recession, however, is of a different order of magnitude: due to the dramatic decline of GDP, the deficit to GDP ratio spikes up and continues to do so until early 2009, when a massive fiscal consolidation takes place. The latter, also unprecedented, implied a halving of the deficit in about four years, but failed to stabilise public debt which continued to increase albeit at a declining rate.

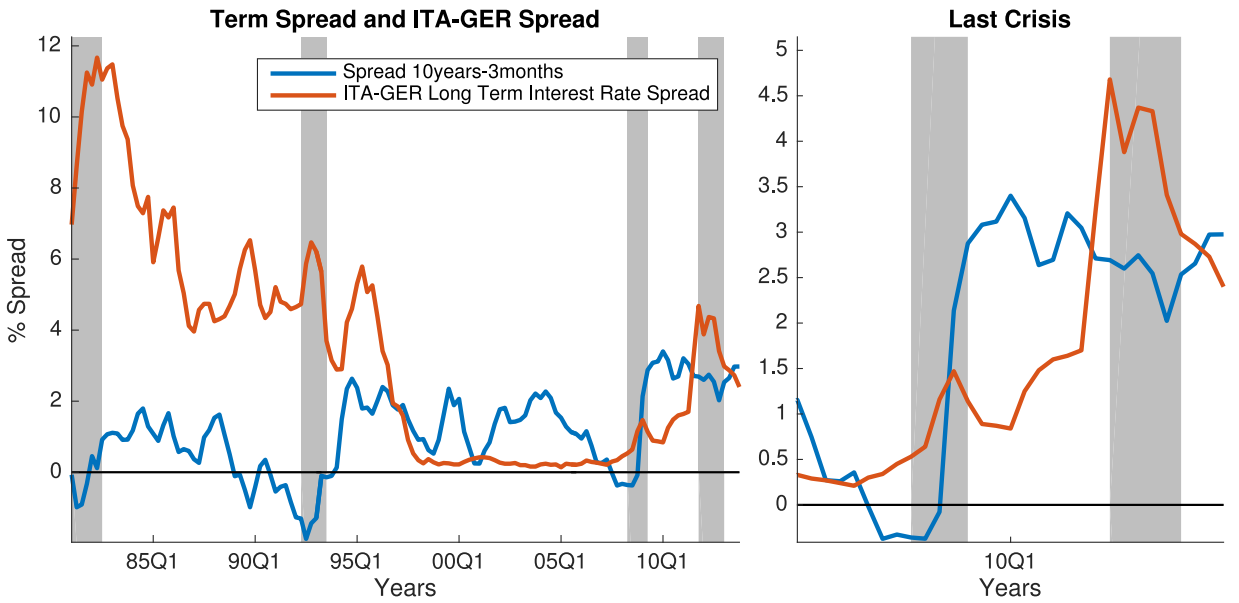


Fig. 1. Italy-Germany long term sovereign interest rates spread and term spread defined as 10 years–3 months.

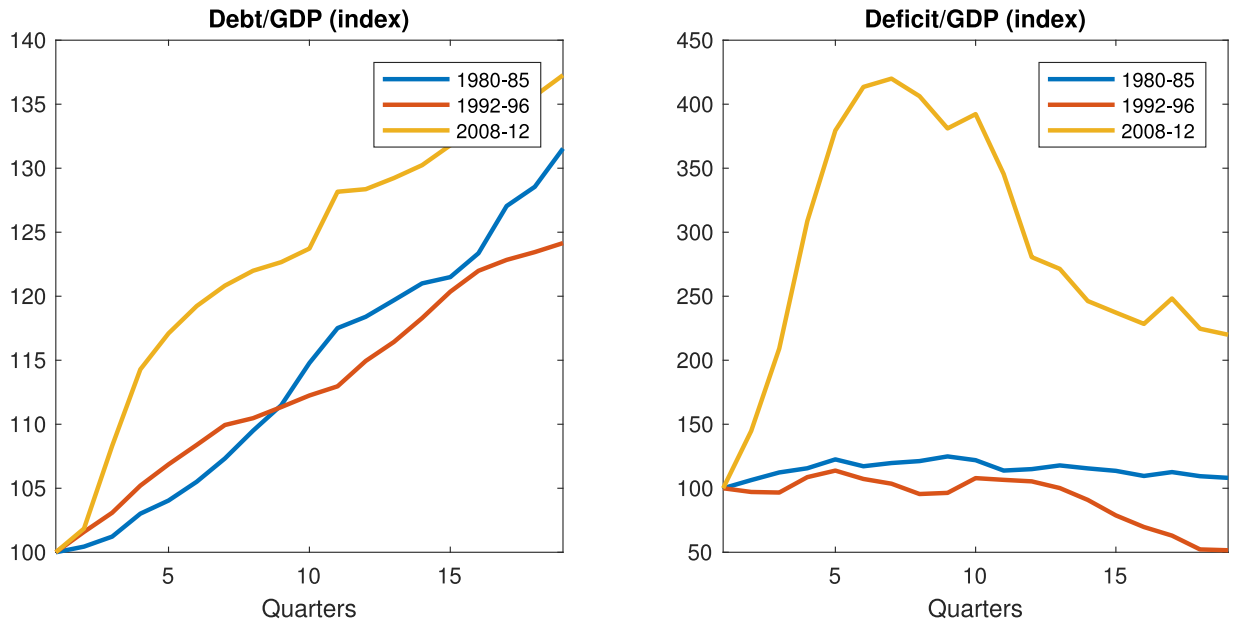


Fig. 2. *Euro Area government debt/GDP and deficit/GDP.* Indices based at 100 in the quarters in which each recession starts.

Table 1
Stock-flow adjustments in 2008–2011. Percent of GDP. Source: Eurostat (2012).

Country	2008	2009	2010	2011	Average	Sum	Sum (% of 2011 EA GDP)
Euro Area	3.2	0.8	1.5	0.6	1.6	6.2	6.2
BE	6.7	−0.5	0.2	2.1	2.1	8.5	0.3
DE	2.7	1.8	7.5	0.3	3.1	12.3	3.2
IE	10.7	1.6	−5.6	2.4	2.3	9.1	0.2
ES	0.5	1.0	−2.1	−0.8	−0.3	−1.4	−0.2
FI	4.3	4.5	4.2	2.5	3.9	15.5	0.3
FR	2.2	1.7	−1.8	0.9	0.8	3	0.6
IT	1.5	1	0.8	−0.4	0.7	2.9	0.5
NL	15.4	−5.5	−1.1	−0.8	2	8	0.5
PT	0.7	−0.1	2.5	9.2	3.1	12.3	0.2

The question of whether fiscal consolidation was excessive, thereby contributing to slow down the recovery due to a large multiplier in a context of distressed financial markets, or whether it was not aggressive enough, has generated a large debate.[7] Less attention has been devoted to the anomalous debt-deficit dynamics related to the interaction between financial distress and public expenditure. To appreciate this point it is interesting to look at the historical relation between public debt and the rate of change (quarterly differences) of public deficit. The relation between debt and deficit can be expressed as:

$$D_t - D_{t-1} = pd_t + adj_t, \tag{1}$$

where D is the stock of the public sector gross debt and pd is the public deficit. The residual, the so-called stock-flow adjustment, is explained by valuation effects, financial transactions which are not reflected in the deficit, and errors and omissions.

Typically the residual is small, but occasionally it can be big. The literature has documented that creative accounting can inflate the residual near election time or when the economy enters a slump (Reischmann, 2016). In Europe, there is also evidence of a persistent positive residual in the nineties when EU rules kicked in (see Alt et al., 2014 for evidence on this point). However, data from 2010 and 2012 are striking and point to very special circumstances. Fig. 3 describes the first difference in public debt and the public deficit. Typically the two series are very similar, indicating a small residual. In the nineties the residual was positive, confirming results of the earlier literature but, in 2009 and 2011, there are two large peaks in the debt series which are unprecedented.

Eurostat data for the period 2008–2011 in Table 1 shows that these peaks are almost entirely explained by financial transactions which did not originate from the deficit but are accounted for in the public debt. These are related to special

[7] Our analysis is silent on this important question.

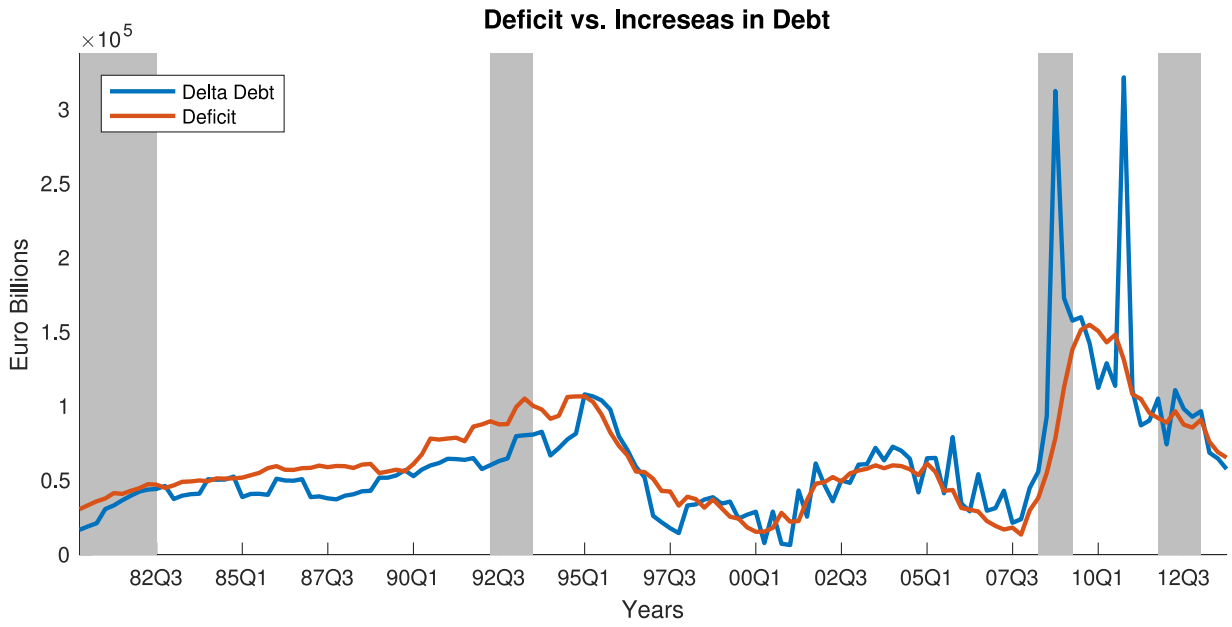


Fig. 3. Euro Area government deficit and first differences of government debt.

measures adopted in the crisis to support the financial sector, mainly acquisition of financial assets by the government (see Appendix B for further details). Several countries in the Euro Area had stock-flow adjustments which exceeded 2% of GDP. The large positive figure in Germany in 2008 reflects the purchases of securities by two special purpose vehicles in the context of operations related to the financial crisis, while in 2010 it reflects the transfer of assets of two public defeasance structures classified in the government sector[8]. The 2009 figure for Ireland reflects capital injection in the form of preference shares. Similar measures are in evidence for other countries (see Eurostat, 2012 for details). Aggregate figures are heavily influenced by Germany, which is the largest country in the Union and also the country that showed the largest debt increase due to extraordinary financial expenses as well as the most drastic fiscal consolidation.

Clearly the increase in debt due to these measures represents a cost in terms of future taxes. Since the Stability and Growth Pact rules are set for public debt as well as public deficit, the very large fiscal consolidation since 2009 is likely to have been motivated by the increase in debt caused by these special measures.

Turning now to the analysis of the deficit, Fig. 4 shows the dynamics of government expenditures and revenues. While public debt was increasing due to measures in support of the financial sector, fiscal consolidation since 2010 was taking place mostly by a flattening of government expenditures. Fig. 5 reports the growth of different public expenditures items as percentage of the rate of growth of total expenditures. It shows that the decline in the growth rate of government expenditures is associated to a decline in the contribution of social payments, government consumption and public investment. Notice also two spikes in the contribution of what is defined as a residual, which is explained by ad hoc capital transfers (that appear directly in the deficit) related to support of the financial sector.

Let us summarise the descriptive features we have illustrated.

1. In 2008, in relation to the collapse of GDP, both the public debt-GDP and public deficit-GDP ratios experienced a sudden deterioration which is much larger than anything experienced in the recessions included in our sample.
2. The dynamics of public debt is partly explained by measures in support of the financial system that were not accounted for as deficit.
3. Since 2009, we have seen a major fiscal adjustment with the deficit-GDP ratio declining more than in any other expansions.
4. The fiscal adjustment was mostly achieved by a flattening of government expenditures.
5. The latter was achieved by a decrease in the contribution of social payments, government consumption and public investment in favour of an increase to expenses in favour of the financial sector (capital transfers).

In the next sections we analyse these facts through the lens of an econometric model.

[8] The ESA2010 Eurostat Manual on Government Deficit and Debt, in sub-section IV.5.2.1 defines the defeasance structures (the so-called 'bad banks') as 'an institutional unit, which has substantial problematic assets, whose principal activity is the resolution of these assets generally over an extended period and not the provision of financial intermediation services. (...) When there is evidence that government is assuming all or the majority of the risks and rewards associated with the activities of a government-controlled defeasance structure, as described above, this structure is classified in the general government sector.'

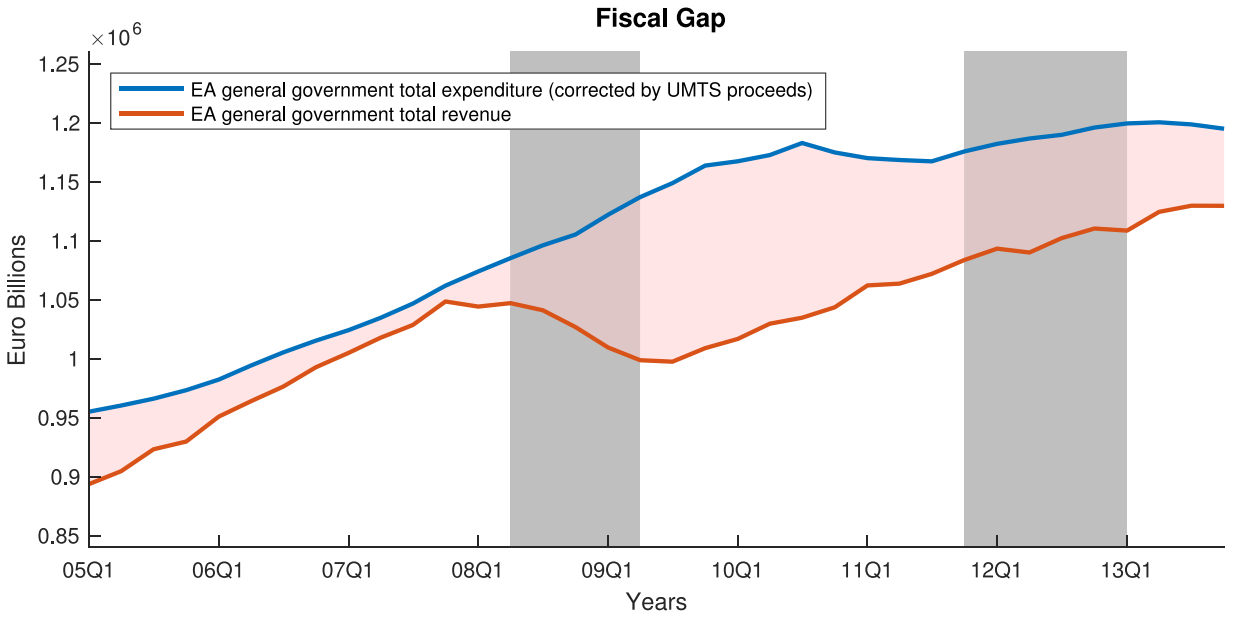


Fig. 4. Euro Area government total expenditures and revenues.

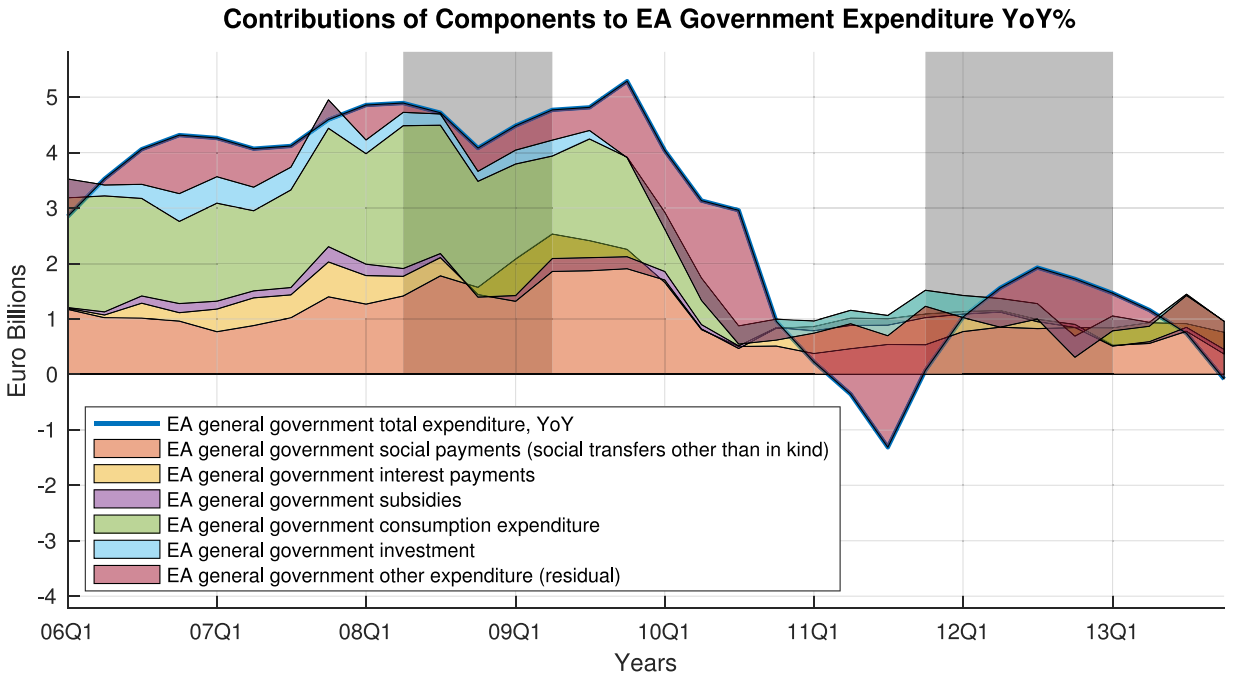


Fig. 5. Contributions to the year on year growth rate of Euro Area government expenditures.

3. A Macro-finance VAR for the Euro Area

In order to capture the complex interactions shaping the aggregate Euro Area economy we adopt a large VAR including a rich set of macroeconomic and financial indicators. In particular we consider 22 time series for the Euro Area aggregate, including fiscal and monetary policy variables, real output and its components, unemployment, prices, assets and several credit and financial variables for the sample 1981Q1-2008Q1. Importantly, we incorporate both standard macroeconomic flow variables and detailed fiscal indicators, but also stocks such as debt in different sectors. Table 2 lists the variables used in the model. Variables enter the model in log-levels, except for variables expressed in rates or with negative levels. When

Table 2
List of Variables. See Appendix A for the details.

Variable	Description	Source
GDP	Real GDP	Euro Area Wide Model
Consumption	Personal consumption	Euro Area Wide Model
Private Investment	Gross investment	Authors' calculations
Public Investment	General government investment	Euro Area Fiscal Database
Unemployment	Unemployment rate	Euro Area Wide Model
Gov Deficit	General government deficit	Euro Area Fiscal Database
Gov Debt	General government debt	Euro Area Fiscal Database
Gov Spending	General government total expenditure, excluding Social Payments and Interest Payments	Euro Area Fiscal Database
Gov Revenues	General government total revenue	Euro Area Fiscal Database
Social Payments	General government social payments	Euro Area Fiscal Database
Interest Payments	General government interest payments	Euro Area Fiscal Database
HH Savings	Household saving rate	Euro Area Wide Model
HH Debt	Households debt	Authors' Calculations
NFC Debt	Non-financial corporations debt	Authors' Calculations
FC Debt	Debt securities of MFI excl. ESCB	Authors' Calculations
CA/GDP	Current account / GDP	Euro Area Wide Model
House Prices	House prices	ECB
Long Term IR	Long term interest rate	Euro Area Wide Model
Short Term IR	Short term interest rate	Euro Area Wide Model
HCPI	Harmonized consumer price index	Euro Area Wide Model
ITA-GER i.r. spread	Spread Italian-German 10-year bond yields	Eurostat
Productivity	Real GDP / Hours	Authors' Calculations

in levels (or log-levels), they are deflated by using the GDP deflator. This choice has the advantage of avoiding problems related to arbitrary choices of data transformations which can distort results.[9]

In incorporating this rich dataset in our VAR we have to deal with four major challenges. First, while VARs are usually specified for flow variables and rates – e.g. output and its components or policy rates –, we need to model the joint evolution of stock and flow variables. In doing this the potentially non-linear relationship between stocks and flows may distort VAR estimates. This is of particular concern, for example, for the deficit and the debt accumulation equation. Second, a model capturing the joint dynamics of many macro and financial variables has necessarily a large cross-sectional dimension and an expansive set of parameters to be estimated with non-standard techniques. Third, VARs tend to extract 'implicit' deterministic components (trends) from the initial conditions of the data, that are taken as given. In doing so they may overfit the data, and explain too much of their variation by these deterministic components. Finally, in our VAR this problems are compounded by the empirical issue that financial stock variables – often thought of as driven by long cycles – tend to have low correlation with real variables at business cycle frequency, and may not be well captured by a VAR with limited lags.

To deal with the possible non-linear equation of debt accumulation, we adopt an approach similar to the one suggested by Favero and Giavazzi (2007) and consider a VARX, that is a VAR with public debt treated as an exogenous variable. Differently from Favero and Giavazzi (2007), we introduce fiscal budget components independently in the VAR and reconstruct the public debt as the cumulative sum of the fiscal deficit. The variables listed in Table 2, with the exception of the public debt and the public deficit, are collected in a vector of endogenous variables Y_t, while we specify separate equations for D_t – the stock of the Euro Area consolidated public debt (without the stock-flow adjustment) –, and for the public deficit pd_t. Our VARX model has the form:

$$Y_t = c + A(L)Y_{t-1} + b(L)D_t + u_t \tag{2}$$

$$D_t = D_0 + \sum_{j=0}^{t} pd_j \tag{3}$$

$$pd_t = G_t + TR_t + IP_t - T_t \tag{4}$$

where u_t is a normally distributed multivariate white noise with covariance matrix Σ and $A(L)$ is a matrix polynomial of order $p = 4$ in the lag operator L. The fiscal deficit, pd_t, is constructed as the sum of the relevant fiscal variables – i.e. public expenditure G, fiscal transfers TR, interest payments IP, and tax receipts T – that are individually present in the vector of endogenous variables Y_t. In this form the debt accumulation equation is a linear function of its components.

[9] The fiscal variables come from an updated version of a unique quarterly database for the Euro Area, described in Paredes et al. (2009). A more detailed description including sources and data treatment is provided in Appendix A.

We deal with the challenge of incorporating in an efficient manner a large set of variables by adopting Bayesian VAR techniques, that offer a convenient way to deal with large datasets. In fact, BVARs can efficiently deal with the problem of over-parametrisation through the use of prior information about the model coefficients. The key idea is to use informative priors that shrink the unrestricted model towards a parsimonious stylised benchmark model, thereby – in frequentist language – reducing parameter uncertainty, while introducing minimal bias.

More specifically, our BVAR is estimated adopting two sets of standard macroeconomic priors: Minnesota priors (Litterman, 1980, 1986) and sum-of-coefficients priors (Doan et al., 1984). While these priors are not motivated by economic theory, they capture commonly held beliefs about how economic time series behave. In fact, Minnesota and sum-of-coefficients are widely applied standard priors in macroeconometric research, that are proven to improve forecasting performances of VAR models.

Minnesota priors can be casted in the form of Normal-Inverse Wishart (NIW) conjugate priors, that assume a multivariate normal distribution for the regression coefficients and an Inverse Wishart specification for the covariance matrix of the error term Σ. Conditional on a draw for Σ, the Minnesota prior assumes the coefficients $A_1, \ldots, A_p$ to be a priori independent and normally distributed, with the following moments

$$\mathbb{E}[(A_\ell)_{ij}|\Sigma] = \begin{cases} \delta_i & i = j, \ \ell = 1 \\ 0 & \text{otherwise} \end{cases} \qquad \mathbb{V}ar\left[(A_\ell)_{ij}|\Sigma\right] = \begin{cases} \dfrac{\lambda}{\ell} & \text{for } i = j, \forall \ell \\ \dfrac{\lambda}{\ell}\dfrac{\Sigma_{ij}}{\sigma_j^2} & \text{for } i \neq j, \forall \ell. \end{cases} \tag{5}$$

In Eq. (5), $(A_\ell)_{ij}$ denotes the coefficient of variable j in equation i at lag ℓ. δ_i is either 0 or 1 – for stationary series, or variables that have been transformed to achieve stationarity, we centre the distribution around zero. The factor Σ_{ij}/σ_j^2 accounts for the different scales of variables i and j. The hyperparameters σ_i are fixed using sample information, as the standard deviations of the residuals of univariate regressions of each variable onto its own lags. Importantly, λ is a hyperparameter that controls the overall tightness of the random walk prior. If $\lambda = 0$ the prior information dominates, and the VAR reduces to a vector of univariate models. Conversely, as $\lambda \to \infty$ the prior becomes less informative, and the posterior mostly mirrors sample information. Minnesota priors can be implemented using dummy observations. Priors on A coefficients are implemented by the following pseudo-observations:

$$y_d^{(1)} = \begin{bmatrix} diag([\delta_1\sigma_1, \ldots, \delta_n\sigma_n])/\lambda \\ 0_{n(p-1)\times n} \end{bmatrix}, \tag{6}$$

$$x_d^{(1)} = [J_p \otimes diag([\sigma_1, \ldots, \sigma_n])/\lambda \quad 0_{np\times 1}]. \tag{7}$$

A second set of priors, the sum-of-coefficients (or 'no-cointegration') priors (Doan et al., 1984), can be relevant in dealing with the challenge of the relatively weak joint dynamics connecting private debt and real variables, while reducing concerns about the overfitting of VARs estimated conditional on initial observations. (See the original discussion on this issue in Sims, 1996, 2000, 2005a,b. A recent contribution to this debate is in Giannone et al., 2016.) In fact, these priors provide more weight to the hypothesis that macro and financial variables can be approximated by independent random walks with drifts.[10] This stylised description is helpful in modelling the joint dynamics of macroeconomic and financial variables, combining stock and flow indicators, and possibly exhibiting heterogenous trend components.

Specifically, the sum-of-coefficients prior captures the belief that when the average lagged values of a variable $y_{i,t}$ is at some level y_i, that same value y_i is likely to be a good forecast of $y_{i,t}$. It also implies that knowing the average of lagged values of variable j does not help in predicting a variable $i \neq j$. This prior is implemented using n artificial observations, one for each variable in y_t

$$\underset{[n\times n]}{y_d^{(2)}} = diag\left(\left[\frac{\bar{y}_{0,1}}{\tau}, \ldots, \frac{\bar{y}_{0,n}}{\tau}\right]\right), \qquad \underset{[n\times(np+1)]}{x_d^{(2)}} = [y_d^{(2)}, \ldots, y_d^{(2)}, 0], \tag{8}$$

where $\bar{y}_{0,i}, \ i = 1, \ldots, n$ are the average of the first four initial values of each variable. The prior implied by these dummy observations is centred at 1 for the sum of coefficients on own lags for each variable, and at 0 for the sum of coefficients on other variables' lags. It also introduces correlation among the coefficients of each variable in each equation. In fact, it is easy to show that equation by equation this prior implies the stochastic constraint

$$\left(1 - (A_1)_{jj} - \ldots - (A_p)_{jj}\right)\bar{y}_{0,j} = \tau u_t^d \qquad \forall j \tag{9}$$

where $(A_\ell)_{jj}$ denotes the coefficient of variable j in equation j at lag ℓ. The hyperparameter τ controls the variance of these prior beliefs. As $\tau \to \infty$ the prior becomes uninformative, while for $\tau \to 0$ the model implies that each variable is an independent unit-root process and there is no cointegration relationship.

[10] While results for a BVARs with only Minnesota priors are qualitatively unchanged, sum-of-coefficients priors are helpful in reducing estimation uncertainty on the long end of the conditional forecast.

In order to assign less probability to versions of the model in which deterministic transient components are more important than the stochastic component in explaining the series variance, we combine sum-of-coefficients dummy observations with dummy observations that favour the VAR intercept to be equal to zero ($c = 0$), as suggested by Sims and Zha (1998). A fairly loose prior for the intercept of this type can be implemented with the following dummy observations:

$$y_d^{(3)} = \left[0_{1\times n}\right],$$
$$x_d^{(3)} = \left[0_{1\times np} \quad \epsilon\right],$$

where ϵ is an hyperparameter set to a very small number.[11]

The setting of the priors depends importantly on the hyperparameters λ and τ, which reflect the informativeness of the prior distributions for the model coefficients. In setting the value of these hyperparameters, regulating the strength of prior beliefs, we follow the approach proposed by Giannone et al. (2015). This involves treating the hyperparameters as additional parameters, in the spirit of hierarchical modelling.

Conditional forecasts are obtained from a Bayesian Vector Autoregression estimated on the pre-crisis sample, by employing the Kalman filtering techniques used first in Giannone et al. (2010) and detailed in Bańbura et al. (2015). The procedure exploits the fact that Vector Autoregressive models can be cast in a state-space form. Hence, the conditional forecasts can be computed using Kalman filtering techniques and the counterfactual simulations can be drawn using the simulation smoother of Carter and Kohn (1994). As discussed in Bańbura et al. (2015), since the Kalman filter works recursively, this algorithm reduces the computational burden significantly for longer forecast horizons, and is particularly well suited for empirical approaches where large data sets are being handled.

4. This time was different

In this section we present three sets of empirical results: (i) we compare the actual path of macroeconomic and financial variables with their model-based forecast conditional on the pre-crisis sample and the realised path for output and inflation during the crisis; (ii) we zoom into the conditional predicted outcome for public debt and deficit and assess the role of stock-flow adjustment and measures of support to financial institutions; (iii) we compare conditional and unconditional forecasts and make inference about pre- and post-crisis trends.

4.1. What if the 2008 crisis had been just a 'normal' recession?

The question we want to ask is whether the observed behaviour of the variables since 2008 could have been expected given their historical correlation with the macroeconomy and the observed path of GDP and inflation. To provide an answer to this question, we compute model-based expectations for all macroeconomic and financial variables, conditional on the actual path of output and prices in 2008Q2–2013Q4, and using parameters estimated on the sample 1981Q1–2008Q1.[12] A significant difference between the observed path and the median of the simulated path (conditional expectation) would suggest that the exceptional decline of GDP alone cannot explain what we have observed, given the realised inflation and the historical pattern of business cycle recessions.

Fig. 6 reports the realised paths of all the variables included in the model, the median of the conditional forecasts as well as 68% (darker blue) and 90% (lighter blue) coverage intervals to provide a measure of uncertainty. A number of features are apparent.

First, while consumption and unemployment followed their historical relation with GDP, the contraction in output was marked by an anomalous protracted downfall in private investment and an increase in households' savings. In fact, while the high persistence of unemployment in Europe is in line with past regularities (albeit in the upper tail of the forecast outcomes),[13] the 'hysteresis' pattern in investment (see Dixit, 1992) – to which the model assigns probability close to zero – is markedly anomalous. Interestingly, this is not explained by large movements in labour productivity, that behaved in line with past regularities. The increase in households' savings reflects the sharp deleveraging in households' debt, that is visible in the path of households' debt after the crisis.

Second, also fiscal aggregates show an anomalous behaviour. It is useful, however, to distinguish between the first recession, in the period 2008Q1–2009Q3, from the subsequent adjustment. The first recession was characterised by an unusual decline in government revenues, which fell below the distribution of the forecast paths conditional on the large observed decline of GDP; and by an increase in government expenditures, in particular public investment and social payments, in the upper tail of the predicted outcomes. The fact that tax revenues declined more than what could have been expected

[11] We set ϵ to have a fairly loose prior variance equal to 10^6.

[12] To obtain conditional forecasts we first estimate the VAR model parameters' posterior distributions for the period 1981Q1–2008Q1. Then, we compute for all variables the conditional expectations for 2008Q2–2013Q4. For any given draw of the model's parameters from their posterior density, the draws from the counterfactual exercise are computed as conditional forecasts in which the conditioning information is given by: (1) the pre-crisis history of all variables in the model; (2) their estimated parameters capturing historical correlations; (3) the observed paths of GDP and inflation for 2008Q2–2013Q4. We report the median as well as 68% and 90% coverage intervals.

[13] Blanchard and Summers (1986) and more recently Galí (2015) observed that 'hysteresis' in labour market (i.e. high persistence of unemployment) in Europe may be due to the nature of its wage setting mechanisms and their impact on the sensitivity of wages to unemployment.

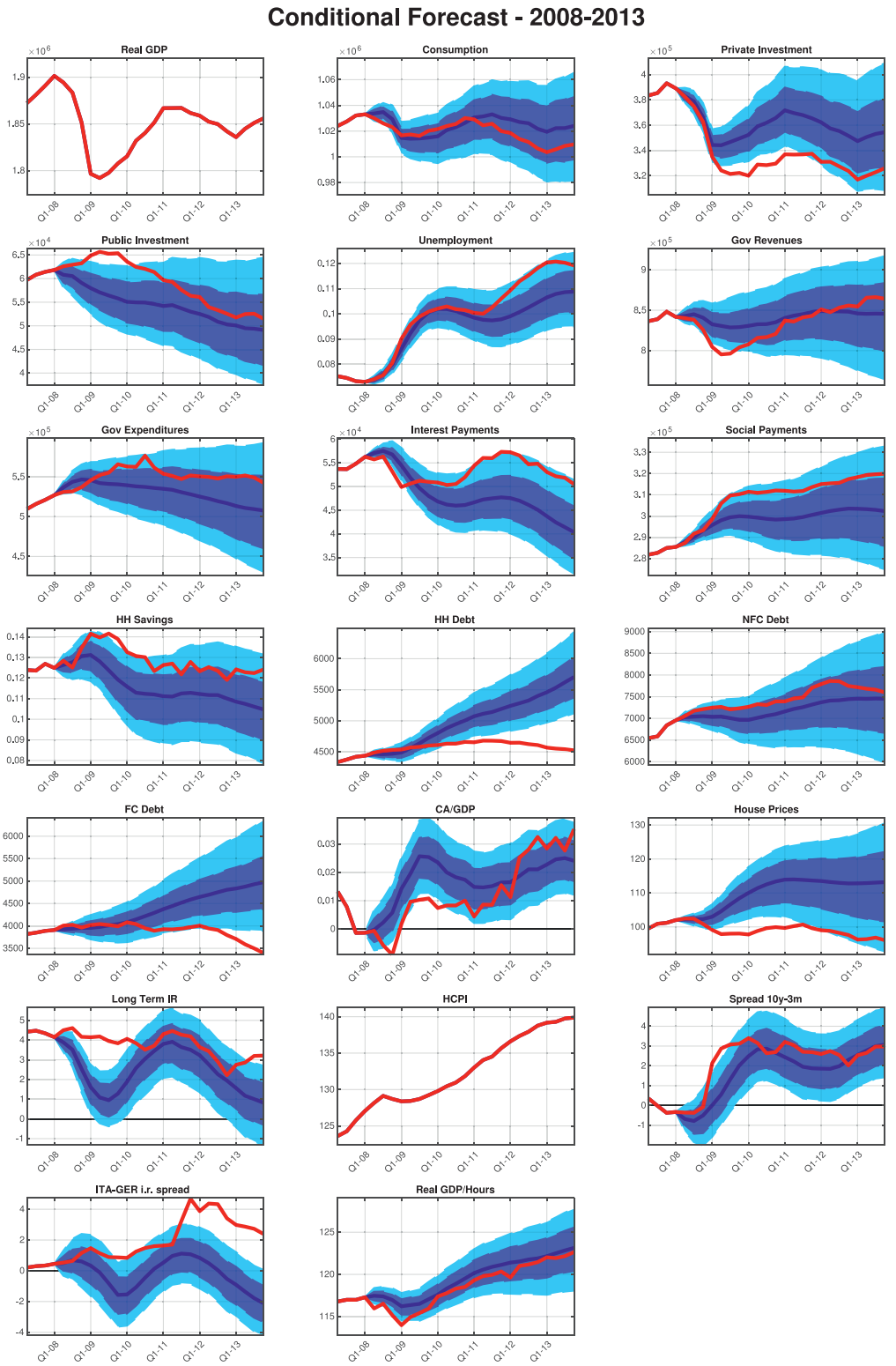


Fig. 6. *Conditional forecast.* The figure shows the realised data (red) and the counterfactual path of the variables. The blue lines are the medians of the forecasts conditional on the path of GDP, plotted with 68% (dark blue) and 90% (light blue) coverage intervals. House Prices and HICP are indices, interest rates and spreads are expressed in yearly rates, HH Savings is the Eurostat saving ratio; all the other variables are in Millions of Euros in real terms, with 1995 as reference year. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

given the behaviour of output and prices could suggest the activations of non-linearities due to the progressive nature of the tax system. However, the adjustment since late 2009 produced a sudden normalisation for tax revenues, government expenditures and social payments.

Third, during the first recession there was an anomalously large current account deficit, possibly explained by the collapse of world trade which, in 2008, was larger than the one of GDP. The adjustment since late 2009 involved a sharp reversal, with the current account returning to the historical counterfactual path and then overshooting to an unusually large surplus. This may also relate to the unusual decline in investment and sharp fiscal adjustment experienced by the Euro Area.

Fourth, while household savings were quite stable, households' and financial corporations' debts and house prices deviated from the predicted paths.[14] This shows a strong deleveraging of the European economy after the crisis. Also, the long-term interest rate stayed for the first part of the crisis at an unusually high level, possibly calling into action the unconventional monetary policy measures enacted by the ECB in the rest of the sample.

Finally, other features of the results deserve some comments. In correspondence to the debt crisis of 2011, we have an unusual steep increase in the Italian-German spread debt which persist till the end of the forecast period. Conversely, the interest rate term spread 10 year - 3 months on government bonds moves steeply to the upper tail of the distribution of the forecast during the 2008–2009 recession. Indeed results quantify the observations of Section 2 by showing that while an unusually high term spread was a feature of the first recession, an unusually high core-periphery sovereign spread was a feature of the second. In other words, the model correctly identifies different financial frictions in the two recessions.

4.2. The debt-deficit dynamics

Against the background described in the previous section, we now focus on to the public debt and fiscal deficit to analyse the effects of the fiscal-financial interaction. As described earlier, we construct the deficit from the disaggregated data on revenues and expenditures while we construct public debt as the cumulative sum of the deficit. Fig. 7a shows the observed and counterfactual paths for the two variables expressed as ratios with respect to GDP. In addition, we report data on public debt without stock-flow adjustments.

The left panel, showing actual and counterfactual paths for the deficit-to-GDP ratio, reflects the features noticed on Fig. 6. A sharp fiscal consolidation from 2009Q3, started more than a year earlier than what predicted by the counterfactual path, brought down the large gap in 2008–2009 between the counterfactual path of the deficit ratio and the actual ratio. By 2011, the realised deficit is back inside the predicted conditional distribution of forecasts. This quantifies in statistical term what observed in the previous section by comparing data across recessions: the fiscal consolidation of 2009–2010 was sudden and of an unprecedented size.

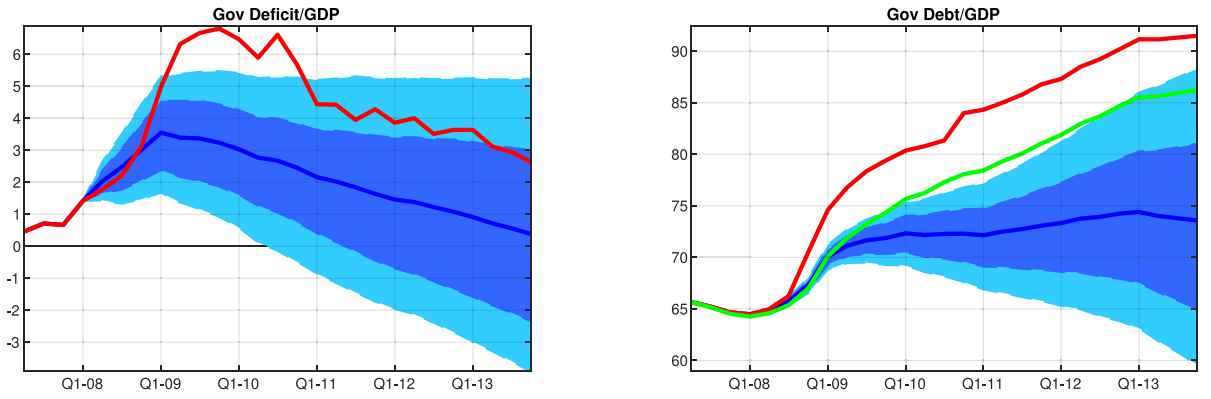
The right panel shows the dynamics of public debt. It reports both the actual level of debt-to-GDP ratio (red line) and the non-stock-flow adjusted ratio (green line). The adjusted debt ratio, that includes measure of support to the financial sector, jumps up immediately above the counterfactual and stays about 10% higher than the non-adjusted line until 2012, when it jumps up again as the effect of an other wave of special measures in support of the financial sector (see Table 1 in Section 2). The non-adjusted path, which we compute as the sum of the deficit, is at the end of the sample just outside the upper limit of the 90% predicted distribution. The big anomaly of the stock-flow adjusted debt dynamics seems therefore largely explained by the special measures in support of the financial sector.

We further explore these results, by performing a robustness exercise and excluding Germany from the Euro Area aggregate. This to the aim of assessing whether the results reported are due to a common pattern across the Euro Area or are determined by it largest member only. Results in Fig. 7b show that the anomalous debt-deficit dynamics is by large a common feature of the Euro Area crisis, albeit Germany provided a major share of the stock-flow adjustments that increased the stock of the debt during the crisis. Finally, Fig. 7c extend the exercise to 2017 to show that the unprecedented effort in bringing the Euro Area deficit down managed to stabilise both deficit and the stock of debt, by lowering their values to the rage of the values forecastable given past business cycles regularities.[15]

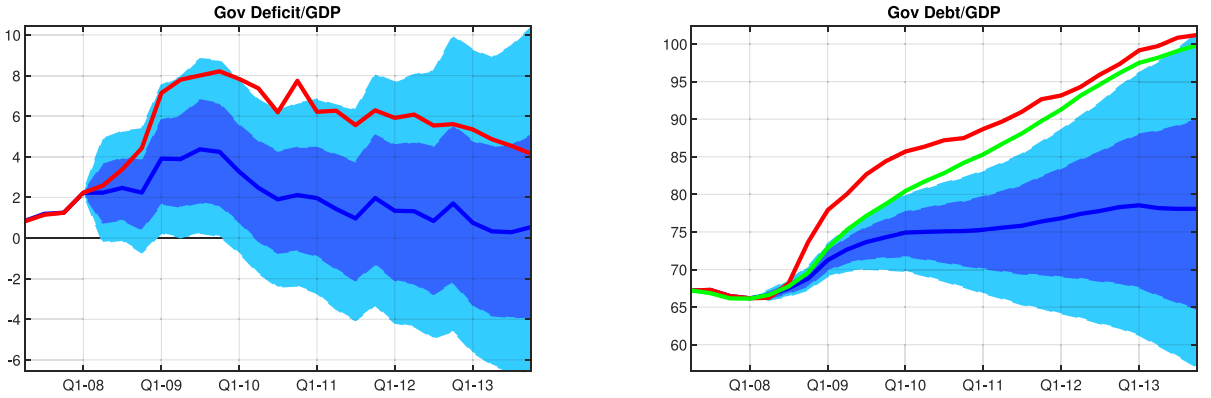
To gain further insight about the joint path of public debt and deficit, let us consider the observed and counterfactual scatter-plot illustrated in Fig. 8. Let us keep in mind that the latter is computed taking into account all general equilibrium relationships implicit in the VAR model. The figure shows that the relationship between deficit and debt is highly non-linear and that, during the fiscal contraction, the increase in debt associated with a given decline in deficit has been larger than expected. The yellow dots, representing the deficit-debt counterfactual scatter plot where the debt is not adjusted, show an inverse U-shape: up to 2009 we have an increase in debt corresponding to an increase in deficit while, after 2009, as the deficit contracts (still remaining positive), debt increases. The data, both when the debt is adjusted (red dots) and when is not (green dots), follow the same pattern but the curves are shifted up and to the right. The red dots in particular are outside the 90% confidence intervals.

[14] To control for potential outliers in the house markets of some smaller countries, as for example Ireland, in a robustness exercise we replace the Euro Area index with a weighted average of the house price indices in the five largest countries. Our results are robust to this test and are reported in Appendix C.3.

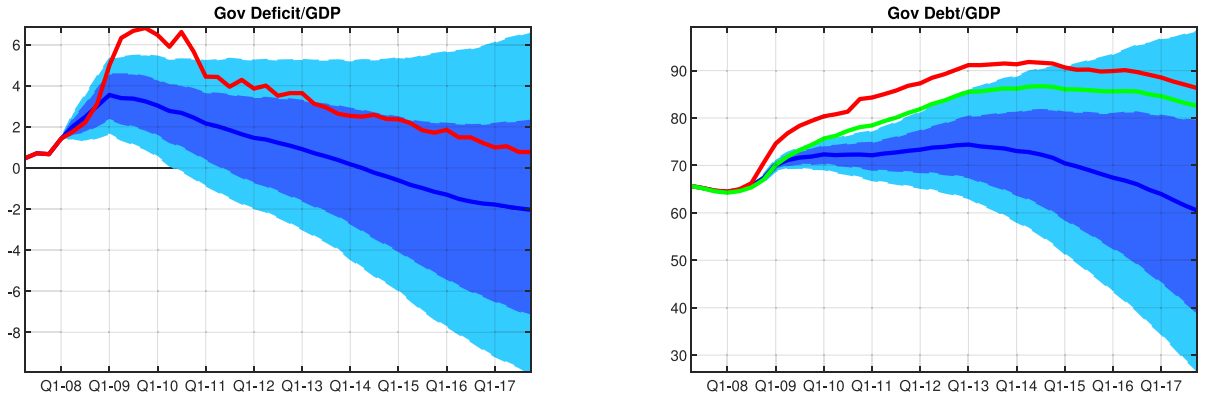
[15] The full set of results provided by these two robustness exercises are reported in Appendix C.3.



(a) **Conditional forecast, public debt and public deficit ratios, 2008-2013.**



(b) **Conditional forecast, Euro Area without Germany, 2008-2013.**



(c) **Conditional forecast, public debt and public deficit ratios, 2008-2017.**

Fig. 7. The figures show the realised data (red), the data minus stock-flow adjustment (green) and the counterfactual path (blue). The blue lines are the medians of the forecasts conditional on the path of GDP and inflation, plotted with 68% (dark blue) and 90% (light blue) coverage intervals. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

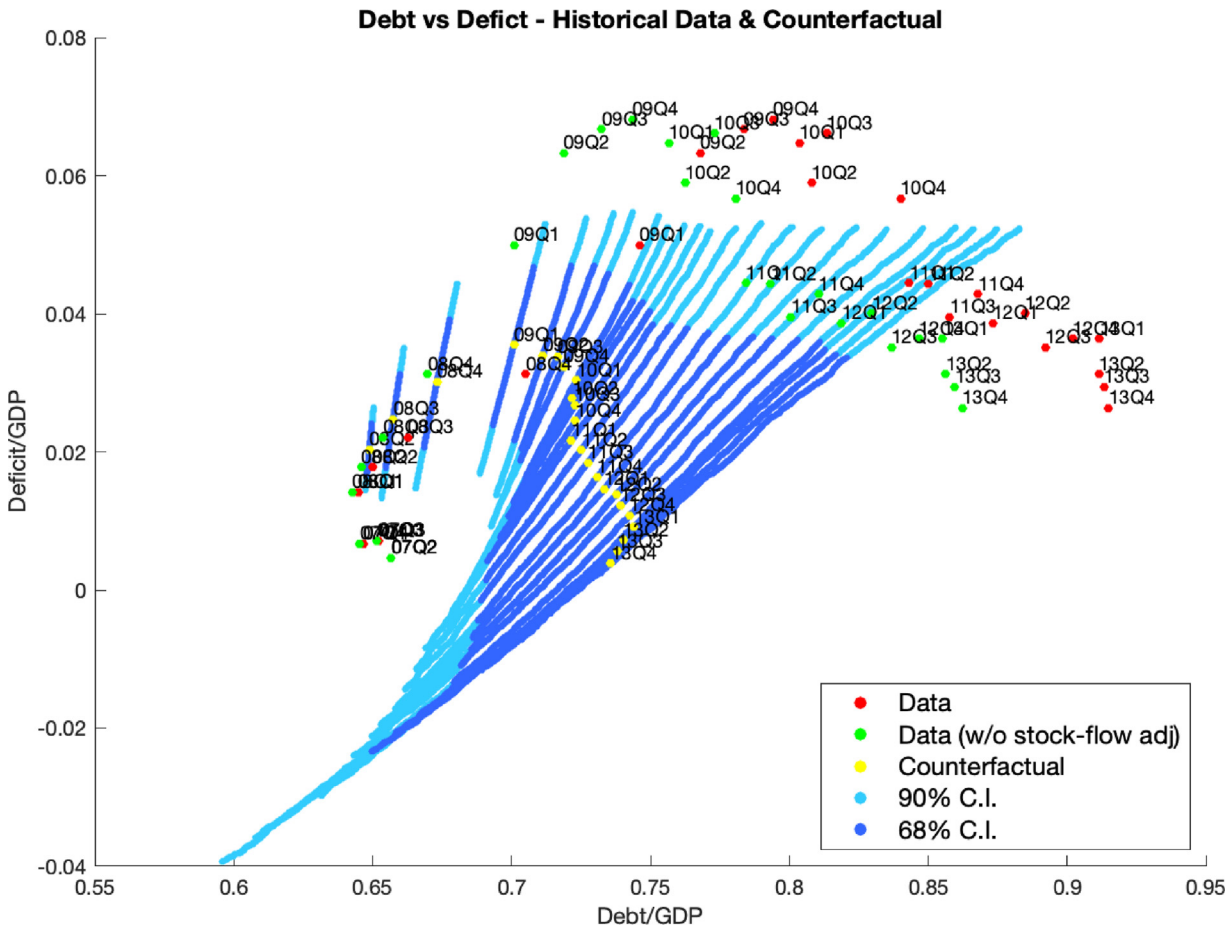


Fig. 8. Scatter plot: Debt and deficit counterfactual.

4.3. Unconditional forecast and trends

Fig. 9 presents conditional and unconditional median forecasts against the realised paths of the variables since 2008. This exercise is meant to assess two aspects of our analysis. First, the unconditional forecasts, based on the pre-crisis estimated parameters, provide on the medium run a gauge on the pre-crisis trends that the model would extrapolate from the data. Second, the difference between the conditional and unconditional forecast provides an indirect measure of the strength or weakness of the coupling of each single variable with GDP and inflation.

It is worth observing that the difference between the realised paths for GDP and HCPI and their unconditional forecasts can be thought of as the deviation by which the conditional forecasts are informed. Conditional on the pre-crisis data, the model would implicitly read them as due to a given sequence of shocks and use this information to produce the conditional forecasts shown in Fig. 6. By doing so the model should be able to capture the cyclical dynamics of those variables that are correlated with GDP and inflation (and that were not subject to structural change).

Fig. 9 shows that several variables were co-moving with GDP and inflation in the pre-crisis period – the gap between the conditional and the unconditional projections is a measure of this. However, this is notably not the case for public, households', and financial corporations' debts. This can be read as an indication of the fact that due to two (pre-crisis) decades of leveraging, these variables have experienced movements unrelated to GDP and in general to the economic cycle. This observation matches with some of the stylised facts on financial cycles reported in the literature (see, for example, Borio, 2014).

Another feature that is in evidence in Fig. 9 is the marked and very persistent deviation of the path of many variables from the pre-crisis trends. The gap that opened up during the crisis with respect to pre-crisis trends – among others for output, consumption, investment, private and public debts, and house prices – does not seem to close down in the final part of the sample. This begs the question whether the observed deviations are due to a very unusual and persistent cyclical event due to hysteresis effects, or they are better thought of as due to structural changes in the trend growth.

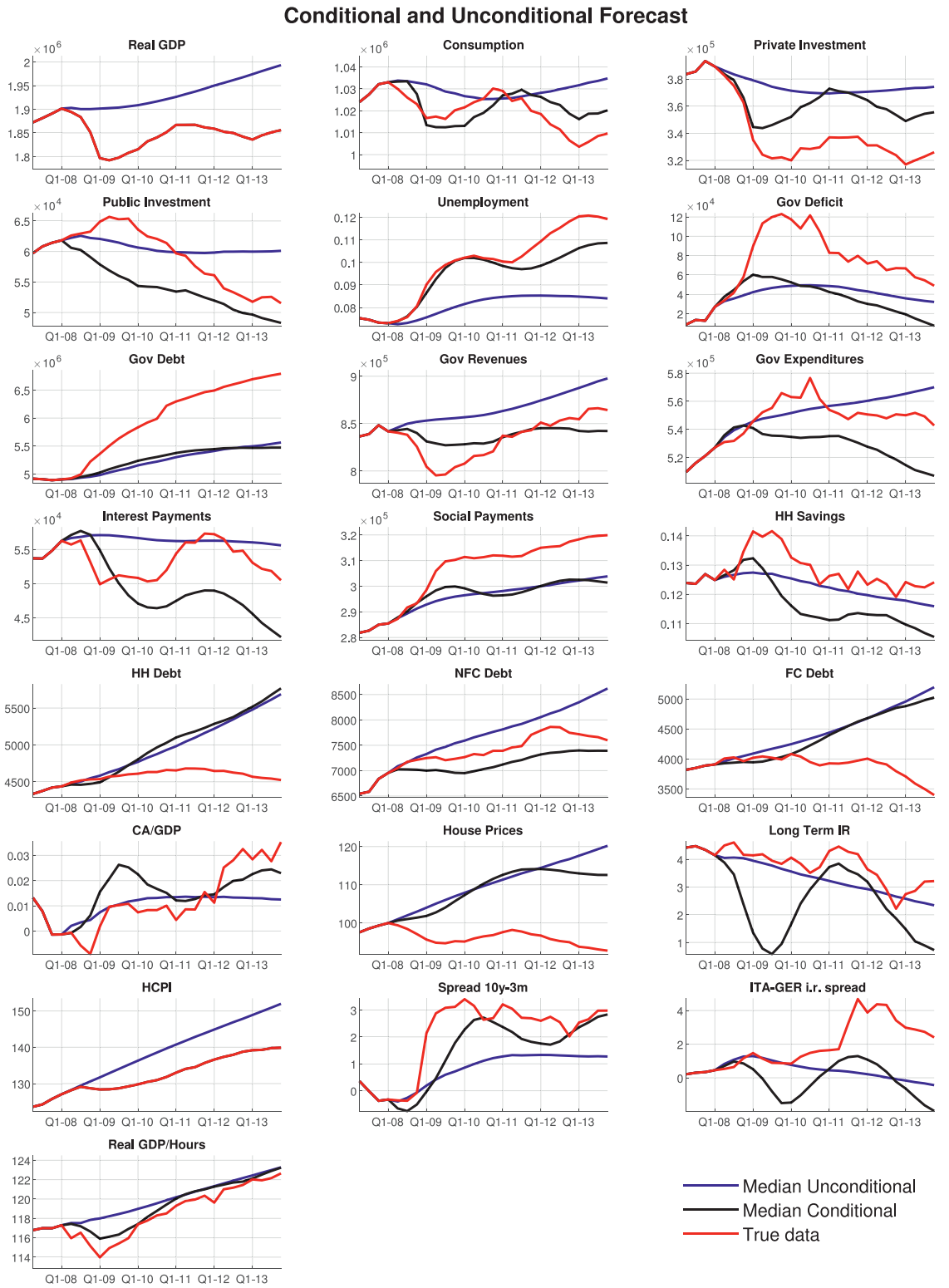


Fig. 9. *Conditional and unconditional forecast.* The figure shows the realised data (red), the median of the forecast conditioned on GDP and HICP paths (black) and the median of the unconditional forecast (blue). House Prices and HICP are indices, interest rates and spreads are expressed in yearly rates, HH Savings is the Eurostat saving ratio; all the other variables are in Millions of Euros in real terms with 1995 as reference year. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

5. Conclusions and discussion

The analysis summarised in this section employs a large VAR incorporating a rich set of macroeconomic, fiscal and financial variables. Our model extracts information on the multivariate dynamics of economic indicators from the 1981–2008 sample, and produces forecasts (i) unconditional and (ii) conditional to the realised paths of output and prices. While the first can be thought of as a measure of the model-implied trends on the medium horizon, the latter provide an indication of how the behaviour of the economy since 2008 deviated from historical business cycle regularities.

Our analysis provides a bird's-eye view of the effect of the financial crisis in the Euro Area, and a few novel stylised facts. First, most of the variables deviated strongly and persistently from pre-crisis trends, among others output, consumption, private investment, private and public debts, and house prices. The deviations from pre-crisis trends do not seem to close down in the final part of the sample. While for some of the variables the deviation is explained by business cycle regularities and the deep contraction in production, for others the deviation was anomalous even given the large drop in output. This is notably the case for the protracted contraction in private investment. Second, households' and financial corporations' debts seem to be weakly associated to the economic cycle in the pre-crisis sample, possibly due to two decades of leveraging. Moreover, during the crisis, households' and financial corporations' debts and house prices markedly deviated from their pre-crisis trends. Finally, the jumps in the fiscal deficit-GDP and debt-GDP ratios in 2008–2009 were unprecedented and so was the fiscal consolidation that followed. Importantly, this anomaly in public debt is in large part explained by extraordinary measures in support of the financial sector, which show up in the stock-flow adjustments and reveals a key interaction between the fiscal and financial sectors.

Our approach does not recover the nature of the shocks that caused the deep recession, nor allows to make causal statements. This limitations are largely common to the literature that has studied financial crises. However, our methodology provides a useful descriptive account of the adjustment since the crisis, by distinguishing what can be explained by its cyclical component and what are its specific characteristics as compared to historical regularities.

The stylised facts recovered by our analysis point to the financial stress and the associated sharp fiscal consolidation and as potential explanatory factors of the observed anomalies. However, it is important to remark that, given our approach, we cannot discriminate amongst potential competing explanations. In particular we cannot determine whether the uncovered anomalous features were due to the 'depth' of the drop in output (and hence the activation of non-linearities and hysteresis effects), to a sudden permanent change in the underlying trends, or to the financial nature of the crisis.

On balance, our results on fiscal debt-deficit dynamics support the observation that, in the Great Recession, the financial-fiscal interaction determined a deterioration of the budget and an increase in the stock of debt, beyond business cycle regularities. As recovery began, countries reacted to the unprecedented accumulation of the stock of debt by a severe fiscal consolidation which is likely to have negatively affected the recovery path. These observations lend support to proposals for reform of the Euro Area governance that would allow a slower fiscal consolidation in case of large negative shocks and would distinguish between that part of the government fiscal balance depending on the business cycle and that part that is explained by the reaction to the increase in the stock of debt (see, for example, Corsetti, 2015a,b).

Appendix A. Data Appendix

A.1. Euro Area data

Table 3
Variables included in the VAR model [1/2]. Euro area data are relative to a fixed composition with 19 members.

Variable	Source	Name	ID / Details
GDP	Euro Area Wide Model	GDP	YER
Consumption	Euro Area Wide Model	Private consumption	PCR
Private Investment	Authors' calculations		
Public Investment	Euro Area Fiscal Database	EA general government investment	GIN, deflated by GDP deflator (ID: YED of EAWM
Unemployment	Euro Area Wide Model	Unemployment rate (as a percentage of labour force)	URX
Gov Deficit	Euro Area Fiscal Database	EA general government deficit (computed = TOE-TOR)	DEF, deflated by GDP deflator
Gov Debt	Euro Area Fiscal Database	EA general government debt	MAL, deflated by GDP deflator
Gov Spending	Euro Area Fiscal Database	EA general government total expenditure (corrected by UMTS proceeds), excluding Social Payments and Interest Payments	TOE, deflated by GDP deflator
Gov Revenues	Euro Area Fiscal Database	EA general government total revenue	TOR, deflated by GDP deflator
Social Payments	Euro Area Fiscal Database	EA general government social payments (social transfers other than in kind, D62)	THN, deflated by GDP deflator
Interest Payments	Euro Area Fiscal Database	EA general government interest payments	INP, deflated by GDP deflator
HH Savings	Euro Area Wide Model	Household savings rate	SAX
HH Debt	BIS and authors' calculations	Debt of Households	Calculations on Q:XM:H:A:M:XDC:A

Table 4
Variables included in the VAR model [2/2]. Euro area data are relative to a fixed composition with 19 members.

Variable	Source	Name	ID / Details
NFC Debt	BIS and authors' calculations	Debt of non-financial corporations	Calculations on Q:XM:N:A:M:XDC:A
FC Debt	IMF, ECB and authors' calculations	Debt of financial corporations	See details below
CA/GDP	Euro Area Wide Model	Current account balance/GDP	CAN, YEN
House Prices	ECB	Residential property prices, New and existing dwellings	RPP.Q.I7.N.TD.00.3.00
Long Term IR	Euro Area Wide Model	10-year interest rate	LTN
Short Term IR	Euro Area Wide Model	3-month interest rate	STN
HCPI	Euro Area Wide Model	Overall HICP (Non-seasonally adjusted)	HICP
ITA-GER i.r. spread	Eurostat	ITA-GER spread	Spread between Italian and German Maastricht criterion bond yields, around 10-year residual maturity
Productivity	EAWM, Eurostat and authors' calculations	Real GDP/Hours	GDP: YER of EAWM; Hours: Thousand hours worked from Eurostat, namq10a10e

A.2. Data details

For "Euro Area Wide Model" we mean the 18th update of the database described in Fagan et al. (2005). All the non seasonally adjusted series have been seasonally adjusted using the TRAMO-SEATS procedure. Additional details:

- *Private investment* - Difference between real Gross Fixed Capital Formation (Source: Euro Area Wide Model, ID: ITR) and Public Investment.
- *HH debt* - Source: BIS data, Long series on total credit and domestic bank credit to the private non-financial sector, Households and NPISHs. Data for the Euro Area are available since 1999. To reconstruct data prior to 1999, we used the quarterly growth rates of the sum of the correspondent data for Belgium, Finland, France, Germany, Italy, Spain and Portugal.
- *NFC debt* - Source: BIS data, Long series on total credit and domestic bank credit to the private non-financial sector, Non-financial corporations. Data for the Euro Area are available since 1999. To reconstruct data prior to 1999, we used the quarterly growth rates of the sum of the correspondent data for Belgium, Finland, France, Germany, Italy, Spain and Portugal.
- *FC debt* - ECB Data for the Euro Area (ID BSI.M.U2.N.A.L40.A.1.Z5.0000.Z01.E) is available since 1997 Q3. To reconstruct data prior to 1997 Q3, we used the quarterly growth rates of the sum of the IMF data of Debt securities for Other Depository Corporations in Austria, France, Germany, Italy, Netherlands, Portugal, Spain.
- *Productivity* We measure it using the ratio between Real GDP and Total Hours Worked. Since the Eurostat data on hours is available since 1995 Q1, we reconstruct data prior to 1995 using the growth rate of the series "Hours worked in the Eurozone" used in Benati (2007). We then compute the index 1995=100.

Appendix B. Public Interventions in support of the financial sector during the crisis

We can distinguish between two types of public interventions for the financial sectors: those that affect both debt and deficit and those that affect debt only. According to the budget rules a capital injection can be considered as a capital transfer (increasing the government deficit, see the "residual" component in Fig. 5) or as an acquisition of equity (a financial transaction, which does not impact on the government deficit; we have shown some figures relative to the period 2008–2011 in the Table 1 in the text).

Between 2008 and 2013 in the European Union there have been recapitalisation measures for 448.16 billions of euros accounting for 3.43% of GDP, and asset relief interventions for 188.24 billions accounting for 1.44% of GDP. Overall these measures accounted for 5.06% of GDP. This however is a small fraction of what was approved. We provide a list of approved measures by categories below.

Guarantees on liabilities (bulk of the intervention):

- The EC authorised a total aid of EUR 3 892.6 billion (29.8% of EU GDP in 2013) for guarantees on liabilities.
- The outstanding amount peaked in 2009 at EUR 835.8 billion (6.39% of EU 2013 GDP), and has decreased since.
- In 2013, outstanding guarantees amounted to EUR 352.3 billion (2.7% of EU 2013 GDP). However only EUR 3.13 billion of the total guarantees provided have been called.

Recapitalisation

The EC authorised aid for EUR 821.1 billion (6.3% of EU 2013 GDP) in the last six years. In 2008–2013, EUR 448 billion (3.4% of EU 2013 GDP) granted in recapitalisation measures. This was mostly for the UK, Germany, Ireland and Spain.

Table 5
Variables relative to Germany used to construct the aggregate EA-Germany [1/2].

Variable	Source	Name	ID / Details
GDP	OECD	GDP	VOBARSA: National currency, volume estimates. Deflated using CPI index (OECD), rebased to 1995.
Consumption	OECD	Private final consumption expenditure	VOBARSA: National currency, volume estimates. Deflated using CPI index (OECD), rebased to 1995.
Investment	OECD	Gross fixed capital formation	VOBARSA: National currency, volume estimates. Deflated using CPI index (OECD), rebased to 1995.
Unemployment	OECD	Unemployment rate	
Gov Deficit	EA Fiscal Database and authors' calculations	General government deficit (computed = TOE-TOR)	DEF, deflated by GDP deflator.
Gov Debt	EA Fiscal Database and authors' calculations	General government debt	MAL, deflated by GDP deflator
Gov Spending	EA Fiscal Database and authors' calculations	General government total expenditure (corrected by UMTS proceeds), excluding Social Payments and Interest Payments	TOE, deflated by GDP deflator
Gov Revenues	EA Fiscal Database and authors' calculations	General government total revenue	TOR, deflated by GDP deflator
Social Payments	EA Fiscal Database and authors' calculations	General government social payments (social transfers other than in kind, D62)	THN, deflated by GDP deflator
Interest Payments	EA Fiscal Database and authors' calculations	General government interest payments	INP, deflated by GDP deflator
HH Savings	Datastream, Bundesbank	Household savings rate	BDPERSAVE; Pan BD Q0191.
HH Debt	BIS	Debt of Households	Q:DE:H:A:M:XDC:A

Direct short term liquidity support

The EC approved EUR 379.9 billion (2.9% of EU 2013 GDP) for liquidity measures. However, Member States have practically used only a very small amount. Spain and the Netherlands account for more than a half of the outstanding amounts in the peak year 2009.

Asset relief measures

In 2008–2013, Member States provided asset relief measures reaching EUR 188.2 billion (1.4% of EU 2013 GDP) while the total aid approved was EUR 669.1 billion (5.1% of EU 2013 GDP).

Appendix C. Robustness

In this section we present the results of some robustness checks conducted on our analysis.

C.1. Results up to 2017

In Fig. 10 we show the conditional forecast exercise performed up to 2017 Q4, showing the results for all the variables.

The results highlight three interesting facts: (i) the normalisation of the long term interest rates, as compared to past regularities, and hence the success of the ECB unconventional monetary policy measures; (ii) the protracted reduction of governments' deficits and hence the stabilisation of the stock of debt; (iii) the post-crisis adjustments in HH debt, FC debt and house prices, that appear as changes in the trends.

C.2. Results relative to the Euro Area without Germany

We report here the results of a robustness exercise performed excluding Germany from the Euro Area aggregate. In Tables 4, 5 we report the details on the data relative to Germany. For National Account variables and other indicators expressed in monetary terms, we have subtracted Germany data from the Euro Area aggregate. For unemployment, interest rates and price indexes, we have subtracted the value for Germany weighted by GDP (constant 1995 PPP prices for the Euro Area), then we have rescaled the indicators multiplying them by GDP_{EA}/GDP_{EA-Ger}. In Fig. 11 we report the results of the conditional forecast for all the variables. The main results are robust, especially looking at the anomalous behaviour of private investment, government deficit, government debt and house prices. Also, the adjustments in households' debt and financial corporations' debt is well evident and in line with the results relative to the Euro Area as a whole.

All the non seasonally adjusted series have been seasonally adjusted using the TRAMO-SEATS procedure. Additional details on the data:

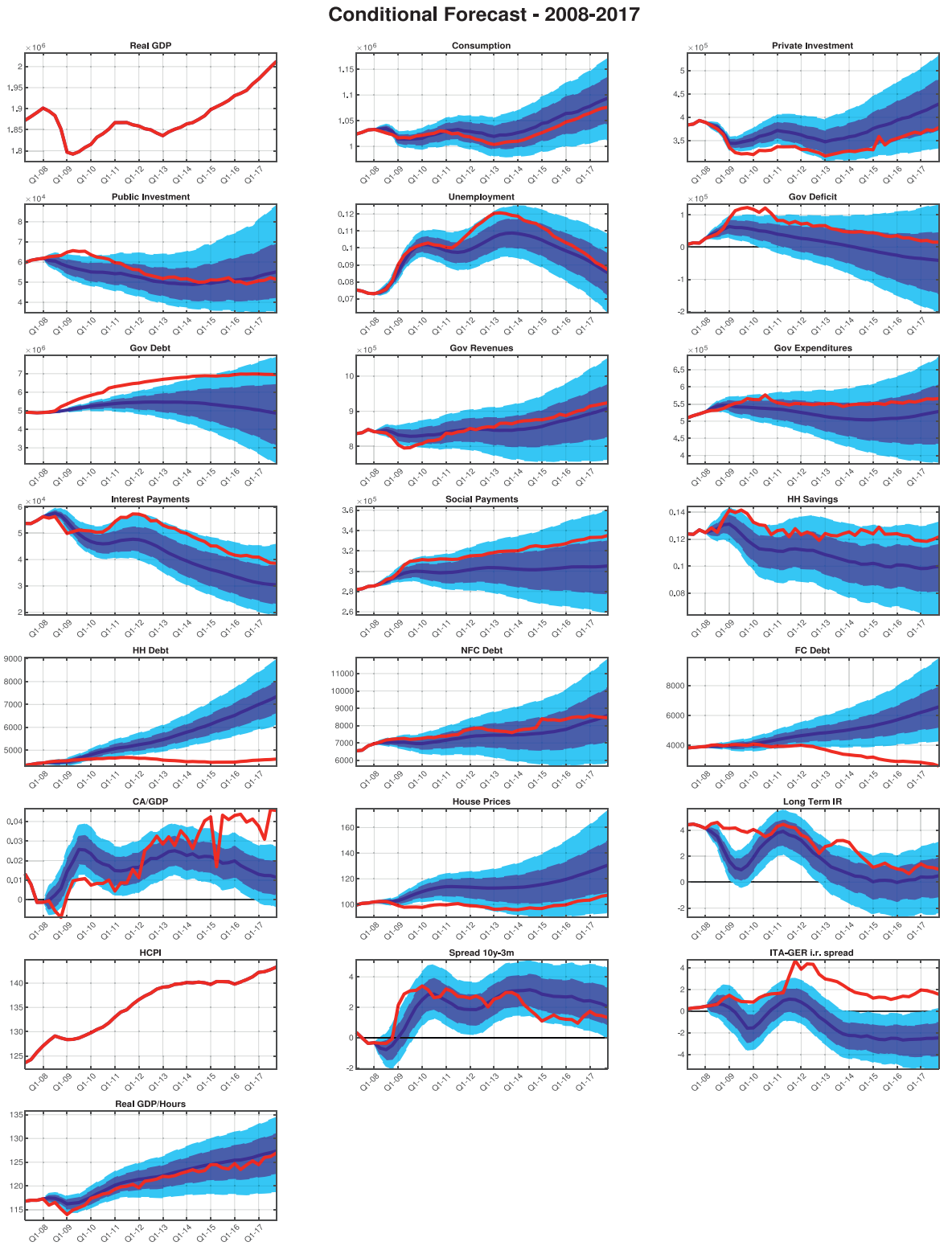


Fig. 10. *Conditional forecast.* The figure shows the realised data (red) and the counterfactual path of the variables. The blue lines are the medians of the forecasts conditional on the path of GDP, plotted with 68% (dark blue) and 90% (light blue) coverage intervals. House Prices and HICP are indices, interest rates and spreads are expressed in yearly rates, HH Savings is the Eurostat saving ratio; all the other variables are in Millions of Euros in real terms, with 1995 as reference year. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

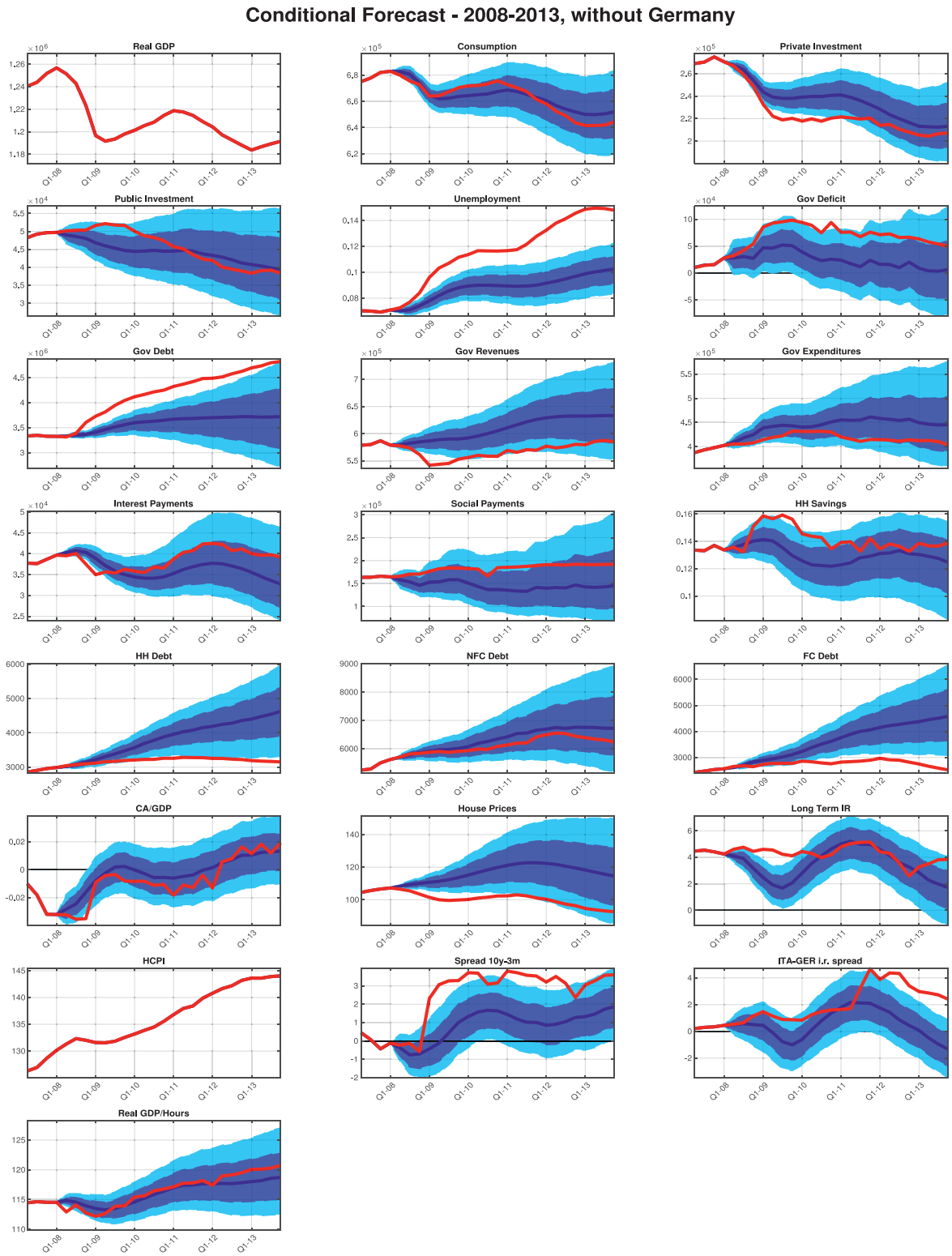


Fig. 11. *Conditional forecast - Euro Area without Germany.* The figure shows the realised data (red) and the counterfactual path of the variables, performing the exercise on a dataset of Euro Area excluding Germany. The blue lines are the medians of the forecasts conditional on the path of GDP, plotted with 68% (dark blue) and 90% (light blue) coverage intervals. House Prices and HICP are indices, interest rates and spreads are expressed in yearly rates, HH Savings is the Eurostat saving ratio; all the other variables are in Millions of Euros in real terms, with 1995 as reference year. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

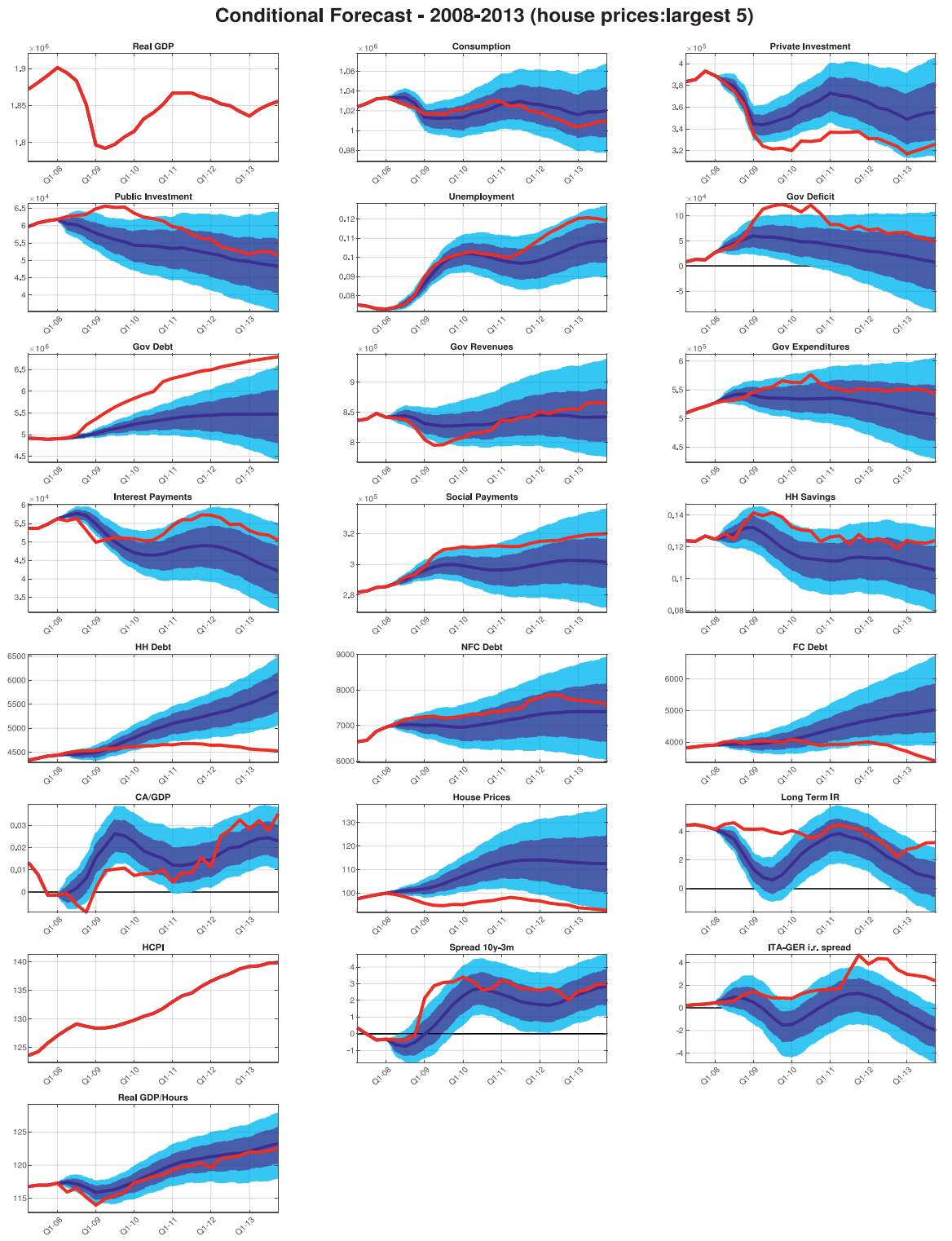


Fig. 12. *Conditional forecast - replacing the house price index.* The figure shows the realised data (red) and the counterfactual path of the variables, performing the exercise replacing the Euro Area house price index with a weighted average of the house prices indices relative to the five largest countries. The blue lines are the medians of the forecasts conditional on the path of GDP, plotted with 68% (dark blue) and 90% (light blue) coverage intervals. House Prices and HICP are indices, interest rates and spreads are expressed in yearly rates, HH Savings is the Eurostat saving ratio; all the other variables are in Millions of Euros in real terms, with 1995 as reference year. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Table 6
Variables relative to Germany used to construct the aggregate EA-Germany [2/2].

Variable	Source	Name	ID / Details
NFC Debt	BIS	Debt of non-financial corporations	Q:DE:N:A:M:XDC:A
FC Debt	ECB, Bundesbank and authors' calculations	Debt of financial corporations	ECB: BSI.Q.DE.N.A.L40.A.1.Z5.0000.Z01.E; Bundesbank: BBK01.OU0370
CA/GDP	OECD	Current account balance/GDP	VOBARSA: National currency, volume estimates. Deflated using CPI index (OECD), rebased to 1995.
House Prices	BIS	Nominal house price index, SA	Long-term series on nominal residential property prices
Long Term IR	Eurostat	10-year interest rate	EMU convergence criterion series, irt-lt-mcby-q
Short Term IR	Datastream	3-month interest rate	BD EU-MARK 3M DEPOSIT (FT/TR) - MIDDLE RATE, ECWGM3M
CPI	OECD	CPI	
ITA-GER i.r. spread	Eurostat	ITA-GER spread	Spread between Italian and German Maastricht criterion bond yields, around 10-year residual maturity
Productivity	Destatis and authors' calculations	Real GDP/Hours	Datastream: BDIAGPHCE and BDGNPEMHE

- *Fiscal data* - Quarterly data are available since 1991 Q1. To reconstruct data prior to 1991, we have interpolated the corresponding annual data using the Chow et al. (1971) procedure.
- *HH debt* - BIS data: Long series on total credit and domestic bank credit to the private non-financial sector, Households and NPISHs.
- *NFC debt* - BIS data: Long series on total credit and domestic bank credit to the private non-financial sector, Non-financial corporations.
- *FC debt* - ECB Data are available since 1997 Q3. Prior to 1997 Q3 we have reconstructed the series using the growth rate of the Bundesbank series "Principal assets and liabilities of banks (MFIs) in Germany by category of banks / Bearer debt securities outstanding / All categories of banks" (real, 1995 prices).
- *Productivity* We measure it using the ratio between Real GDP and Total Hours Worked. Since data on GDP/Hours is available since 1995 Q1, we reconstruct data prior to 1995 using the growth rate of the GDP per man/hour. We then computed the index 1995=100.

C.3. Results replacing the house price index

We performed another robustness exercise replacing the existing index with a weighted average (weighted by constant GDP at market prices, PPP, for 1995) of the house price index in Germany, France, Italy, Spain and Netherlands (Source: BIS, Long-term series on nominal residential property prices, seasonally adjusted using TRAMO-SEATS). Results are not significantly affected, as shown in Fig. 12.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.euroecorev.2019.08.002

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