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Monetary policy stress in EMU during the moderation and the global crisis

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Abstract

This paper re-examines the problem of monetary policy stress in the EMU, both prior to the crisis as well as after its outbreak. It aims to (firstly) reconfirm that monetary policy during the great moderation (i.e. until late 2008) was responsible for fuelling the process of imbalance accumulation in the EMU, and (secondly) to determine to what extent the stress was caused by macroeconomic divergences.

We employ a forward-looking Taylor-type monetary policy reaction function with real-time forecasted data to mimic the ECB monetary policy during the great moderation. The estimated coefficients are subsequently used to create counterfactual series of rule-consistent country-specific interest rates and compute monetary policy stress in EMU individual member states.

The results confirm that peripheral countries were exposed to risks emerging from excessively low interest rates, while the "core" countries had to live with too-high interest rates, and the stress was generally stronger in the former case. Interestingly, the bulk of it was non-fundamental, i.e. not caused by inflation and output gap differentials between countries. There are several potential sources of this stress and we show that missed forecasts were making an important contribution and they were mainly responsible for pushing the interest rate below its rule-consistent level.

Keywords: monetary stress, crisis, Taylor rule, EMU

JEL:C22, E52, E58.

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1. Introduction

The current economic crisis has deep roots. As many reports and papers have shown, its main cause has been the accumulation of external and internal imbalances (for comprehensive reviews of the causes of the crisis, see: Milesi-Feretti, 2012, Gros, 2012, Mathieu and Sterdyniak, 2013). There is a set of factors which are usually blamed for triggering and fostering these processes. Lax fiscal policy, rigidities in the product and labor markets, lack of prudence in financial sectors and excessive consumption are perhaps the most frequently pointed out.

While all the above mentioned factors are certainly relevant, some economists claim that the imbalance accumulation was enabled in the first place by the single monetary policy, which had created an environment of low interest rates in the periphery (Johansson and Ljungberg, 2013). It is therefore contended that the "one size does not fit all" monetary policy can be named the 'mother of all problems'. Indeed, it is now clear that countries which formed the Economic and Monetary Union (EMU) were structurally too different to benefit from a single monetary policy without major side effects. The idea that monetary policy was far from optimal for some EMU member states is not new. After all, this problem was the subject of fierce debates prior to introducing the euro (e.g. Bean, 1998, Frankel, 1999, Feldstein, 2000, Issing, 2001). A few studies attempted to discuss the issue *ex post* and indeed found some evidence of harmful effects of the common monetary policy in some countries, emerging from insufficient fulfillment of the Optimum Currency Areas (OCA) criteria (Wyplosz, 2006, Blanchard, 2007). Generally however, as early as in the early 2000s attention was diverted from the potentially devastating effects of excessively low or high interest rates towards the benefits from having the euro, as countries converged in terms of government bond yields and inflation rates, and enjoyed a period of stable growth. The perceived flow of capital from core to periphery was seen as a natural and desirable process of its free movement, facilitating a more optimal allocation following the abolishment of important obstacles. e.g. transaction costs and exchange rate risk.

It is true that the potentially inadequate monetary policy could have been offset, at least partly, with the help of fiscal policy and improved flexibility of the economy. But none of these (or even a mix of them) is a perfect substitute for monetary policy; i.e. for a monetary policy that delivers substantially different macroeconomic conditions for particular EMU member states indicates violations of the OCA criteria fulfillment. If the resulting stress was large, than perhaps we should not attribute the accumulation of imbalances (and the ongoing crisis) to economic policy during the EMU, but rather to the premature decision that brought it to life in the first place.

For obvious reasons, related to short time-series, even less attention is given to monetary policy stress after the outbreak of the crisis. This has been the period that has changed the doctrine of running monetary policy in EMU. Having faced an unprecedented rise of tensions in financial markets, the ECB stepped in to limit the tail risk of a euro-currency break-up.

This paper reexamines the problem of monetary policy stress, both prior to the crisis as well as after its outbreak. Without entering into the discussion on optimal monetary policy in EMU, it aims to (firstly) confirm that monetary policy during the great moderation (until late 2008) was responsible for fuelling the process of imbalance accumulation in EMU, and (secondly) to determine to what extent the stress was caused by macroeconomic divergences and missed forecasts. To accomplish our purposes, we follow a two-stage procedure. First, we estimate parameters of a forward-looking Taylor-type monetary policy reaction function to create a counterfactual path of interest rates, corresponding with macroeconomic fundamentals of the EMU aggregate. Second, we compute deviations between actual and counterfactual interest rates to determine monetary policy stress in EMU as well as in particular member states. We also decompose this stress to extract the role of missed forecasts and macroeconomic divergences.

The structure of the paper is as follows. Section 2 contains a synthetic review of the literature regarding monetary policy stress in EMU. Section 3 presents theoretical framework. In particular, it derives a rule to mimic the ECB monetary policy before the crisis. Section 4 is devoted to the data and methodology used. Section 5 presents the results, and Section 6 closes with conclusions.

2. Literature review

As has already been mentioned, the debate over the "one size fits all" policy was lively as Europe was preparing for EMU. Frankel and Rose (1998) were among those who believed in the smooth functioning of the EMU due to the OCA criteria endogeneity. In contrast, Feldstein (2000) warned that a single monetary policy was not suitable for Europe because *cyclical and inflation conditions vary substantially among countries*. As a consequence he deemed it (…) *likely to lead to political conflict within Europe* (…). After the EMU had been launched, Wyplosz (2006) attempted to examine the monetary policy optimality, but he admitted that no (much feared) major asymmetric shocks had occurred to test it, so the problem remained unresolved. Blanchard (2007) identified (and coined the term) “rotating slumps” – a pattern of non-synchronized output fluctuations which, he claimed, had affected Portugal and Italy. Spain was named as another plausible candidate.

Overall, the problem of stress from having a common monetary policy for EMU member states is certainly not among the most frequently researched topics, although there are several important contributions. A majority of them employ Taylor-type monetary policy reaction functions to compare monetary policy under two regimes: monetary independence and the EMU. Sturm and Wollmershäuser (2008) examine business cycle synchronization from a monetary policy perspective. They find that Germany was witnessing the most restrictive monetary policy stance between 1999 and 2006, whilst it was most accommodative for Ireland and Greece over this period, and best suited for Belgium and Finland. Lee and Crowley (2009) also rely on the Taylor rule and perform a set of counterfactual exercises to calculate the paths of country-specific interest rates by estimating coefficients for the ECB and using its own historical values as explanatory variables. They reach the conclusion that the ECB monetary policy was most appropriate for the German economy. Surprisingly, they also find Greece and Spain to be in the group of countries (together with the Benelux countries) which could consider the loss of an independent monetary policy least costly. Generally, the study suggests that the ECB rates are subject to considerable inertia, as actual rates are significantly less volatile than the rates “desired” by countries, considering their underlying macroeconomic situations. Also Hansen (2012) follows a similar approach and constructs a measure of monetary policy in-optimality for particular EMU member states in the period 1999-2008. His conclusions are broadly in line with those from the studies outlined above: monetary policy was considerably more lax than warranted by the economic developments in Ireland, Greece, Portugal and Spain during most of the period analyzed. The opposite situation occurred in the “core” EMU members. Unlike Lee and Crowley (2009), Hansen (2012) finds the ECB monetary policy to have been excessively restrictive for Germany, Belgium and Finland.

Lee and Crowley (2009) also provided a review of earlier studies that attempted to evaluate the performance of the ECB in managing the aggregate economy of EMU. We acknowledge however that the results discussed there are hardly comparable to those obtained later, as they suffer from a short time-series problem due to the short history of EMU, and are therefore rather anecdotal.

Ferreira-Lopes (2010) approached the problem from another perspective. The question she attempted to answer was: should the opt-out countries join the EMU and sacrifice its autonomous monetary policies? She found that the ECB monetary policy would be inappropriate for Sweden, Denmark and the UK to the extent that all three countries would be better off by refraining from adopting the euro.

3. Theoretical framework

The first empirical task is to determine the relationship between interest rates and macroeconomic conditions in EMU. It is not the aim of this paper to enter the discussion on an optimal monetary policy rule. Rather, we make use of the Taylor-rule framework to mimic the decisions taken by the ECB.

Originally, the rule advocated by Taylor (1993) with regard to the Fed's monetary policy, was in the form:

$$i_t = r^* + \pi_t + \beta_1(\pi_t - \pi^*) + \beta_2(y_t - y^*) \qquad (1)$$

Where i_t stands for the policy rate, r^* is the equilibrium real interest rate, π_t is the actual rate of inflation, π^* is the target inflation rate and $y_t - y^*$ is the output gap. Taylor proposed 0.5 as optimal values of both parameters β_1 and β_2.

Equation (1) assumes a time invariant natural rate of interest and it is convenient to rearrange equation (1) for the estimation purpose:

$$i_t = r^* - \beta_1\pi^* + (1+\beta_1)\pi_t + \beta_2(y_t - y^*) \qquad (2)$$

Expression $r^* - \beta_1\pi^*$ in equation (2) can now be captured by the constant term without losing the possibility of extracting the value of the natural rate of interest, if needed.

Even though the Fed's monetary policy is quite different from the one pursued in the EMU and in non-EMU EU member states[2], the Taylor rule provides a useful and universal tool of analysis. As Sauer and Sturm (2007) noted, even though the ECB does not explicitly admit taking output gap into consideration while setting interest rates, it is still a widely regarded variable used to forecast inflation and therefore enters the monetary policy reaction function. Weights on inflation and output gap are subject to further considerations. It is important however, that β_1 is at least positive, which is a necessary condition of inflation stabilization (the Taylor principle). A positive β_2 implies that monetary policy stabilizes output as well.

One of the early extensions of the original Taylor rule is to include a smoothing component. By doing so, researchers assume that central banks tend to adjust rates only gradually in order to avoid generating turbulence in financial markets (see: Goodfriend, 1991). Orphanides (2001) puts forward the idea that monetary authorities respond moderately to perceived shocks because they do not want to respond to noise in the data. Mishkin(1999) argues that monetary authorities are very averse to reversing the policy rate course too frequently because of credibility problems, i.e. sudden, large reversals might lead agents in the economy to reduce their confidence in the Central Bank's competence (see: Castelnuovo, 2007).

Even though it has become a common practice to include an interest rate smoothing component in empirical analyses, some controversies remain. Rudebush (2002) argues that "*quarterly interest rate smoothing (or monetary policy inertia) is a very modest phenomenon in practice"*. High estimated values of ρ might (he claims) reflect serially correlated or persistent special factors, or shocks that cause the central bank to deviate from the policy rule.[3] Although he offers indirect evidence to support this hypothesis, Rudebush admits that it appears difficult to develop direct evidence against the partial adjustment rule. Some other studies conclude that monetary policy inertia is a factual phenomenon even though the smoothing parameter estimates might additionally cover financial market conditions not modeled explicitly, which introduces the omitted variable problem (see: Gerlach-Kirsten, 2004). Castelnuovo (2007) tests the Rudebush hypothesis on the European (EMU) data and finds that the partial adjustment mechanism has played a significant role for the monetary

[2]EU member states that do not participate in the third stage of the EMU, to be more precise.

[3] Our work is based on intrapolated monthly data (as will be made clear later), so Rudebush's arguments are weaker, but they still should be kept in mind.

policy. He also concludes that the Taylor rule is confirmed to adequately describe the EMU monetary policy.

Deep financial market integration following monetary integration delivered a high degree of convergence of financial conditions, whic was reflected in equalizing risk premia on government bonds. This convergence was not reversed until late 2008, or even late 2009 when tail risks re-emerged and country-specific risk premia started to play an important role in determining domestic financial conditions. If Gerlach-Kirsten (2004) is right, then it should be relatively safe to treat the autoregressive component as an adequate measure of policy inertia in EMU during the great moderation, when financial market conditions were relatively stable and similar across states.

Following the extensive evidence of monetary policy inertia and the usual research practice, we take account of the smoothing behavior of the ECB by assuming:

$$i_t = \rho(i_{t-1}) + (1-\rho)i_t^* \qquad (3)$$

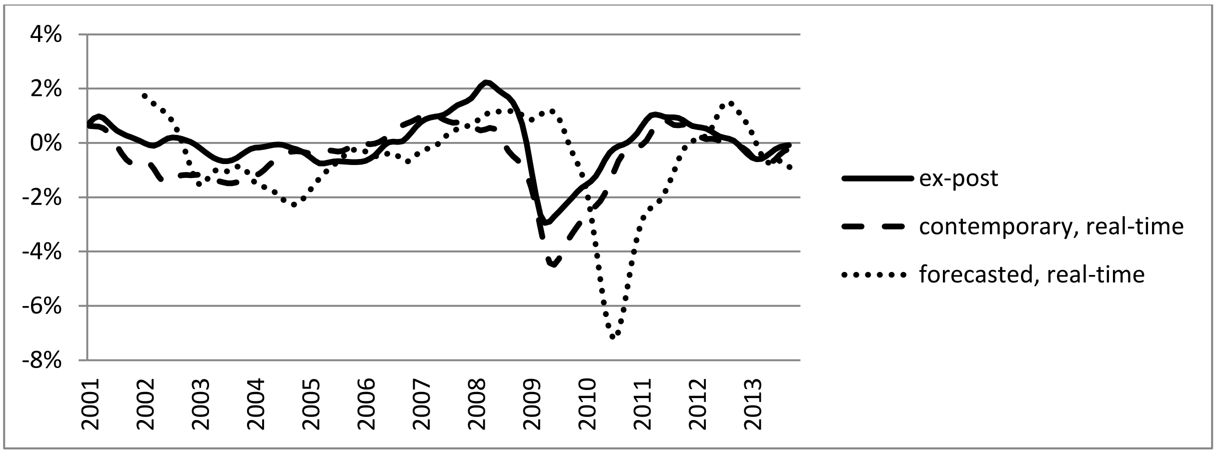
Where ρ measures the strength of monetary rate smoothing. For ρ =1 current interest rate would be exclusively determined by its previous values, while ρ =0 would indicate the absence of the partial adjustment mechanism.

From a theoretical point of view a more important extension of the Taylor rule regards the introduction of a forward-looking perspective (proposed by Clarida et al, 1998). The rationale behind forward-looking behavior of the ECB can be directly derived from its official statements (and minutes), as well as the theoretical background for monetary transmission mechanisms. It is difficult to reconcile a forward-looking perspective with the use of ex-post data in estimations. Indeed, this was the point made e.g. by Orphanides (2001), who questioned estimating parameters of the Taylor reaction functions with ex-post data, which of course had not been available to monetary authorities at the time of taking monetary policy decisions. The empirical evidence supporting Orphanides's critique is presented in the next section.

4. Data and methodology

GDP data is subject to substantial revisions and the real-time output gap is sometimes quite different from its ex-post realizations, as shown in Fig.1. In EMU, contemporary estimates were generally too pessimistic, while forecasts tended to include an extrapolation component, which is particularly visible in EMU around turning points. A trend of improving macroeconomic conditions in 2004-2007 resulted in extrapolating these positive developments towards future periods, but as the crisis struck and negative output gap started to open up in 2008, forecasters in 2009 extrapolated those developments further towards the beginning of 2010. Later in 2009 forecasters were again misled. As GDP started to improve, forecasts quickly adjusted to extrapolate this positive trend. By 2010 forecasters became very optimistic as the (contemporaneously perceived) output gap started to close and then turned positive. Once again it was forecasted that this tendency would be prolonged. Unfortunately, output gap ceased to improve in the course of 2011, which again was reflected in sudden downward revisions of forecasts for 2012.

Fig 1. Measures of output gap in EMU (% of potential GDP)*, Jan 2001 – Sep 2013

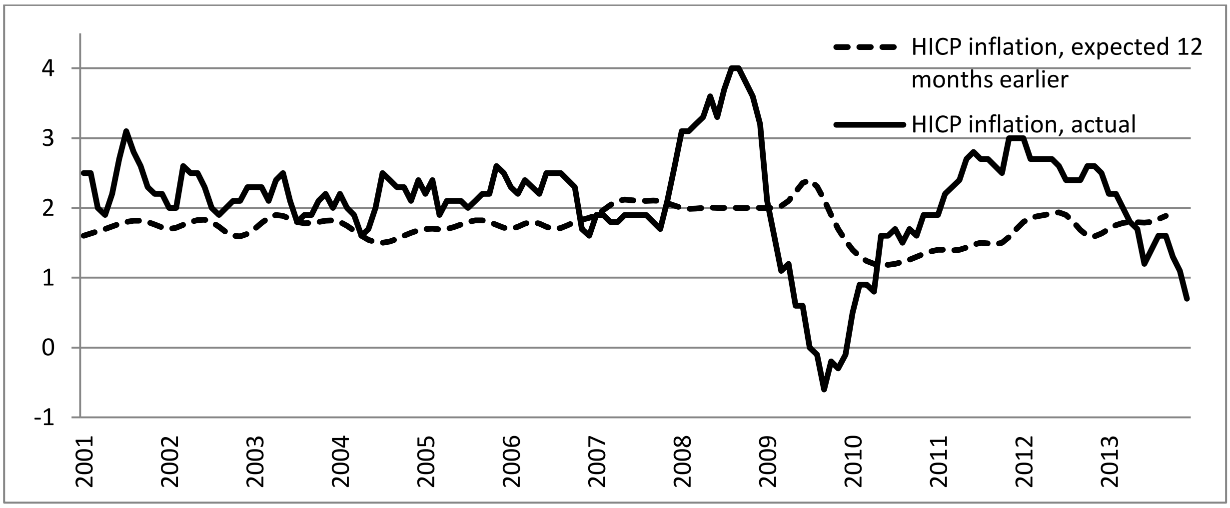


Notes: *Contemporary and real-time output gap is estimated based on the most recent available data. Forecasted and real-time output gap is the deviation between a one-year-ahead forecast of real GDP and potential GDP at the assumption of 2% annual potential growth of GDP between 2001 and 2008, and 1% thereafter. Output gap series are interpolated from quarterly to monthly frequency using cubic spline. All output gaps were extracted using the HP-filter.
Source: Eurostat, ECB, own estimations.

This game of cat and mouse could even be considered amusing had those missed forecasts not been underlying the monetary policy in EMU. Fig.1 also shows how incorrect it would be to try to mimic the ECB monetary policy by applying ex-post rather than real-time forecasted data. We therefore fully acknowledge arguments of Orphanides (2001) and other researchers who claim that a forward-looking perspective and real-time data are crucial to obtain a credible picture of monetary policy.

The inflation forecasting performance has not been much better so far. Fig. 2 presents evidence for the firm anchoring of expectations at the ECB target (close, but below 2%), rather than the accuracy of forecasts. Despite the systematically higher inflation for the most of the great moderation period, the one-year-ahead expected inflation rate never exceeded 2%. Interestingly, contrary to the expected output gap, expected inflation did not react much to the turning points associated with the crisis. On top of this, Fig. 2 offers more support to Orphanides's critique and the need to use real-time data, especially when a forward-looking perspective is assumed.

Fig. 2. Actual and expected inflation (%), Jan 2001 – Sep 2013



Source: ECB, *Real Time Database*.

The data on expected inflation and output growth rates were taken from the quarterly ECB survey of professional forecasters, published on the ECB website as "one-year-ahead forecasts". Expected output gaps can be computed using these forecasts, but real-time GDP series are also needed, as well as some assumptions concerning the evolution of potential GDP. Real-time potential output series were computed using data from the Euro Area real-time database, which provides data starting from 4th quarter 2000. For each quarter, potential GDP series was extracted using the HP filter applied to an expanding data window.

The one thing then left is the expected potential growth rate of GDP. It is assumed to be 2% in the period until 2008 and 1% thereafter. In fact, the 2% potential growth rate of GDP was widely accepted in ECB publications and confirmed in external reports (e.g. by the OECD).[4]

[4] Also, extracting trend from log of GDP series using the HP filter confirms this value to be between 2% and 2.1% before the crisis.

There is more uncertainty regarding its (expected) evolution after 2008. Mathieu and Sterdyniak (2013) claim that it was rather 0.5%, and applying the HP-filter to the logarithm of ex-post GDP series brings it even to around zero. But the ECB (which, after all, has the final word in forecasting the underlying variables for purposes of its monetary policy) was never that pessimistic. In 2011, it estimated the potential GDP growth to slow down to around 1% (ECB, 2011), the value which we take for our exercise. The inflation target is assumed to be constant at 2% throughout the entire period.

All expected quarterly data are interpolated to monthly frequencies using cubic spline. Interpolating forecasts (in contrast to historical data) for estimation purposes is justified, since forecasts tend to be adjusted only gradually and their series are smooth and normally resemble interpolated series. This is especially true of forecasts beyond a very short run. Descriptive statistics of the final dataset are presented in table A1, in the annex.

To summarize, the ECB monetary policy for the purpose of our exercise is described by a forward-looking Taylor-rule type monetary policy reaction function with a smoothing component, estimated using real-time forecasted data. Equation (4) below presents the function in a form prepared for estimation:

$$i_t = \rho(i_{t-1}) + (1-\rho)\{\beta_\Pi E(\pi_{t+12} \mid \Omega_t) + \beta_y[E(y_{t+12} \mid \Omega_t) - y_t*] + (1-\beta_\Pi)\pi * + \beta_0\} + \varepsilon_t \qquad (4)$$

We relabel β_2 as β_y and introduce $\beta_\Pi = \beta_1 + 1$. Ω_t is the information set available in month t. Since all the variables are modeled explicitly, the expected estimated value of constant term β_0 equals $r*$ - the time-invariant (real) natural rate of interest (NRI).

The interest rate in a given month corresponds to twelve-month ahead expected output gaps and inflation rates. This constrains the size of the sample to the period ranging from November 2000 (when first forecasts of output gaps are available) to September 2012 (when forecasts for September 2013 are assumed to be known).

We suspect that the ECB was trying to conduct a rule-based monetary policy only until about end of 2008, when the stabilization of financial markets became a priority, which was reflected by supporting low money market rates despite the rising expected inflation rate and output gap. To identify the moment of the "regime switch" we carry out rolling regressions of equation (4). We use fixed estimation window of 80 months, ending between February 2008 and August 2010 and check the significance of the inflation parameter in each regression. The results of this test are shown in table A2 in annex. They confirm that inflation made a significant parameter until end of 2008. In January 2009 the p-value fell below 5% for the first time. Thus, based on these results, we divide the sample in two periods: November 2000 – December 2008 and January 2009 – September 2012. The former sub-sample encompasses the great moderation period, while the latter refers to the crisis regime.

With monetary policy reaction function parameters' estimates in hand we will be able to create counter-factual series of money market rates, which we assume to contain no stress. In other words, we assume that there would be no monetary policy stress in EMU (aggregate) if the monetary policy rule was followed and if inflation and output gap forecasts were accurate.

We define monetary policy stress as the deviation between the rule-consistent interest rate and its actual level. A rule-consistent interest rate is, in turn, defined as the money market rate that would have been observed had the ECB conducted its monetary policy exclusively for a given country and had it relied on the estimated function (4) parameters. Thus, an EMU country can suffer from monetary policy stress due to both low synchronization of its inflation and output gap with the EMU respective aggregates, as well as due to several other factors that form a "non-fundamental", EMU-wide component, the most important being: responding to auxiliary variables in the reaction function; time-varying natural interest rate; time-varying sensitivity to the inflation rate and output gap; and finally, missed forecasts of both these variables.

5. Empirical results

5.1. Monetary policy reaction function

Coefficients of equation (4) are estimated in both the sub-samples. The estimation method must account for the possible (and highly likely) problem of endogeneity. Indeed, we have already shown that the expected values of macroeconomic variables are related to its present values due to the "extrapolation bias". Equation (4) is estimated by the generalized method of moments (GMM). We use a heteroskedasticity and autocorrelation consistent (HAC) weighting matrix with the Newey-West kernel, and lag order is selected using Newey and

West's (1994) optimal lag-selection algorithm. The instruments are lags 1, 2 and 3 of expected output gap and expected inflation, as well as the lagged dependent variable (Eonia)[5].

In both samples the Hansen-Sargan test for over-identifying restrictions does not reject the null of joint validity of the selected instruments. Further results are presented in Table 1.

Table 1. Estimation results of the monetary policy reaction function (4)

	Nov 2000 – Dec 2008	Jan 2009 – Sept 2012
Smoothing	0.90	0.81
p-val	0.00	0.00
Inflation	1.58	-1.46
p-val	0.04	0.00
Output gap	0.83	0.23
p-val	0.00	0.00
Intercept	3.33	0.03
p-val	0.00	0.48
Obs	94	57
J-stat	6.51	3.91
p-val	0.59	0.87

The parameters of the Taylor reaction function (4) estimated for the first sample are fairly similar to those proposed by Taylor (1993). The expected inflatio**n** parameter is found to be only slightly higher than the original rule suggested (1.58 instead of 1.5), and also the output gap weight is above the proposed 0.5 (at 0.83). As is common for this type of exercise, the smoothing component turns out to be relatively strong (although some empirical studies find it to be even stronger) and highly significant. The results point to a fairly high natural rate of interest (NRI) at the level of 3.3%, which is around one percentage point above its level found in, e.g., Crespo-Cuaresma at al. (2003), but similar to its estimates in Bomfin (2001) or Giammaroli and Valla (2003).

[5] The final set of instruments was chosen to minimize the GMM criterion function.

In the second period (starting in January 2009), parameter estimates tell a completely different story or, to be more precise, do not say much. The expected inflation coefficient changes sign, partial adjustment mechanism becomes weaker and the output gap parameter loses significance. Moreover, the natural rate of interest is not significantly different from zero (which in fact might be the case). Generally, the monetary policy over that period seems to have become detached from the framework defined by the reaction function (4). To mimic the behavior of ECB since 2009, additional variables should be included, capturing financial market tensions, above all. This however remains outside of the scope of this study since the results summarized in the first column are sufficient to obtain a path of rule-consistent interest rates for the purpose of quantifying monetary policy stress in the entire period.

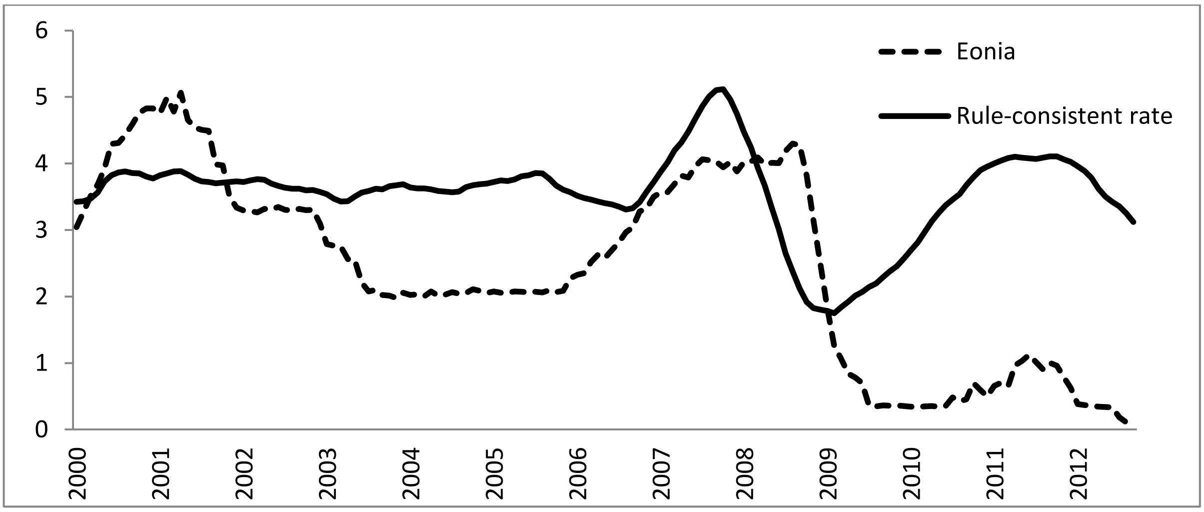
5.2.Monetary policy stress

Because the reaction function employed contains a smoothing parameter, an initial interest rate must be set and enough time must be provided for this initial value to converge towards rule-consistent country-specific rates. The initial value is set at 3.14%[6] for all countries in January 1999, and we allowed until December 1999 to complete convergence. Since we are not restricted by the time span of available real-time forecasted data, the beginning of the evaluation period can be moved back to January 2000.

Actual and rule-consistent money market rates for EMU as an aggregate are presented in Fig. 3. Between 2002 and 2006 the monetary policy stance was rather loose, which reflects the permanently lower actual - as compared to projected - output gaps over that period and also the systematic upside inflation surprises (see Figs. 1 & 2). The relative stability of the rule-consistent interest rate might be linked to the one-year ahead expected inflation rate, which was also quite stable, as was shown in Fig. 2.

[6] This is the average rate observed in January 2000 – the first month of the evaluation period.

Fig. 3. Actual and rule-consistent interest rates in EMU



Source: ECB, own calculations.

The differences between the projected and actual (ex-post) output gaps declined substantially in the second half of 2006, which is partly responsible for bringing money market rates to their rule-consistent level in late 2006. The graph also shows a delayed reaction to the crisis, which can again be largely attributed to missing the contemporaneously available forecasts. The actual rate declined and followed its rule-consistent level, but it was lagged by 3 – 4 quarters. This suggests that in times of high uncertainty, the ECB might have adopted a more contemporaneous perspective. Fig. 3 also visualizes the structural break in monetary policy doctrine. In January 2009 the monetary policy reaction function suggested the need to terminate the process of lowering interest rates, but they kept falling rapidly instead. Since then the gap between the rule-consistent and actual rate has remained elevated.

The results of our exercise as applied to individual EMU countries are illustrated in Fig. A1 (in the annex) and summarized in Tables 2 and 3. Looking at the pre-crisis period, we conclude that the monetary policy was best suited for Finland and Austria, followed by Germany, France, Italy and Belgium, where the root mean squared errors were lowest. Except for Germany and Finland, the average distance between the actual and rule-consistent interest rates in all countries was negative. Of the two, only Finland had to cope with excessively high interest rates for most of the time (in 79 of 108 months). Not surprisingly, the strongest interest rate stress before 2009 was experienced by Greece, Ireland and Spain. Their actual level was higher than the monetary policy rule would have suggested by 2.5 (in Greece) and 1.9 (in both Ireland and Spain) percentage points.

The crisis has changed the landscape of monetary policy stress in EMU. While until 2008 interest rates were generally lower than their rule-consistent levels in most of the countries, as well as the EMU aggregate, this problem was further exacerbated after 2008. Monetary policy stress during crisis was highest in Greece (data on GDP are only available until March 2011 in the Eurostat). All countries faced stronger stress during the crisis period, as compared to the earlier times.

Table 2. Overall interest rate stress

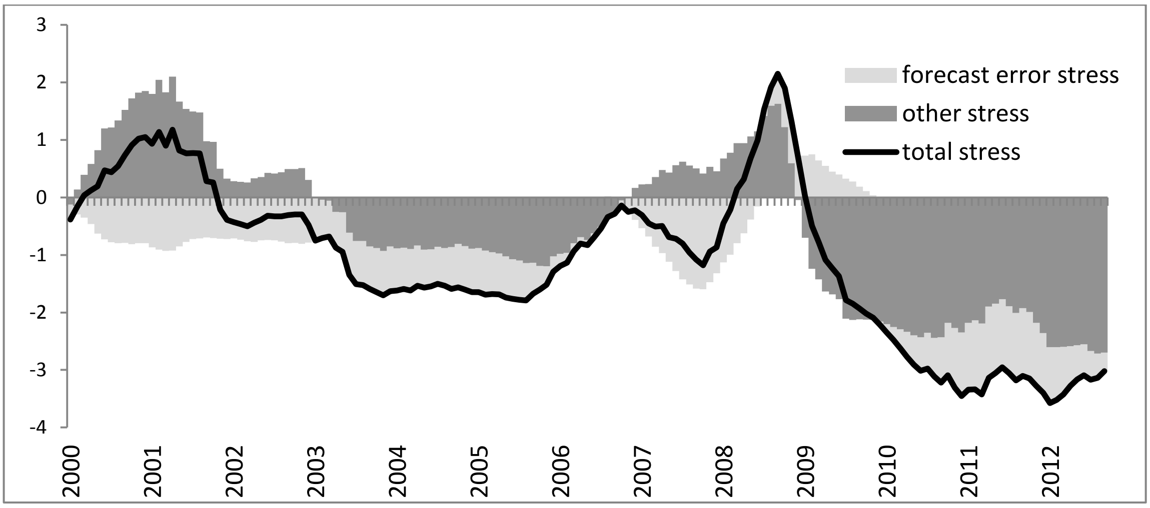
	RMSE			Average distance			Number of months with interest rates being…					
							full		Jan 2000 - Dec 2008		Jan 2009 - Sep 2012	
	full	Jan 2000 - Dec 2008	Jan 2009 - Sep 2012	full	Jan 2000 - Dec 2008	Jan 2009 - Sep 2012	too low	too high	too low	too high	too low	too high
EA	0.14	0.11	0.42	-1.12	-0.48	-2.67	122	31	78	30	44	1
BE	0.17	0.11	0.50	-1.26	-0.45	-3.21	108	45	64	44	44	1
DE	0.13	0.11	0.36	-0.44	0.31	-2.23	99	54	55	53	44	1
IE	0.19	0.25	0.25	-1.33	-1.91	0.07	123	30	98	10	25	20
GR*	0.33	0.29	0.99	-3.08	-2.48	-4.98	107	4	80	4	27	0
ES	0.21	0.23	0.47	-2.21	-1.89	-2.98	139	14	95	13	44	1
FR	0.13	0.11	0.37	-0.73	-0.06	-2.34	102	51	58	50	44	1
IT	0.17	0.12	0.49	-1.45	-0.75	-3.15	130	23	85	23	45	0
LU	0.22	0.21	0.58	-2.12	-1.43	-3.78	131	22	86	22	45	0
NL	0.16	0.13	0.43	-1.29	-0.74	-2.61	123	30	78	30	45	0
AT	0.16	0.09	0.50	-0.95	-0.03	-3.15	101	52	56	52	45	0
PT	0.19	0.20	0.45	-1.76	-1.42	-2.57	136	17	96	12	40	5
FI	0.17	0.06	0.55	-0.87	0.25	-3.57	74	79	29	79	45	0

*Data for Greece data is only available for 111 months, from January 2002 to March 2011.

Source: own calculations.

With these calculations in hand it is easy to extract the part of the stress resulting from missed forecasts simply by subtracting rule-consistent interest rates based on the expected values of the variables from ex-post rule-consistent rates, i.e. encompassing total stress. This can be done only for the EMU aggregate, since we do not have real-time forecasted data for individual countries in our database. Fig 4 shows results of this decomposition.

Fig. 4 The role of missed-forecasts for interest rate stress in EMU.



Source: own calculations.

It seems that missed forecasts have so far tended to systematically drive interest rates below its rule-consistent level for most of the time period under consideration, which makes them one of the factors fuelling imbalance accumulation in the EMU. The only exception was the negative surprise period at the beginning of the crisis in 2008, when they contributed to excessively high rates. Only in the early years of EMU were missed forecasts offset by other non-fundamental factors which were putting upward pressure on interest rates. However, between 2003 and 2006 these other factors reinforced missed forecasts in pushing down actual interest rates, resulting altogether in exacerbating the problem of excessively low interest rates over that period.

Another important question refers to the extent to which the monetary policy stress was caused by real divergences across individual countries. We can adjust for the non-fundamental component, as defined earlier by assuming no interest rate stress for the EMU aggregate and obtain the resulting country-specific components, resulting from the divergences between country-specific underlying macroeconomic variables and EMU respective aggregates. It is especially important to have an insight into these divergences, as they may indicate a general exposure to monetary policy stress if the common component approaches zero in the long-run. Table 3 summarizes the estimates of this intended stress for all countries.

Table 3. Fundamental interest rate stress

	RMSE			Average distance			Number of months with interest rates being…					
							full		Jan 2000 - Dec 2008		Jan 2009 - Sep 2012	
	full	Jan 2000 - Dec 2008	Jan 2009 - Sep 2012	full	Jan 2000 - Dec 2008	Jan 2009 - Sep 2012	too low	too high	too low	too high	too low	too high
EA	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0	0	0
BE	0.05	0.06	0.10	-0.14	0.03	-0.55	94	59	57	51	37	8
DE	0.06	0.09	0.07	0.68	0.79	0.43	0	153	0	108	0	45
IE	0.19	0.20	0.44	-0.21	-1.44	2.73	95	58	95	13	0	45
GR*	0.20	0.19	0.55	-1.12	-1.45	-0.32	131	22	104	4	27	18
ES	0.10	0.15	0.07	-1.09	-1.42	-0.32	138	15	103	5	35	10
FR	0.04	0.05	0.06	0.39	0.42	0.32	19	134	12	96	7	38
IT	0.04	0.04	0.09	-0.33	-0.27	-0.48	135	18	90	18	45	0
LU	0.10	0.12	0.17	-1.00	-0.95	-1.11	140	13	95	13	45	0
NL	0.11	0.15	0.10	-0.17	-0.27	0.05	62	91	48	60	14	31
AT	0.04	0.05	0.08	0.17	0.44	-0.48	50	103	5	103	45	0
PT	0.11	0.14	0.11	-0.64	-0.94	0.10	111	42	88	20	23	22
FI	0.11	0.14	0.14	0.25	0.73	-0.90	81	72	36	72	45	0

Source: own calculations.

Interestingly, by comparing the results in Tables 2 and 3, it appears that much of the overall stress was EMU-wide (non-fundamental). Macroeconomic divergences that make up country-specific components were found to be more important before the crisis, whilst after 2008 the stress could be attributed to EMU-wide factors.

Another important finding is that with, the exception of Finland (and perhaps the Netherlands) during the great moderation and Ireland during the crisis, the common component of the stress raised its total level for all countries. Table 3 suggests that Italy, France, Austria, Belgium and Germany form a group of countries which should not suffer from excessive monetary policy stress in the long run, while Greece might be considered the most exposed country.

6. Conclusions

One of the prevailing views on the causes of the ongoing economic crisis in the EMU is the lax fiscal policy in some countries over the preceding years (e.g. Arroyo, 2011, Buiter and Rahbari, 2013, Kaplanoglou and Rapanos, 2013). While this argument is probably true, it is fair to make the point that the EMU countries faced different monetary policy environments, which also determined economic policy landscapes, and that both endogenous fiscal and exogenous monetary policy are responsible for the accumulation of imbalances since 1999. This paper focuses on the latter (monetary) component and confirms that some – notably peripheral – countries experienced prolonged periods of significant monetary policy stress in the form of excessively low interest rates. It is true that some core countries had to cope with excessively high interest rates, but the stress was weaker in their case.

Moreover, we find that a large part of the overall stress was not due to macroeconomic divergences, as it is generally believed. On contrary, especially since the outbreak of the crisis, the EMU-wide, non-fundamental component of stress played a more important role than deficiencies in business cycle synchronization.

While adjusting for the non-fundamental component leaves most non-core EMU member states with higher stress compared to most core states, the differences are smaller. For example, Spain's stress before the crisis would have not exceeded the Holland's, and Portugal's would have been even lower.

The problem of excessively high interest rates was exacerbated with the outbreak of the economic crisis in 2008. The ECB eventually lowered its rates, responding to falling inflation and rising negative output gap. The monetary policy stance was further relaxed to relieve tensions in financial markets in 2009. Since then, the ECB has abandoned its traditional way of conducting monetary policy and left (almost) all EMU member states in an environment of excessively low interest rates. It should be emphasized however, that monetary policy stance during crisis should not only be seen through the prism of the deviation between the money market rate level consistent with underlying macroeconomic variables and its actual level. Due to financial market fragmentation and banking system stress in several states, the monetary policy transmission mechanism was severely damaged, which was reflected in, inter alia, the divergence of commercial interest rates. The fact is that these problems only exacerbate the interest rate stress, since deleveraging was strongest in the peripheral economies, i.e. those most in need of accommodative monetary settings.

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Annex

Table A1. Descriptive statistics of variables used in estimations

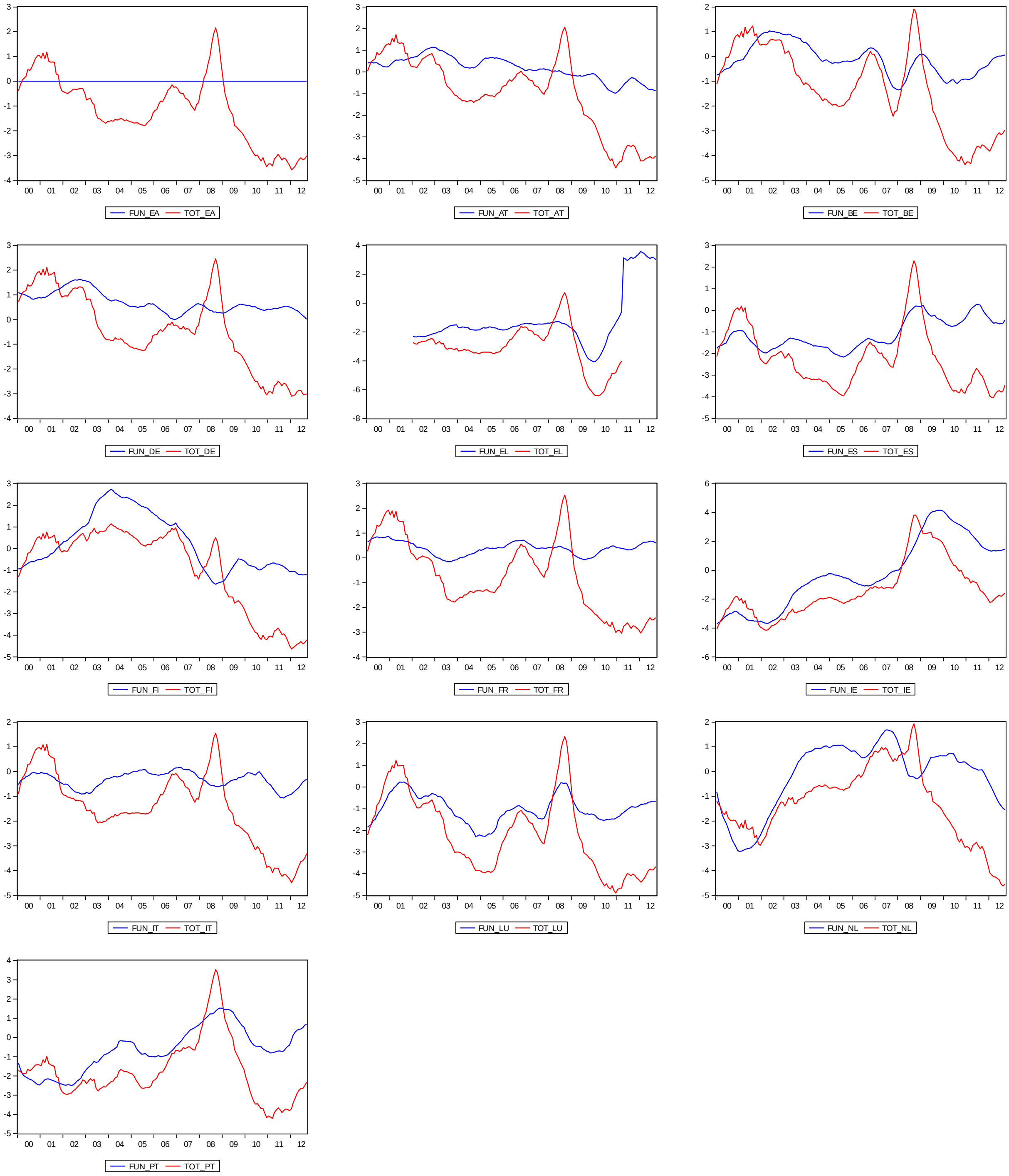
Variable	Obs	Mean	Std. dev.	Min	Max
November 2000 - December 2008					
Eonia	98	3.12	0.93	1.97	5.06
Expected output gap, 12 months-ahead (percent of potential GDP)	98	-0.29	1.09	-2.63	1.73
Expected inflation (HICP) rate, 12 months-ahead	98	1.85	0.19	1.50	2.40
Actual output gap, 12 months later (percent of potential GDP)	98	-0.70	1.29	-4.50	1.04
Actual inflation (HICP) rate, 12 months later	98	2.07	0.86	-0.60	4.00
January 2009 - September 2012					
	Obs	Mean	Std. dev.	Min	Max
Eonia	45	0.60	0.35	0.10	1.81
Expected output gap, 12 months-ahead	45	-1.53	2.48	-7.25	1.51
Expected inflation rate, 12 months-ahead	45	1.56	0.24	1.18	1.94
Actual output gap	45	-0.30	0.89	-2.65	0.88
Actual inflation (HICP) rate	45	2.12	0.59	0.80	3.00

Table A2. Significance of equation (4) parameters in rolling regressions

Sample	Smoothing	Inflation	Output gap	Intercept
2001Jul - 2008Feb	***	***	-	***
2001Aug - 2008Mar	***	***	-	***
2001Sep - 2008Apr	***	***	-	***
2001Oct - 2008May	***	***	-	***
2001Nov - 2008Jun	***	***	-	***
2001Dec - 2008Jul	***	***	-	***
2002Jan - 2008Aug	***	***	***	***
2002Feb - 2008Sep	***	***	***	***
2002Mar - 2008Oct	***	***	***	***
2002Apr - 2008Nov	***	***	***	***
2002May - 2008Dec	***	**	***	***
2002Jun - 2009Jan	***	*	***	***
2002Jul - 2009Feb	***	**	***	***
2002Aug - 2009Mar	***	-	***	***
2002Sep - 2009Apr	***	-	***	***
2002Oct - 2009May	***	-	***	***
2002Nov - 2009Jun	***	-	***	***
2002Dec - 2009Jul	***	-	***	***
2003Jan - 2009Aug	***	-	***	***
2003Feb - 2009Sep	***	-	***	***
2003Mar - 2009Oct	***	-	***	***
2003Apr - 2009Nov	***	-	***	***
2003May - 2009Dec	***	-	***	***
2003Jun - 2010Jan	***	-	***	***
2003Jul - 2010Feb	***	-	***	***
2003Aug - 2010Mar	***	-	***	***
2003Sep - 2010Apr	***	-	***	***
2003Oct - 2010May	***	-	***	***
2003Nov - 2010Jun	***	-	***	***
2003Dec - 2010Jul	***	*	***	***
2011Jan - 2010Aug	***	**	***	***

Notes: Estimates obtained via GMM estimation. The instruments are lags 1, 2 and 3 of expected output gap and expected inflation, as well as the lagged dependent variable (Eonia).

Fig. A1. Total and fundamental interest rate stress (in percentage points)



Source: own calculations.