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Abstract: This paper aims at discovering the decision rule the Governing Council of the ECB uses to set interest rates. We construct a Taylor rule for each member of the council and for the euro area as a whole, and aggregate the interest rates they produce using several classes of decision-making mechanisms: chairman dominance, bargaining, consensus, voting, and voting with a chairman. We test alternative scenarios in which individual members of the council pursue either a national or a federal objective. We then compare the interest-rate path predicted by each scenario with the observed euro area's interest rate. We find that scenarios in which all members of the Governing Council are assumed to pursue Euro-area-wide objectives are dominated by scenarios in which decisions are made collectively by a council consisting of members pursuing national objectives. The best-performing scenario is the one in which individual members of the Governing Council follow national objectives, bargain over the interest rate, and their weights are based on their country's share of the zone's GDP.

1. Introduction

Like most other central banks, the European Central Bank (ECB) sets monetary policy in the European Monetary Union (EMU) based on decisions made by a monetary policy committee. Decisions in the ECB are made by the Governing Council, which consists of the central bank governors of member countries, who are appointed by their respective governments, and the six members of the European Central Bank (ECB) Executive Board, who are appointed by the European Council.

As with any committee, individual members of the Governing Council may disagree on monetary policy decisions. The committee members may have different information about the state of the economy, employ different economic models, and come from different personal backgrounds, resulting in different views about appropriate adequate policy. For instance, Gerlach-Kristen (2003), Spencer (2006), Bhattacharjee and Holly (2006), and Besley et al. (2008) show that different personal backgrounds have an effect on the positions taken by members of the Monetary Policy Committee of the Bank of England.

Most of all, in a federally organised central bank like the ECB preferred policy choices of Governing Council members may differ because they represent different countries, with different business cycles and different economic problems (Berger and de Haan, 2002). Similar differences have been documented for the Federal Reserve Bank's (Fed) Federal Open Market Committee (FOMC) by Gildea (1992), Meade and Sheets (2005), and Chappell et al. (2008). Gildea (1992) finds that unemployment rates in the regions represented by the Fed presidents help predict their votes in the FOMC. Meade and Sheets (2005) reach similar conclusions, not just for regional Fed presidents but also for members of the Board of Governors, who are supposed to represent only federal interests.

It appears likely that regional interests will play a role in a monetary union such as the EMU, which is relatively new and consists of largely autonomous states. Yet, the ECB's Governing Council has never openly acknowledged such disagreements. On the contrary, it officially always reaches decisions by consensus (see ECB press statements). Nevertheless, voting is explicitly envisaged in Article 10.2 of the statutes of the European System of Central Banks and of the European Central Bank. To cope with the forthcoming enlargement of the

union and the ensuing increased size of the Governing Council, a new rotation principle designed to replace simple majority voting was developed in 2003 and ratified by EMU member countries in 2004. Originally, this principle was to be put into practice when the EMU increased to 15 members. Interestingly, even before this 15-member threshold was met, the rotation principle was amended (in 2009) and is now specified to come into force when the number of EMU member countries reaches 18. Thus, there appears to be a certain reluctance to abandon the one-country–one-vote principle, suggesting that member countries fear that monetary policy may be less fitting to their needs when they can no longer cast a vote. In spite of these considerations, the official position of the ECB is that the members of the council have never resorted to voting to make a decision. However, if consensus is indeed the only way decisions are made, voting rules would be irrelevant—and there would be no need to change them. Also, it seems a bit doubtful that the Governing Council can avoid voting, considering that so many other monetary policy committees (MPCs) do: Fry et al. (2000) state that 36 out of the 88 central banks in their sample use formal voting in making decisions.

Additional doubt is raised by the fact that unlike other central banks, the ECB does not publish minutes of Governing Council meetings. Thus, disagreements, if any, are hidden behind a diplomatic veil. It is thus impossible for outsiders to observe disagreements among Governing Council members, or how such likely disagreements are overcome. In fact, the ECB does not even reveal the actual decision mechanism that it uses to reach decisions.

Nevertheless, a large body of theoretical contributions emphasises the importance of the decision rule used by monetary policy committees because the chosen decision rule determines the extent to which asymmetric national characteristics are considered in federal monetary policy. Some contributions consider differences in preferences, in the structure of member economics, or in shocks. For instance, Alesina and Grilli (1992), Montoro (2007), and Riboni and Ruge-Murcia (2010) focus on differences in inflation aversion among committee members. Aksoy et al. (2002), Hefeker (2003), and Arnold (2006) emphasise structural differences across countries. Others, such as von Hagen and Süppel (1994), Gros and Hefeker (2002), Grüner and Kiel (2004), Matsen and Røisland (2005), Fatum (2006), and Farvaque et al. (2009), look at differences in shocks across member countries. The common

message of these papers is that decision rules in MPCs matter, especially in a federal monetary union.

However, our knowledge of the actual decision-making mechanisms used by the ECB lags far behind the sophistication of theoretical contributions. As no information is published about Governing Council debates, its decisions are analysed from an aggregate, namely, federal, point of view. Accordingly, most researchers study the ECB's monetary policy by estimating interest-rate reaction functions or Taylor rules, relating the economic situation of the euro area to observed interest rates. A number of studies estimate such an aggregate reaction function for the euro area (Gerlach and Schnabel, 2000, Mihov, 2001, Doménech et al., 2002, Fourçans and Vranceanu, 2004, Gerdesmeier and Roffia, 2004, Clausen and Hayo, 2005, Hayo and Hofmann, 2006, Gerlach, 2007). These studies differ substantially in terms of theoretical assumptions, empirical implementation, and, perhaps not surprisingly, results. Riboni and Ruge-Murcia (2010) adopt a slightly different perspective by also studying the aggregate evolution of interest rates set by five central banks, including the ECB, but their aim is to determine the decision rule they use. They report that the consensus model, i.e., where no member has proposal power and a 'super-majority' is required for a policy change, fits actual policy decisions better than the alternative models. A major drawback of Riboni and Ruge-Murcia's (2010) approach is that they do not describe the institutional details of decision making in the euro area. First, they overlook the evolution of the Executive Board and do not adjust its size after Greece joined. Second, and even more importantly, their approach does not take into account the federal nature of the ECB. In Riboni and Ruge-Murcia's (2010) setting, members of the monetary policy committee disagree because their relative weights on inflation and output differ, but they all base their decisions on the euro area's aggregate evolution, without any specific consideration of their home country's economic situation.

Some contributions consider the connection between national interests and ECB policy, generally with a focus on whether the ECB looks at aggregate euro area only, or may also cater to the needs of particular countries. Heinemann and Huefner (2004) find that regional divergences help explain ECB interest-rate decisions, which suggests that the Governing Council does not look only at aggregate data. Other studies find similar evidence

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and suggest that the ECB places a disproportionately high weight on economic conditions in the bigger EMU member countries, particularly France and Germany (von Hagen and Brückner, 2001, Kool, 2006). In contrast to these findings, which are based on data from the early phase of EMU, Sturm and Wollmershäuser (2008) report that economic conditions in small member countries receive more than proportional weights in actual ECB monetary policy decisions. Sousa (2009) assumes that national representatives on the Governing Council take into account national perspectives when they vote on interest-rate decisions, and discovers evidence that voting coalitions are likely. He argues, however, that the current strong strategic position of the Executive Board is sufficient to prevent such coalitions from actually having any effect on monetary policy. Finally, Bénassy-Quéré and Turkish (2009) consider the aggregation of national interests within the Governing Council. They estimate the counterfactual optimal interest rates that would be set by member countries under autonomous monetary policy using *a priori* postulated national Taylor rules to simulate the ECB's interest-rate path implied by its new rotating decision-making system. However, they cannot compare simulated interest rates to actual ones because their study is a counterfactual of a mechanism that, so far, has not been implemented. Therefore, their analysis does not tell us anything about the status quo of decision making in the Governing Council but instead analyses what its policy would look like if the ECB used the rotation system.

This paper uses a novel approach to infer the ECB's actual decision-making mechanism from its past decisions. The idea is to estimate national Taylor rules using historical data so as to produce counterfactual national interest-rate paths and an interest-rate path that would be followed by a policymaker concerned only with the euro area. These counterfactual interest-rate paths are then aggregated using different decision procedures and various assumptions as to preferences of members of the Governing Council to produce hypothetical interest rates that can be compared to the historical interest rates set by the Governing Council. We consider four important decision procedures: (i) full chairman dominance, (ii) one man, one vote, (iii) several versions of bargaining, and (iv) the agenda-setting power of the president, under different assumptions about the behaviour of Executive Board members. We also consider two alternative types of preferences of the members of the Governing Council: (i) 'federal' preferences, whereby council members seek to implement

policies that best suit the euro area as a whole, (ii) 'national' preferences, if they seek to implement policies that best suit their country of origin. By comparing the fit of hypothetical interest rates to observed ones, we can determine the decision rule that best describes the ECB's decisions.

We contribute to the literature on monetary policy committees by testing whether *de jure* decision rules are applied *de facto*, as we test the official one-man–one-vote rule found in the ECB's statutes. Moreover, our results contribute to our knowledge of monetary policy making in a monetary union. By testing whether members of the Governing Council pursue national or federal objectives, we check the validity of the assumption made in the theoretical literature on decision rules in monetary unions that governors act as representatives of their country's interest. Grüner (1999) showed that the welfare effect of monetary integration depended on the federal or national orientation of central bankers. Moreover, we assess the extent to which the provision of the Maastricht Treaty mandating that members of the Governing Council set monetary policy designed for the needs of the euro area as a whole is implemented in practice. This bears on the theory of policy making in the European Union in particular, and, more generally, in federations and in international organisations. Finally, we also contribute to the policy debate on the nationality of Governing Council members of the ECB, which recently came back to the fore with the appointment of Mario Draghi instead of Axel Weber as president of the ECB. If members of the Governing Council pursued strictly federal objectives, then their nationality would be irrelevant.

Our results show that of all the scenarios we consider, the best-performing is the one in which individual members follow national objectives, bargain over the interest rate, and their weights in the negotiation are based on their country's share of the zone's GDP.

The rest of this paper is organised as follows. The next section describes the econometric strategy used to produce counterfactual national interest rates, and the various decision rules applied to aggregate national rates. The third section contains a discussion of decision rules and scenarios; the fourth section describes our empirical results. The last section concludes.

2. Reaction functions

It is now common to operationalise monetary policy actions using the short-term interest rate. This variable is both easy to obtain and perceived to be the main policy instrument of central banks (Borio, 1997). Taylor's (1993) attempt to describe interest-rate setting in terms of a monetary policy reaction function has been widely adopted. In a 'Taylor rule', the short-term nominal interest rate, representing the central bank's monetary policy instrument, responds to deviations in inflation and output from their target levels. The first step in our analysis is the construction of counterfactual Taylor rules for the EMU member countries. The central bank's target level for short-term nominal interest rates is modelled as a function of the deviation of current output from its trend and of the expected deviation of inflation from its (constant) target:

$$ i^T_t = r^* + \pi^* + \beta\,(\pi_{t+k} - \pi^*) + \gamma\,y_t \tag{1} $$

with i^T denoting the target nominal interest rate, r^* the long-run real interest rate, y the output gap, π the inflation rate, π^* the target inflation rate, β the inflation weight in the target interest rate, γ the output weight in the target interest rate, and k the number of periods policymakers look ahead.

By estimating historical Taylor rules, we determine the relative weights of inflation and the output gap in each country's reaction function, and implicitly assume that those weights are constant over time. However, we allow those parameters to vary across countries so that different countries may weigh the two objectives differently.

It is well known that empirical Taylor rule estimates tend to be sensitive to differences in specification and sampling. Therefore, instead of relying on just one particular study, we take an arithmetic average over three reasonable specifications of the Taylor rule. In terms of empirical Taylor rule estimates, we use two comparative studies by Eleftheriou et al. (2006) and Hayo (2007) that cover the EMU countries and apply a comparable methodology across countries. In Hayo (2007), all national Taylor rules are estimated with a one-year forward-looking horizon for the inflation rate; Eleftheriou et al. (2006) maximise the fit of the Taylor

rule to the actual interest-rate series.[1] As a third type of Taylor rule, we apply Taylor's (1993) original rule, which has become a sort of benchmark in the literature. The one-year forward-looking reaction function for the euro area as a whole is taken from Hayo and Hofmann (2006).

Due to changes in the real rate of interest, the national Taylor rules contain estimated constant terms (α) that deviate substantially from the one estimated for the ECB Taylor rule in Hayo and Hofmann (2006). From Equation (1) it follows that the constant α of the target interest rate is:

$$\alpha = r^* + (1 - \beta)\,\pi^* \tag{2}$$

To compensate for changes over time, we derive the implied long-run real interest rate by rearranging Equation (2) and replacing the national estimates of the long-run interest rates obtained from Eleftheriou et al. (2006) and Hayo (2007) with value estimated for the EMU period:

$$r^* = \alpha - (1 - \beta)\,\pi^* \tag{3}$$

In the analysis below, we use counterfactual national target-rate series based on the long-run coefficients β, γ, and adjusted α, and then construct simple arithmetic averages. We interpret the final series as indicators of how national interest rates would have been set in the absence of the EMU. Figure A1 in the Appendix shows these counterfactual interest-rate paths for each country together with the Eonia series.[2]

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[1] Eleftheriou et al. (2006) estimate Taylor rules for the period 1993 to 1998, whereas Hayo (2007) investigates data from 1979 to 1998. In both studies, general method of moments (GMM) estimators are applied to monthly national series.

[2] In general, our simulated interest rate paths tend to be above the EONIA. This finding is also true for the euro area rule estimated by Hayo and Hofmann (2006), which would have predicted higher European interest rates. This may be the European version of what Taylor (2009) criticised as a deviation of actual monetary policy from some sort of interest rate rule, leading to worldwide excess liquidity.

3. Decision rules and scenarios

We consider five types of decision rules, each of which can be adapted to various institutional settings: consensus, voting, bargaining, full chairman dominance, and voting with a chairman. In various scenarios, we apply these decision rules to particular sets of objectives. Such objectives will be referred to as 'federal' if council members seek to implement monetary policies that best suit the euro area as a whole, and as 'national' if they seek to implement policies that are optimal for their country of origin.

3.1. Voting

According to Article 105 of the Constitution of the European System of Central Banks and of the European Central Bank, voting is the Governing Council's official decision rule for our period of study. Moreover, Article 105 mandates that the same weight be given to each member's vote—the one-man–one-vote rule. How this rule works in a monetary union has been investigated frequently since von Hagen and Süppel's (1994) seminal contribution.

As the Governing Council's decision has a single dimension, the median voter theorem applies. Accordingly, the interest rate set by the council under voting is the median of interest rates favoured by its members.[3]

We complement the official voting rule by two institutional settings in which only a subset of Governing Council members can vote. In the first scenario, only national governors vote, which reflects the intergovernmental design of the European Council. In this scenario, the chosen interest rate corresponds to the interest rate preferred by the median governor. In the second scenario, only members of the Executive Board are allowed to vote; here, the chosen interest rate will be the one favoured by the median board member.

3.2. Consensus

Consensus is the Governing Council's official decision-making mechanism. To model it, we follow Austen-Smith and Banks (2005, chapter 4) and Riboni and Ruge-Murcia (2010) in

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[3] Note that Greece has been a member of the Governing Council only since January 2001, which increased the size of the council to 18 members.

assuming that decisions are made in a two-stage process. In the first stage, the Governing Council determines, by a simple majority vote, whether the interest rate should be increased or decreased with respect to the status quo. Based on the first-stage decision, the council next, based on supermajority, moves the interest rate up or down in a series of votes for or against incremental changes in the rate.

Based on the national Taylor rules, we arrive at a distribution of preferred interest-rate targets $i_t^{T,j}$, $j = 1, ..., 17$ (or 18, when Greece is included). Let i_t^M denote the median of this distribution, and i_t^{100-K} (respectively, i_t^K) the $100\%-K\%$ (respectively, $K\%$) quantiles of this distribution.[4] K thereby measures the size of the supermajority needed to reach a conclusion. Then, the outcomes are as in Equations (4a) to (4c):

$$i_t = i_t^{100-K} \qquad \text{if} \qquad i_{t-1} < i_t^{100-K} \tag{4a}$$

$$i_t = i_{t-1} \qquad \text{if} \qquad i_t^{100-K} \leq i_{t-1} \leq i_t^K \tag{4b}$$

$$i_t = i_t^K \qquad \text{if} \qquad i_{t-1} > i_t^{M+K} \tag{4c}$$

The logic behind this is simple: in Equation (4a), the previous interest rate is smaller than preferred by more than $K\%$ of voting members. Hence, council members will decide to raise interest rates until the interest rate i_t^{M-K} is reached. Afterward, less than the required supermajority still believes the interest rate is too low; hence, no further increases will be made. Equation (4c) is analogous, whereas it is evident that in Equation (4b) the required supermajority cannot be reached to either raise or decrease interest rates.

To apply the consensus rule, one must specify the size of the supermajority required to change the interest rate in the second stage of the decision process, that is, the value of K. Based on the fact that many countries use a two-thirds majority rule to decide important issues, we here assume that two-thirds of the council must support a decision for it to pass. This assumption is further supported by Caplin and Nalebuff (1988, 1991), who show that a 66% majority always avoids cycling on multidimensional decisions. Although the decision

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[4] The interested reader will find a formal demonstration of the outcome of the consensus rule in Riboni and Ruge-Murcia (2010).

considered here is unidimensional, in 'real life', the Governing Council may have to make multidimensional decisions. For instance, when offering variable rate tenders in the main refinancing operations of the ECB, both minimum bid rate as well as volume of allocated liquidity need to be fixed. In such a case, imposing a 66% majority guarantees that the council will be able to make a decision.

3.3. Bargaining

We model the outcome of a bargaining process by computing the weighted average of the interest rates favoured by individual members of the Governing Council. We consider two distributions of bargaining power, corresponding to different weighting mechanisms. In the first distribution, all members are given equal weight. In the second, members are weighted based on their country's share of the zone's GDP.[5] One should note that those weighting schemes are not tantamount to maximising an aggregate welfare function for the euro area. Maximising aggregate euro area welfare would result in averaging national interest rates weighted by GDPs. In our approach, reflecting the ECB's institutional design, the preferred interest rates of the countries that are represented in the Executive Board are over-weighted.

3.4. The president: Full dominance and agenda setting

The first, and simplest, way to model the role played by the ECB president is to assume that he has complete discretion in setting the interest rate. Although simple, this is not completely unrealistic; for example, some accounts of Alan Greenspan's chairmanship at the Fed suggest that he was influential enough to almost always impose his view on the FOMC (Gerlach-Kristen and Meade, 2010). Hence, modelling president full dominance consists in assuming that the Governing Council always decides in favour of the chairman's preferred interest rate.

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[5] In the cases of national Executive Board members, we weigh the optimal interest rate of each Board member by the GDP of his/her country of origin. The latter countries' interest rate weight then receives a double weight. In the cases where Executive Board members are assumed federalist, we (i) compute a GDP-weighted average of the interest rates of the countries that are represented in the Executive Board, then (ii) compute a GDP-weighted average of the interest rates of the euro area member countries, and finally (iii) average the two using a 6/17 and 11/17 distribution.

Another way to model the president's role is to follow Montoro (2007), Farvaque et al. (2009), and Riboni and Ruge-Murcia (2010), and assume that the ECB president is an agenda setter. This assumption is in line with Pollard's (2003) argument that the role of the ECB president is, indeed, to set the agenda. One interpretation of agenda-setting power is to assume that the president's role is to put to a vote a given value of the interest rate. By majority vote, the council then chooses between this interest rate and the previous period's interest rate.

In such an agenda-setting framework, the president announces the interest rate closest to the one he favours under the constraint that a majority of the council will vote for it. In other words, from the set of interest rates preferred to the status quo by the median voter on the council, the president puts to the vote the one closest to his own preferences. This framework can accommodate both federalist and nationalist preferences, but we can remain general at this point. The exact definition of the president's and other members' optimal interest rates will be specified below for each scenario.

Let i_t^P denote the president's optimal interest rate, i_t^M, the median council member's optimal interest rate, i_{t-1} the current interest rate, and i_t the new interest rate. Then the outcome of the decision problem will be:

$$i_t = i_{t-1} \quad \text{if} \quad i_t^M \geq i_{t-1} \geq i_t^P \quad \text{or} \quad i_t^P \geq i_{t-1} \geq i_t^M \quad (5a)$$

$$i_t = 2i_t^M - i_{t-1} \quad \text{if} \quad 2i_t^M - i_t^P \leq i_{t-1} < i_t^M \quad \text{or} \quad 2i_t^M - i_t^P \geq i_{t-1} > i_t^M \quad (5b)$$

$$i_t = i_t^P \quad \text{otherwise} \quad (5c)$$

In the first case (Equation (5a)), the president's optimal interest rate and the median voter's optimal interest rate lie on opposite sides of the current interest rate. In such a case, the median voter has no incentive to vote for an interest rate that is closer to the president's optimum than the current interest rate. Conversely, the president has no incentive to put to a vote an interest rate that is closer to the median member's optimum than the current interest rate. Hence, this configuration preserves the status quo, i.e., the interest rate remains unchanged.

In the second case (Equation (5b)), the previous interest rate is lower than the median voter's optimum but close to it. More precisely, the difference between the previous interest rate and the median voter's favourite interest rate is smaller than the distance between the median voter's interest rate and the chairman's favourite interest rate. The best the president can achieve is to announce the interest rate that makes the median council member indifferent between that interest rate and the status quo. This interest rate is equal to the median voter's interest rate plus the difference between the median voter's interest rate and the previous interest rate.

The third configuration (Equation (5c)) appears when the past interest rate is far enough from the median voter's optimum so that the median member prefers the president's optimal interest rate to the status quo. The chairman is then able to impose his optimal interest rate.

3.5. Objectives

The ECB's official stance is that members of the Governing Council should not act as national representatives, but work to implement a policy that meets the needs of the euro area as a whole. It is at least plausible that members of the Executive Board will, indeed, act in this manner because they are appointed following a procedure involving all EMU member countries. According to Article 11.2 of the statutes of the European System of Central Banks and of the European Central Bank, members of the Executive Board are appointed by 'common accord of the governments of the Member States at the level of the Heads of State or Government, on a recommendation from the Council after it has consulted the European Parliament and the Governing Council'. Thus, as they are appointed at the EMU level, they are presumed to pursue euro-zone-wide objectives.

However, there is no guarantee that they will. First, they have national backgrounds, and may have particular ties with their country of origin. One way to avoid national biases would be to employ EMU outsiders as members of the council. Currently, this possibility is explicitly ruled out by Article 11.2 of the statutes of the European System of Central Banks and of the European Central Bank, which states that 'only nationals of Member States may be

members of the Executive Board'.[6] Moreover, if regional representatives of the FOMC are sensitive to the condition of their home region, as Gildea (1992), Meade and Sheets (2005), Chappell et al. (2008), and Hayo and Neuenkirch (2011) report, it is plausible that the same applies to members of the ECB's Governing Council. As governors of national central banks are directly appointed by their home government, they are even more likely than members of the Executive Board to pursue national objectives.

What objectives board members actually pursue is an empirical matter and is addressed below. We consider various combinations of the two assumptions about member behaviour and determine which one produces the outcome that best fits the observed ECB decisions. We do not consider a scenario in which the Executive Board is nationalist while national governors are federalist, as the former are appointed at the federal level and work in Frankfurt, while the latter are appointed nationally and work in their home country.

That both the governors and the members of the Executive Board follow federal objectives cannot be ruled out *a priori*. This eventuality would result in a systematic consensus about setting the interest rate to the level that is optimal for the euro area. Accordingly, decision rules would be irrelevant, as all configurations would lead to the same policy. We therefore use this scenario, referred to as 'full federalism', as our benchmark case.[7]

When modelling simple voting, we consider that national governors always act as representatives of their country of origin. In other words, we assume that they behave as nationalists. As regards the Executive Board members, we consider two contrasting scenarios:

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[6] The names and nationality of the members of the Executive Board are listed in the Appendix. In theory, the Executive Board could be a mix of federalist and nationalist members. To save on space, we do not consider that possibility here.

[7] An alternative definition of full federalism would be to weigh national interest rates by GDP, regardless of the country of origin of the members of the Governing Council. Gros and Hefeker (2002) argue that such a rule could be optimal. We leave this alternative aside, because it would mix positive and normative arguments. Here, we are only concerned with providing a positive analysis, which, of course, does not imply that a normative analysis would be without merit.

one in which they all act as national representatives and one in which they all embrace a federal point of view.

When voting is restricted to governors, we assume that they are nationalists. When it is restricted to the Executive Board, we only consider the possibility that the board is nationalist. In both cases, the alternative scenario, that is, where governors or Executive Board members are federalist, would simply replicate the interest-rate path determined by the euro-wide Taylor rule.

In bargaining scenarios, we allow board members to be either nationalist or federalist for each distribution of bargaining power, whereas governors are assumed to always behave nationalistically.

In the scenario in which the president has full discretion over interest rates, we assume that he may be either federalist, which results in the federal rule being implemented, or nationalist. In the latter case, the chosen interest rate is the interest rate favoured by the Netherlands during Wim Duisenberg's mandate and the one preferred by France during Jean-Claude Trichet's. If the president is assumed to act as an agenda setter, we assume that all governors are nationalists, and let the Executive Board, including the president, behave in either a nationalist or federalist manner.

We consider 13 alternative scenarios. The next section investigates how well these scenarios mimic actual development of the European interest rate.

4. Findings

Graphical representations of each scenario together with the evolution of the Eonia can be found in the Appendix (Figure A2) over the period January 1999 to December 2006. They show that the period of study allows testing the capacity of each scenario to reproduce periods of stability of the interest rate, such as 2003-2005, but also sudden policy reversals, such as the reversal from a series of interest rate increases to a succession of interest rate cuts that occurred in 2001.

Table 1 displays the summary statistics of the interest rates produced by each scenario. The means of all simulated interest rates are larger than the Eonia average. Moreover, the

difference is significant at any standard level of confidence. On average, the ECB was therefore less hawkish than expected by our counterfactuals.

Table 1: Summary statistics

Decision rule	Preferences	Mean	Standard deviation
Eonia	Eonia	2.98	0.91
Full federalism	Federalist governors and federalist board	3.91	0.72
Chairman dominance	Nationalist chairman	4.70	2.37
One member one vote	Nationalist governors and nationalist board	4.07	1.03
One member one vote	Nationalist governors and federalist board	3.95	0.72
Restricted: One governor one vote	Nationalist governors	4.05	1.06
Restricted: One member of the board one vote	Nationalist board	4.07	1.01
Consensus	Nationalist governors and nationalist board	4.30	0.98
Consensus	Nationalist governors and federalist board	3.86	0.78
Bargaining equal weights	Nationalist governors and nationalist board	4.25	1.02
Bargaining equal weights	Nationalist governors and federalist board	3.83	0.79
Bargaining GDP weights	Nationalist governors and nationalist board	3.77	0.89
Bargaining GDP weights	Nationalist governors and federalist board	3.83	0.78
Chairman	Nationalist governors and nationalist board	4.40	1.57
Chairman	Nationalist governors and federalist board	3.92	0.73

Nevertheless, ordering scenarios by decreasing interest-rate averages leads to a fairly consistent ranking. The scenario that generates the average interest rate closest to Eonia is the bargaining scenario in which governors and board members are all nationalist, and their weight in the negotiations is based on their country's relative GDP size. The two bargaining scenarios in which governors are nationalist and the board federalist generate the next closest

match of interest rates. The two scenarios producing the largest interest rates are the ones where the chairman is nationalist.

In our sample, a scenario's capacity to reproduce the volatility of the observed interest rate is a more discriminatory criterion, as our simulations produce very different standard deviations of the interest rate. Indeed, five scenarios produce standard deviations that are not statistically distinguishable from the standard deviation of the observed interest rate: bargaining with GDP weights, national representatives and national governors; consensus with national representatives and national governors; voting restricted to a nationalist executive board; bargaining with equal weights, national representatives and national governors; and voting with national representatives and national governors. Six scenarios produce a lower than observed volatility of the interest rate: full federalism; voting with nationalist governors and a federalist board; a federalist chairman facing nationalist governors and a federalist board; bargaining with GDP weights, nationalist governors, and federalist board; consensus with nationalist governors and federalist board; and bargaining with equal weights, nationalist governors, and a federalist board. The two scenarios involving a nationalist chairman stand out as producing the largest volatilities. Perhaps unsurprisingly, the volatility of the simulated interest rate is particularly high in the scenario where a single, unchecked nationalist chairman sets the interest rate.

Table 2 complements Table 1 by providing three selection criteria for each scenario: root mean square error (RMSE), mean average error (MAE), and the deviation of first-order serial correlation of simulated interest-rate paths from Eonia's (AC). The RMSE criterion and MAE criterion are based on selecting the scenarios that best describe the Eonia interest-rate series, which we believe to be a natural and important selection criterion. The AC criterion assesses whether the autocorrelation of simulated interest-rate paths is close to Eonia's first-order serial correlation coefficient, which exceeds 0.988. Given the high degree of persistence observed for Eonia, it could be argued that a scenario's capacity to generate autocorrelation is a desirable property. In our view, this criterion should be considered with caution in the present context because it weighs heavily a scenario's capacity to produce gridlock, regardless of its capacity to accurately predict the Eonia. Therefore, a scenario may perform well simply

because it generates long periods of status quo, while, when they finally do occur, inaccurately predicting the magnitude of changes in the interest rate.

RMSE and MAE select the same three best-performing scenarios, which are all bargaining scenarios. Bargaining with GDP weights where governors and members of the Executive Board are nationalist leads to the smallest RMSE and MAE. That scenario outperforms the two bargaining scenarios where governors are nationalist and members of the board are federalist, which yields similar results regardless of the applied weighting scheme. All three lead to RMSEs and MAEs smaller than 1, which implies that the average error is below 1 percentage point. The consensus scenario in which the Executive Board is assumed to be federalist also produces a RMSE and a MAE that are lower than 1, and therefore ranks fourth according to both scenarios.

Table 2: Selection criteria

Decision rule	Preferences	RMSE	MAE	AC
Full federalism	Federalist governors and federalist board	1.25	1.04	0.288
Chairman dominance	Nationalist chairman	2.36	1.85	0.034
One member one vote	Nationalist governors and nationalist board	1.22	1.13	0.053
One member one vote	Nationalist governors and federalist board	1.23	1.04	0.226
Restricted: One governor one vote	Nationalist governors	1.20	1.11	0.043
Restricted: One member of the board one vote	Nationalist board	1.20	1.12	0.044
Consensus	Nationalist governors and nationalist board	1.96	1.33	0.010
Consensus	Nationalist governors and federalist board	1.05	0.93	0.044
Bargaining equal weights	Nationalist governors and nationalist board	1.34	1.29	0.032
Bargaining equal weights	Nationalist governors and federalist board	0.99	0.90	0.064
Bargaining GDP weights	Nationalist governors and nationalist board	0.91	0.86	0.028
Bargaining GDP weights	Nationalist governors and federalist board	0.99	0.91	0.068
Chairman	Nationalist governors and nationalist board	1.68	1.43	0.028
Chairman	Nationalist governors and federalist board	1.23	1.04	0.247

The RMSE and MAE criteria also concur in selecting the same worst three scenarios, although in different orders. According to both criteria, the worst scenario is chairman dominance when the chairman is nationalist, which leads to a RMSE of 2.36 and an MAE of 1.85. The consensus scenario with a nationalist Executive Board and nationalist governors is next to last according to the RMSE criterion, and second to last according to the MAE criterion. It produces a RMSE of 1.96 and a MAE of 1.33. With a RMSE of 1.68 and a MAE of 1.43, the scenario in which a nationalist chairman faces a nationalist council is ranked second to last according to the MAE criterion and third to last according to the RMSE criterion. Thus, the best and the worst-performing scenarios in our simulations are not affected by outliers, which only have some effect on the ranking of scenarios in between.

The last column of Table 2 (AC) shows the deviation of the estimated first-order autocorrelations implied by each scenario from that of actual interest rates. The table reveals that Eonia shows greater persistence than any interest-rate series produced by the scenarios under consideration. Reflecting the caveat about the usefulness of this criterion mentioned above, the scenario that most likely produces a gridlock—the consensus scenario in which where all members of the council are assumed nationalist—performs best, with a coefficient of autocorrelation that is very close to Eonia's. It is closely followed by the Chairman scenario with nationalist governors and nationalist board member, which also produces gridlocks. The bargaining scenario in which members of the council are nationalist and have equal bargaining power, the chairman dominance scenario, and the bargaining scenario in which members of the council are nationalist and bargaining powers are determined by GDP also come close. The three worst-performing scenarios by far are: full federalism, a federalist chairman facing nationalist governors and a federal board, and the scenario where nationalist governors and a federal board vote.[8] The poor performance of the scenario in which a federalist chairman faces nationalist governors and a federal board may seem initially surprising, because the chairman model can relatively easily produce gridlock. However, it can be explained by recalling that gridlocks occur in that model when the chairman and the board stand on opposite sides of the status quo. When the chairman is federalist, he prefers an interest rate that must, by construction, lie in the middle of the governors' preferred interest rates. The likelihood of a gridlock is therefore small, which, in our context, generates low interest-rate persistence.

Table 3 displays the results of the regressions where the actual interest rate is regressed on the simulated interest rate. At least three criteria can be used to compare the accuracy of a given scenario: large R-squared (R-squared criterion), constant term equal to zero (Abs. const. criterion), and slope coefficient equal to unity (slope criterion). The first criterion is the overall fit of each regression as measured by its R-squared. According to that criterion, the scenario that performs best is one in which members of the council are all

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[8] These three scenarios produce first-order autocorrelation parameters that are significantly lower than Eonia's at a 1% level.

nationalist and they set the interest weight by bargaining with equal weights. This one-national-member–one-weight rule explains more than 80% of the observed variance of the euro area's interest rate. At the other extreme, three scenarios stand out for their very low R-squareds. The worst-performing scenario is the full federalist scenario, with an R-squared of 25%. This is a very interesting finding, as it stands in stark contrast to the official position of the ECB, which is that members of the board set interest rates based on the evolution of the euro area as a whole. Other badly performing scenarios are: a federalist chairman setting the agenda for a federalist board and nationalist governors, and voting when the executive board is federalist and the governors are nationalist. The former's R-squared does not exceed 30%, whereas the latter's remains below 35%. The R-squared of the other scenarios range from 67–79%.

Table 3: Regression results

Decision rule	Preferences	Simulated interest rate	Constant	R^2	Coefficient = 1
Full federalism	Federalist governors and federalist board	0.632 (5.617) ***	0.503 (1.124)	0.251	F(1,94) = 10.7***
One member one vote	Nationalist governors and nationalist board	0.745 (15.46) ***	-0.0532 (0.263)	0.718	F(1,94) = 28***
One member one vote	Nationalist governors and federalist board	0.731 (6.990) ***	0.095 (0.226)	0.342	F(1,94) = 6.6**
Restricted: One governor one vote	Nationalist governors	0.728 (15.52) ***	0.0337 (0.172)	0.719	F(1,94) = 34***
Restricted: One member of the board one vote	Nationalist board	0.779 (16.92) ***	-0.196 (1.017)	0.753	F(1,94) = 23***
Consensus	Nationalist governors and nationalist board	0.805 (17.48) ***	-0.481 (2.369) **	0.765	F(1,94) = 18***
Consensus	Nationalist governors and federalist board	0.952 (13.86) ***	-0.7 (-2.586) **	0.671	F(1,94) = 0.49
Bargaining equal weights	Nationalist governors and nationalist board	0.801 (20.35) ***	-0.428 (2.485) **	0.815	F(1,94) = 25***
Bargaining equal weights	Nationalist governors and federalist board	0.956 (14.53) ***	-0.681 (2.648) ***	0.692	F(1,94) = 0.44
Bargaining GDP weights	Nationalist governors and nationalist board	0.896 (18.17) ***	-0.404 (2.114) **	0.778	F(1,94) = 4.43**
Bargaining GDP weights	Nationalist governors and federalist board	0.955 (14.23) ***	-0.68 (2.592) **	0.683	F(1,94) = 0.44
Full chairman dominance	Nationalist chairman	0.338 (18.58) ***	1.388 (14.50) ***	0.786	F(1,94) = 1319***
Chairman	Nationalist governors and nationalist board	0.505 (17.66) ***	0.755 (5.655) ***	0.768	F(1,94) = 300***
Chairman	Nationalist governors and federalist board	0.682 (6.329) ***	0.3 (0.698)	0.299	F(1,94) = 8,68***

Notes: *, **, and *** indicate significance at a level of 10%, 5%, and 1%, respectively; t-values in parentheses.

The second criterion is the value of the estimated constant. A scenario exactly replicating the observed interest rate should result in an estimated constant equal to zero. Six scenarios perform well according to this criterion because their estimated constant is not distinguishable from zero at standard levels of significance: Voting restricted to a nationalist Executive Board, unrestricted voting when all board members are nationalist, voting restricted to nationalist governors, unrestricted voting when governors are nationalist and members of the board are federalist, a federalist chairman with a federalist board and nationalist governors, and full federalism. In the latter scenario, however, the estimated constant is large, its insignificance being due to a high standard error.[9]

The four scenarios involving bargaining result in constants that are significantly negative, implying that the scenarios, on average, tend to overshoot the interest rate. It therefore appears that bargaining scenarios tend to overestimate the average interest rate regardless of the hypotheses made about the preferences of the members of the ECB's Governing Council, and the same is true for both consensus scenarios.

Finally, assuming that a fully dominant federalist chairman is an agenda setter in a council where members of the Executive Board are federalist and governors are nationalist, results in a constant that is significantly positive at the 1% level of significance. Those scenarios therefore tend to undershoot the actual interest rate. However, this outcome appears to be largely due to the fact that France requested a lower interest rate than other member countries.

Our favourite criterion of this group is the size of the coefficient of the estimated interest rate because it measures the relationship between a 1 percentage point change in the simulated interest rate and the corresponding change in the real-world rate. A perfect simulation should generate a coefficient equal to 1. However, we find that all estimated coefficients are smaller than 1, suggesting that the ECB's behaviour is more cautious than any of our simulations imply. Nevertheless, marked differences between various scenarios appear and, in the case of three scenarios, we cannot reject the hypothesis that the coefficient is

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[9] The residuals of the models in Table 3 show evidence of autocorrelation and heteroscedasticity. However, employing Newey-West robust standard errors does not change our conclusions.

statistically equal to unity at any reasonable level of significance: Bargaining with equal weights when governors are nationalist and members of the Executive Board are federalist leads to the highest coefficient (0.956). This scenario is closely followed by the one where nationalist governors and federalist members of the Executive Board bargain using GDP weights, with a coefficient of 0.955. The consensus scenario in which members of the board are federalist and the governors are nationalist comes close, with a coefficient equal to 0.952.

The two bargaining scenarios in which all members of the Governing Council are nationalist produce coefficients that exceed 0.8, although the scenario assuming GDP weights instead of equal weights performs better, with a coefficient of 0.896 instead of 0.801. Between them is the consensus scenario in which the entire council is nationalist, which produces a coefficient of 0.805.

Next in line, performance-wise, are the four scenarios in which members of the Governing Council are assumed to vote, which show coefficients ranging from 0.728 to 0.779. The three following scenarios are those involving a chairman and the full federalist scenario. Finally, the scenario producing the smallest coefficient is that of full chairman dominance. This is intuitively plausible, as, by construction, the situation of any single country is more volatile than that of the whole euro area.

A sorting of the rankings of the ECB Governing Council decision-making scenarios according to the various criteria is presented in Table 4. In general, comparing the performance of different scenarios suggests that the ranking of most decision rules is robust to the assumed preferences of the members of the Executive Board. A tentative interpretation of this finding could be that the economic situation in the home countries of the Executive Board members is somewhat similar to that of the euro area as a whole.

Looking at the best-performing scenario across the eight criteria reveals a clear winner—the scenario in which members of the council bargain, are all nationalists, and have bargaining power reflecting the size of their country in the euro area's GDP. Not only does this scenario have the best arithmetic average and median ranking across all the criteria, it is ranked first by four of those criteria: it produces an average interest rate and a standard deviation that are the closest to the Eonia's, and shows a high fit as demonstrated by its low RMSE and MAE values. Furthermore, it performs well according to three other criteria, as it

ranks third in terms of R-squared in bivariate regressions and fourth in terms of the slope coefficient. With a rank of 5, it performs better than expected according to the autocorrelation criterion, as it clearly outperforms one consensus scenario and one chairman scenario. Table 4 also shows that the scenario's median ranking is the best in our set of scenarios and it performs well quite consistently, as it has the lowest standard deviation with respect to the various rankings.

In terms of average and median ranking, the bargaining scenario with equal weights, national governors, and a federalist board performs second best. It ranks first according to the slope coefficient in a regression of this scenario's interest-rate path on Eonia, second in respect to both RMSE and MAE, third with regard to its average being close to Eonia's, and fifth in terms of matching Eonia's standard deviation. However, compared to the bargaining scenario with GDP weights that assumes only national preferences, it shows not only a higher average and median ranking but also less consistency across the different criteria, as can be seen from the much higher standard deviation in the last column of Table 4.

The third-best-performing simulation is yet another bargaining scenario, this time assuming GDP weights of Governing Council members, nationalist governors, and a federalist Executive Board. This scenario performs second best in terms of the slope coefficient close to 1 in a regression of its interest-rate path on Eonia, comes second with regard to its average interest rate, and it reaches third rank according to RMSE and MAE. Both in terms of mean ranking as well as consistency across different criteria, however, it clearly lags behind the bargaining scenario that assumes nationalist behaviour throughout. In terms of median ranking, it is equal to the consensus scenario with nationalist governors and a federalist board.

Table 4: Summary of the ranking of scenarios

Decision rule	Preferences	Mean	Std. dev.	RMSE	MAE	Slope	Abs(Const.)	R^2	AC	Average rank	Median rank	Std. dev. of rankings
Full federalism	Federalist governors and federalist board	5	11	10	7	14	12	9	14	10.3	10.5	3.2
Chairman dominance	Nationalist chairman	14	14	14	14	4	14	14	2	11.3	14.0	5.1
One member one vote	Nationalist governors and nationalist board	10	6	7	10	9	8	2	8	7.5	8.0	2.6
One member one vote	Nationalist governors and federalist board	7	12	8	5	12	9	3	12	8.5	8.5	3.4
Restricted: One governor one vote	Nationalist governors	8	9	5	8	7	10	1	7	6.9	7.5	2.8
Restricted: One member of the board one vote	Nationalist board	9	3	6	9	8	7	4	6	6.5	6.5	2.2
Consensus	Nationalist governors and nationalist board	12	2	13	12	1	5	8	5	7.3	6.5	4.7
Consensus	Nationalist governors and federalist board	4	8	4	4	6	3	12	11	6.5	5.0	3.5
Bargaining equal weights	Nationalist governors and nationalist board	11	4	11	11	3	6	7	1	6.8	6.5	4.0
Bargaining equal weights	Nationalist governors and federalist board	3	5	2	2	10	1	11	9	5.4	4.0	4.0
Bargaining GDP weights	Nationalist governors and nationalist board	1	1	1	1	5	4	6	3	**2.8**	**2.0**	**2.1**
Bargaining GDP weights	Nationalist governors and federalist board	2	7	3	3	11	2	10	10	6.0	5.0	4.0
Chairman	Nationalist governors and nationalist board	13	13	12	13	2	13	13	4	10.4	13.0	4.6
Chairman	Nationalist governors and federalist board	6	10	9	6	13	11	5	13	9.1	9.5	3.2

5. Conclusion

In this paper, we inquire into how the ECB makes monetary policy decisions for the euro area. Given that there is no public information about how the ECB Governing Council makes decisions, we rely on a set of counterfactuals. Using Taylor rules estimated for the pre-euro period, we derive 13 interest-rate scenarios that vary with respect to the underlying decision rules and the assumed preferences of the members of the Governing Council. Five types of rules are considered: voting, consensus, bargaining, full chairman dominance, and voting with a chairman. We apply these rules to three sets of assumed preferences: a fully federalist Governing Council, a federalist Executive Board facing national governors in the Governing Council, and a fully nationalist Governing Council. Using a series of criteria, we assess how well each of the scenarios matches Eonia. Four main conclusions can be drawn.

First, the scenario that performs best is the one in which individual members of the Governing Council follow national objectives and bargain over interest-rate setting based on weights derived from their country's share in the euro area's GDP. This scenario produces a mean interest rate closest to the average of Eonia, with the lowest standard deviation around that mean. It also generates the smallest prediction errors measured by both RMSE and MAE. It even outperforms, in terms of its capacity to reproduce the observed interest rate's persistence, scenarios that yield periods of status quo.

Second, scenarios in which it is assumed that the members of the Governing Council bargain over interest rates generally perform better than scenarios in which it is assumed that decisions are made by consensus or by using various voting rules. This finding reveals that actual behaviour does not match that mandated in the ECB statutes, which stipulate that the Governing Council should make its decisions using a simple majority vote. The finding also throws some doubt on the credibility of the ECB's official position that all its decisions are based on consensus.

Third, scenarios in which the ECB president plays a key role generally perform poorly. These scenarios are especially outperformed by scenarios assuming collective decision-making procedures, whether by way of bargaining or through consensus.

Finally, scenarios in which all members of the Governing Council are assumed to pursue Euro-area-wide objectives are dominated by scenarios in which decisions are made collectively by a council consisting, at least partly, of members pursuing national objectives. This finding is also at odds with the ECB's official mandate that members of the Governing Council are to implement policies that best meet the needs of the euro area as a whole. It is, however, in line with previous studies that have unveiled regional influences in the United States as well as in the euro area.

In this paper, our sole aim was to discover how decisions are actually made in the Governing Council. A promising avenue for extending this research would be to determine whether the ECB's decision-making process changes when membership in the EU increases, as well as the effect of the rotating rule, when (or if) it becomes applicable. Another fruitful avenue for future research would be to derive the normative implications of the decision structures observed here. We hope that our findings will stimulate and guide those investigations.

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Appendix

Table A1: Nationalities and identities of the members of the Executive Board

|	President	Vice-President	Member	Member	Member	Member
As of January 1999	Dutch (Willem Duisenberg)	French (Christian Noyer)	Spanish (Solans)	Finnish (Sirkka Hämäläinen)	German (Otmar Issing)	Italian (Tommaso Padoa-Schioppa)
As of June 2002	Dutch (Willem Duisenberg)	Greek (Lucas Papademos)	Spanish (Eugenio Domingo Solans)	Finnish (Sirkka Hämäläinen)	German (Otmar Issing)	Italian (Tommaso Padoa-Schioppa)
As of June 2003	Dutch (Willem Duisenberg)	Greek (Lucas Papademos)	Spanish (Eugenio Domingo Solans)	Austrian (Gertrude Tumpel-Guggerell)	German (Otmar Issing)	Italian (Tommaso Padoa-Schioppa)
As of November 2003	French (Jean-Claude Trichet)	Greek (Lucas Papademos)	Spanish (Eugenio Domingo Solans)	Austrian (Gertrude Tumpel-Guggerell)	German (Otmar Issing)	Italian (Tommaso Padoa-Schioppa)
As of June 2004	French (Jean-Claude Trichet)	Greek (Lucas Papademos)	Spanish (González-Páramo)	Austrian (Gertrude Tumpel-Guggerell)	German (Otmar Issing)	Italian (Tommaso Padoa-Schioppa)
As of June 2005	French (Jean-Claude Trichet)	Greek (Lucas Papademos)	Spanish (José González-Páramo)	Austrian (Gertrude Tumpel-Guggerell)	German (Otmar Issing)	Italian (Lorenzo Bini Smaghi)
As of June 2006	French (Jean-Claude Trichet)	Greek (Lucas Papademos)	Spanish (José González-Páramo)	Austrian (Gertrude Tumpel-Guggerell)	German (Jürgen Stark)	Italian (Lorenzo Bini Smaghi)

Fig. A1: National Taylor rules
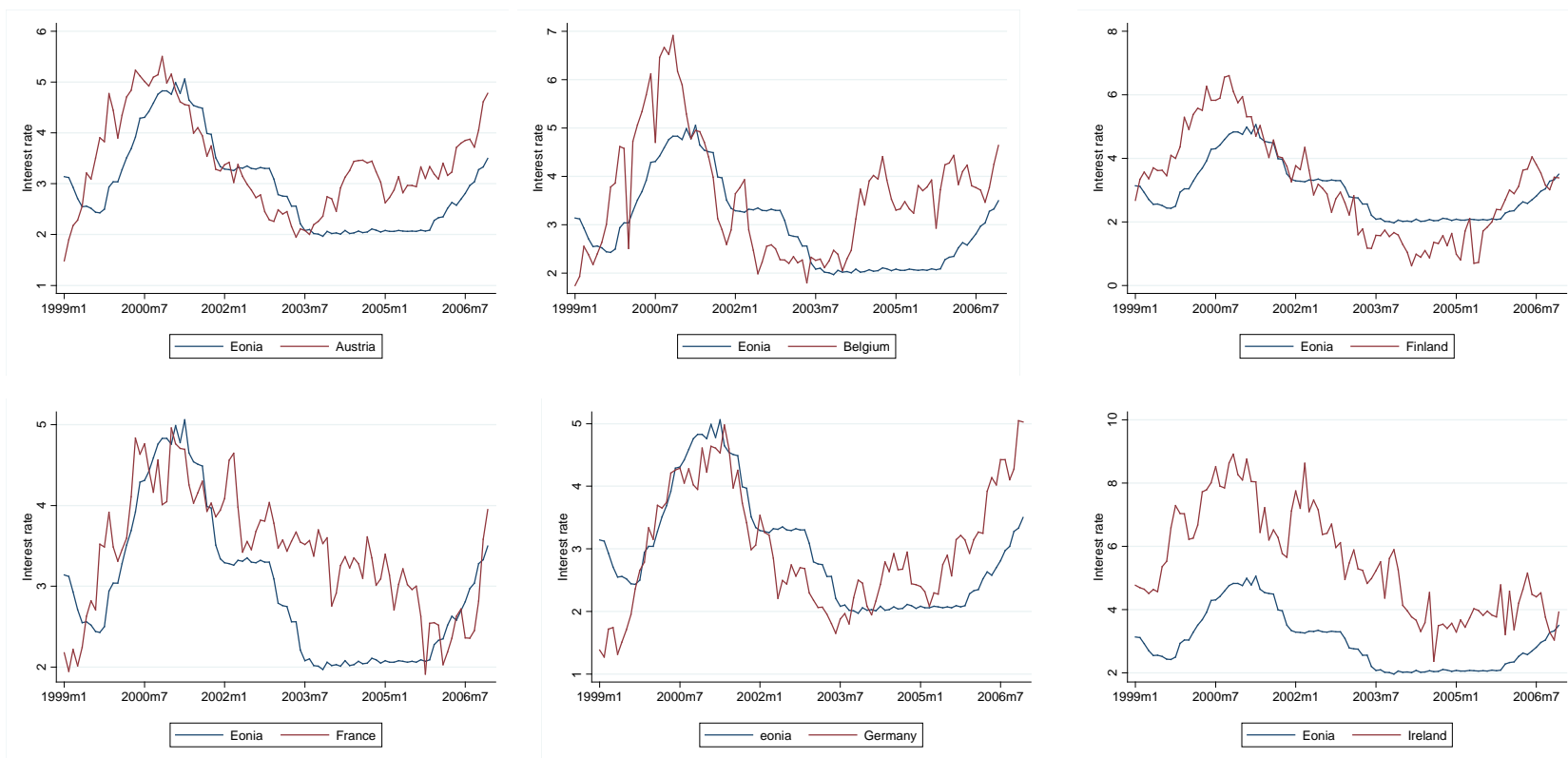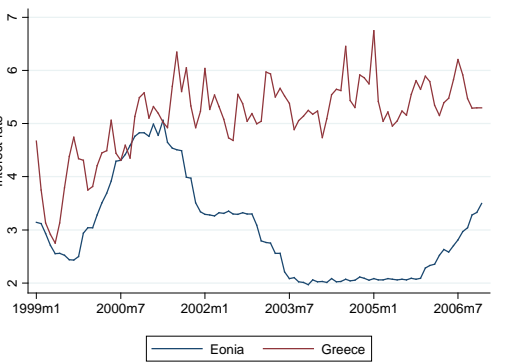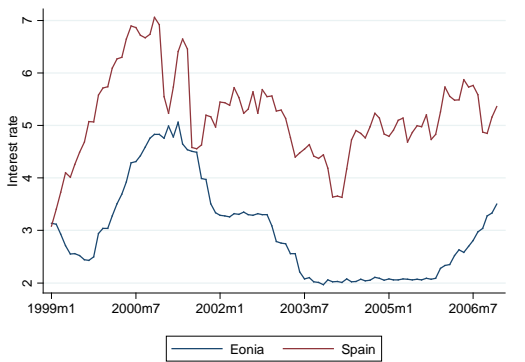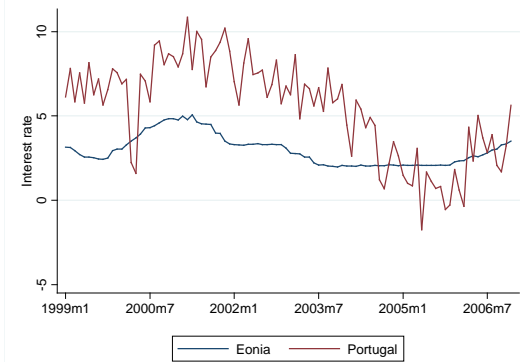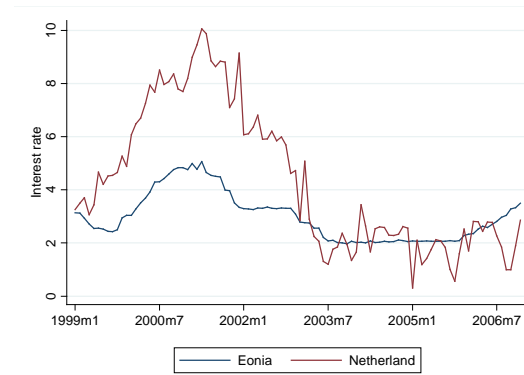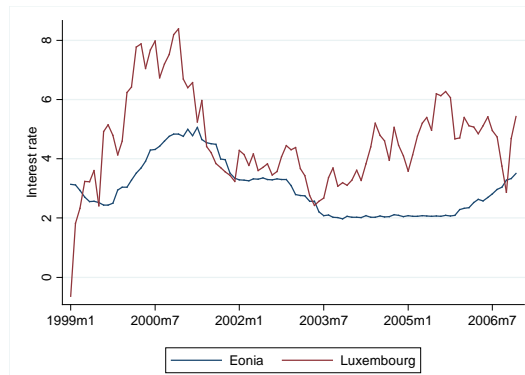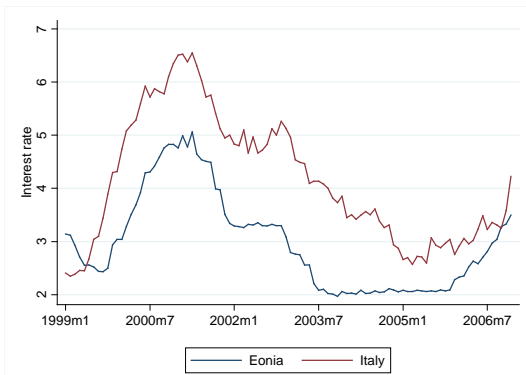
Fig. A2: Interest rates produced by alternative scenarios