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"European Government Bond Markets and Monetary Policy Surprises: Returns, Volatility and Integration"

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Abstract

In this paper we investigate the response of bond markets to euro area and US monetary policy shocks. Specifically, we analyze the effect of unexpected changes in interest rates implemented by the European Central Bank (ECB) and the Federal Open Market Committee (FOMC) not only on the returns, but also on the volatility and the integration of European government bond markets. For all three characteristics our results show that the response to monetary policy surprises varies across groups of countries (EMU EU-15 central, EMU EU-15 peripheral, non-EMU EU-15 and non-EMU new EU). We also find that the effects of monetary policy announcements on the level of integration are more pronounced than those on returns and volatility. Finally, our results paint a complex picture of the effects of monetary policy news releases on the level of integration. The effect of ECB monetary policy surprises differs across old and new European Union members, while the effect of FOMC monetary policy surprises differs across EMU and non-EMU members.

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1. Introduction

The extent of international bond market linkages merits investigation, as it may have important implications for the cost of financing fiscal deficit, monetary policymaking independence, modeling and forecasting long-term interest rates, and bond portfolio diversification. Following the launch of the euro in January 1999, sovereign debt markets priced the debt of the various Member States as virtually identical. During the period 2003-2007, the spreads were very small and failed to reflect the different fiscal positions across countries, even when the ratings changed. As such this period was characterized by a significant underpricing of risk, with investors searching for yield in an environment of abundant global liquidity. This progress towards financial integration, however, was interrupted and reversed by the global financial crisis and, more recently, by the European sovereign debt crisis with sovereign bond markets being dominated by sharp differentiation, especially across borders.

The integration of European government bond markets has been addressed in the recent literature from a variety of perspectives. One strand of the literature has assessed the relative importance of systemic and idiosyncratic risk in European Monetary Union (EMU) sovereign yield spreads (see Geyer et al., 2004; Gomez-Puig, 2009a and 2009b; Pagano and von Thadden, 2004). Another perspective is provided by Christiansen (2007), who assesses volatility spillovers in European bond markets. Finally, a number of papers have studied financial integration by exploiting the implications of asset pricing models (see Barr and Priestley, 2004; Hardouvelis *et al.,* 2006 and 2007; Abad *et al.,* 2010 and 2013). This paper adopts a different perspective as it seeks to tie together the market integration and news announcement literature by examining the reaction of European government bond market returns, volatilities and correlations to *unexpected* monetary policy announcements.

Given the diversity of the economic and financial structures across the European Union (EU) economies, monetary policy shocks can be reasonably expected to have different effects. For this reason, we divide our sample of European government bond markets into four groups: (1) EMU EU-15 central bond markets (Austria, Belgium, France, Germany and the Netherlands), (2) EMU EU-15 peripheral (Ireland, Italy, Portugal and Spain), (3) Non-EMU new EU (the Czech Republic, Hungary and Poland), and (4) non-EMU EU-15 (Denmark, Sweden and the UK).

To analyze the effect of monetary policy news announcements on conditional returns, volatility and the integration or correlation between European government bond markets and our proxy for the entire EMU, we use an extension of Engle's (2002) dynamic conditional correlation (DCC) multivariate

model. This specification, while more flexible and parsimonious than most available multivariate models, has been shown to perform equally well in a variety of situations.

Our study makes a number of contributions to the relevant literature. First, we analyze the effects of monetary policy announcements not only on European government bond returns and volatilities but also on correlations. The main focus in the announcement literature has been on the effects of news on the conditional returns and volatility of asset prices, but announcements may also have a significant effect on conditional correlations or integration.[1] More importantly, the analysis of the response of correlations to monetary policy announcements should shed new light on the evolution of the convergence process. Second, we examine simultaneously the effect of the Fed and the ECB's actions in an attempt to determine if they are of equal importance to the European government bond markets analyzed.[2] Third, we analyze a large number of European countries (EMU EU-15 central, EMU EU-15 peripheral, non-EMU EU-15 and non-EMU new EU) which enables us to examine the heterogeneity of the response within and across countries.

Our main findings can be summarized as follows. First, we find different effects of surprise announcements on bond market returns, volatility and integration. The effects of monetary policy news on the level of integration are more marked than those on returns and volatility. Second, we also show differences in the response to monetary policy surprises across groups of countries. Peripheral, central and non-EMU EU-15 bond market returns and volatility are more markedly influenced by ECB monetary policy than they are by Fed policy. However, the capacity of the Fed and the ECB to influence non-EMU new EU bond markets is similar. Finally, our results reveal an homogeneous response to ECB surprise announcements within the former members of the EU-15 and within the new members of the EU and an homogeneous response to Fed surprises within EMU and non-EMU members.

The remainder of the paper is organized as follows. Section 2 describes our data. Section 3 lays out the methodology we use to analyze the effects of macroeconomic news announcements on returns, volatilities and correlations of European government bond markets. Section 4 discusses the empirical results and, finally, Section 5 concludes.

[1] An incomplete list of the recent literature on the effects of monetary policy on bond markets includes Jones et al. (1998), Balduzzi et al. (2001), Christie-David et al. (2002), Goeij and Marquering (2006), Andritzky et al. (2006), Nowak et al. (2011).
[2] Manganelli and Wolswijk (2009) show that international risk aversion (as proxied by spreads between 10-year US interest rate swaps and Treasury bonds) continues to play a role in determining euro area government bond spreads.

2. Data

2.1. Bond data

We use daily data for the period January 2004 through June 2013. The data consist of the 10-year JPMorgan Government Global Bond Index (JPMGBI), expressed in terms of a common currency, the euro, and the sample includes 15 European countries. Our study focuses on nine EMU EU-15 countries (Austria, Belgium, France, Germany, Ireland, Italy, the Netherlands, Portugal and Spain[3]) and six non-EMU countries (Denmark, the Czech Republic, Hungary, Poland, Sweden and the UK).[4] As a proxy for the entire euro area we use the JP Morgan EMU Government Index. These bond market indices are transformed into returns by taking the first difference of the natural log of each bond price index. All data have been collected from Thomson Datastream.

2.2 Announcement data

We examine the effect of unexpected changes in policy interest rates by the European Central Bank (ECB) and the Federal Open Market Committee (FOMC).[5] The ECB normally takes interest rate decisions only at the first meeting of each month[6] while the FOMC meets eight times a year (approximately every six weeks). This difference in frequency of meetings means that we have a much larger number of monetary policy announcements from the ECB than from the FOMC – 76 target rate decisions from the Fed compared to 114 from the ECB. We omit all unscheduled meetings from our analysis, as they tend to have a somewhat different impact to that of target rate decisions made at regular, scheduled meetings (see Bernanke and Kuttner, 2005; Fleming and Piazzesi, 2005).

Figure 1 illustrates the evolution of monetary policy rates during the sample period. The figure shows that the ECB tends to adjust its target interest rate in a manner that seems to mirror movements in the target Federal funds rate. While the Fed started a loosening of monetary policy in December 2007, it was not until the end of 2008 that the ECB started to reduce its target rate. Interestingly, the Fed has opted to leave its target rate unchanged since the end of 2008.

The announcement data are provided by Bloomberg. An important common finding in the existing literature is that only the surprise component of monetary policy has a significant effect on asset returns

3 Finland and Greece are not included in the study due to a lack of available data.
4 The earliest data available for the Czech Republic and Hungary date from November 2004, while in the case of Portugal the earliest date from March 2005.
5 We only examine the effect of interest rate announcements because most aggregate euro area data releases are published after the euro area Member States have published their data releases, and so the added informational value of these releases is considered small (see Andersson et al., 2009).
6 This procedure has been in place since 8 November 2001. Before that time, the ECB issued a press release following each of its twice monthly meetings.

and volatilities, whereas the effect of expected policy actions is statistically insignificant (see Bomfin, 2003, and Bernanke and Kuttner, 2005, among others). Therefore, in assessing the response of bond returns, volatilities and correlations to monetary policy we focus our attention on the surprise component. To obtain a measure of the surprise in the FOMC announcements we use the methodology proposed by Kuttner (2001). For an event taking place on day *d*, the unexpected, or "surprise" target rate change can be calculated as the change in the rate implied by the current-month futures contract, scaled up by a factor related to the number of days in the month affected by the change. In sum, we compute the unexpected target rate change or the "surprise", as

$$S = \frac{D}{D-d} f_d - f_{d-1} \tag{1}$$

where f_d is the current-month futures rate at the end of the announcement day *d* and *D* is the number of days in the month. Kuttner (2001) uses a scaled version of the one-day change in the current-month federal funds future rate because in the US the futures contract's payoff depends on the monthly average federal funds rate, and the scaled factor is included to reflect the number of days remaining in the month that are affected by the change. This scaled factor is not required to obtain a measure of the surprise in the ECB announcement and, following Bredin *et al.* (2007), we proxy surprises in ECB policy rates using the one-day change in the three-month Euribor futures rate.[7]

Table 1 reports summary statistics for the monetary policy surprises.[8] Recall that a positive surprise means that the monetary policy rate was increased more or reduced less than the market anticipated, thus representing bad news. Similarly, a negative surprise means that the monetary policy rate ended up lower than expected, thus representing good news.

Several differences can be noted in both the frequency and magnitude of surprises in the respective announcements of the two central banks. First, the Fed's monetary policy decisions surprise market participants less frequently than those issued by the ECB (the percentage of monetary policy decisions that do not surprise market participants is 16 and 12%, respectively). Second, the percentage of positive surprises (bad news) is the same in both cases (45%); however, more negative surprises (good news) were observed in ECB announcements (43%) than in Fed announcements (39%). Finally, the mean of

[7] Bernoth and Von Hagen (2004) find that the three-month Euribor futures rate is an unbiased predictor of euro area policy rate changes.
[8] Following Balduzzi *et al.* (2001), we use standardized surprise for our estimation procedure. That is, we divide the surprise by its sample standard deviation to facilitate interpretation.

the (absolute) surprises is somewhat higher for the decisions of the Federal Reserve and the standard deviation of the ECB's surprises is much lower than that of the Fed's.

3. Methodology

Our methodology to assess bond market reactions in the euro area to monetary policy decisions announced by the ECB and the Federal Reserve is based on Engle's (2002) dynamic conditional correlation (DCC) multivariate model. The DCC model has the flexibility of univariate GARCH models but does not suffer from the 'curse of dimensionality' of multivariate GARCH models. The estimation consists of two steps. First, the conditional mean return and variance of each variable are estimated. Second, the standardized regression residuals obtained in the first step are used to model conditional correlations between each country and our proxy for the entire euro area.

To allow for the possibility that the response of bond returns, volatility and correlations depend on the surprise component being positive or negative, we model the evolution of bond returns and the volatility of country *i* as:

$$
\begin{aligned}
r_t^i &= \mu_i + \gamma_i^{+ECB} S_t^{+ECB} + \gamma_i^{-ECB} S_t^{-ECB} + \gamma_i^{+FED} S_{t-1}^{+FED} + \gamma_i^{-FED} S_{t-1}^{-FED} + \rho_i\, r_{t-1}^i + \varepsilon_t^i, \qquad \varepsilon_t^i \,|\, F_{t-1} \sim \mathrm{N}(0, h_t^i) \\
h_t^i &= \omega_i + \delta_i^{+ECB} \left|S_t^{+ECB}\right| + \delta_i^{-ECB} \left|S_t^{-ECB}\right| + \delta_i^{+FED} \left|S_{t-1}^{+FED}\right| + \delta_i^{-FED} \left|S_{t-1}^{-FED}\right| + \\
&\quad \alpha_i\, (\varepsilon_{t-1}^i)^2 + \left(\xi_i^{+ECB} \left|S_t^{+ECB}\right| + \xi_i^{-ECB} \left|S_t^{-ECB}\right| + \xi_i^{+FED} \left|S_{t-1}^{+FED}\right| + \xi_i^{-FED} \left|S_{t-1}^{-FED}\right|\right)(\varepsilon_{t-1}^i)^2 + \beta_i\, h_{t-1}^i
\end{aligned}
\qquad (2)
$$

where r_t^i denotes the excess bond returns of country i, h_t^i denotes the variance of country i and F_{t-1} denotes the information set at time t-1.[9] Return and variance equations in (2) are also estimated for the JP Morgan EMU Government Index as a proxy for the entire euro area (EMU). The FOMC announcements are scheduled to be released at 14:15 EST and so they only affect European markets on the subsequent business day. For this reason, surprise monetary policy announcements issued by the Fed enter the model lagged one period. In the above specification, S_t^{+ECB} and S_{t-1}^{+FED} (S_t^{-ECB} and S_{t-1}^{-FED}) refer to positive (negative) monetary policy surprises in the euro area and the US, respectively. The set of surprises regarding monetary policy news from the ECB and the Federal Reserve enters in the form of dummy variables that take the value of the surprise for those days when an announcement is made and zero otherwise. In line with the financial literature, surprise monetary policy news

[9] The dependent variable in our model is the excess return which is calculated relative to the appropriate 1-month euro-deposit rate quoted in London. Euro-deposit rates are used as a proxy for the risk-free rate due to the lack of a liquid Treasury bill market in some of the countries.

announcements enter the variance equation in absolute value (see Christiansen and Ranaldo, 2007, and Brenner *et al.,* 2009, among others). As standard, equation (2) specifies a first-order autocorrelation model to control for microstructure effects, and gradual convergence to equilibrium of returns and a GARCH(1,1) model to characterize the conditional variance.

The above specification allows for asymmetric effects of surprises on conditional bond returns and volatility. Coefficients γ_i^{+ECB} and γ_i^{+FED} (γ_i^{-ECB} and γ_i^{-FED}) capture the impact on the mean returns of country *i* of positive (negative) surprise announcements made by the ECB and the Federal Reserve, respectively. Similarly, coefficients δ_i^{+ECB} and δ_i^{+FED} (δ_i^{-ECB} and δ_i^{-FED}) proxy for the impact on the conditional mean variance of positive (negative) absolute surprise announcements from the ECB and the Federal Reserve, respectively. Finally, ξ_i^{+ECB} and ξ_i^{+FED} (ξ_i^{-ECB} and ξ_i^{-FED}) capture the impact on the variance persistence of positive (negative) absolute surprise announcements from the ECB and the Federal Reserve, respectively. As Christiansen (2000) points out, one simple and often used metric to measure volatility persistence is the sum of the GARCH parameters. This specification permits differences in persistence on announcement and non-announcement days in that the sum of the GARCH parameters is greater on announcement days by ξ_i^{+ECB} and ξ_i^{+FED} (ξ_i^{-ECB} and ξ_i^{-FED}) for positive (negative) announcement surprises from the ECB and the Federal Reserve, respectively. When the market incorporates the information related to the surprise faster (slower) than other kinds of information, the parameters ξ_i^{+ECB}, ξ_i^{+FED}, ξ_i^{-ECB} and ξ_i^{-FED} are negative (positive).

Finally, to analyze the impact of news announcements on the conditional level of integration between each government's bond market and our proxy for the entire euro area (as measured by correlation), the following exponential smoothing function is used:

$$q_t^{i,EMU} = \left[\lambda_i q_{t-1}^{i,EMU} + (1-\lambda_i)\eta_{t-1}^{i}\eta_{t-1}^{EMU}\right] \left(1+\alpha_i^{+ECB}\left|S_t^{+ECB}\right|+\alpha_i^{-ECB}\left|S_t^{-ECB}\right|+\alpha_i^{+FED}\left|S_{t-1}^{+FED}\right|+\alpha_i^{-FED}\left|S_{t-1}^{-FED}\right|\right) \quad (3)$$

To deal with the problem suggested by Forbes and Rigobon (2002) that shocks to the conditional correlation between asset returns in proximity to certain macroeconomic announcements may be due to shocks to return volatility, we use residuals standardized as follows:

$$\eta_t^i = \frac{\varepsilon_t^i}{\sqrt{h_t^i}} \text{ and } \eta_t^{EMU} = \frac{\varepsilon_t^{EMU}}{\sqrt{h_t^{EMU}}} \quad (4)$$

In equation (3), the coefficients α_i^{+ECB} and α_i^{+FED} (α_i^{-ECB} and α_i^{-FED}) capture the impact on the conditional correlation between any pair of standardized residuals (country *i* and *EMU*) of positive (negative) surprise announcements made by the ECB and the Federal Reserve, respectively.

In order to estimate the model in equations (2) and (3), a conditional normal distribution for the innovation vector is assumed and the quasi-maximum likelihood method is applied. Bollerslev and Wooldridge (1992) show that the standard errors calculated using this method are robust even when the normality assumption is violated.

4. Empirical results

Tables 2, 3 and 4 report the quasi-maximum likelihood estimates resulting from equations (2) and (3). Tables 2 and 3 display the results for the mean and variance equations, respectively; Table 4 does likewise for the correlations. As noted above, we divide our sample of European government bond markets into four groups: (1) EMU EU-15 central bond markets (Austria, Belgium, France, Germany and the Netherlands), (2) EMU EU-15 peripheral (Ireland, Italy, Portugal and Spain), (3) Non-EMU new EU (the Czech Republic, Hungary and Poland), and (4) non-EMU EU-15 (Denmark, Sweden and the UK).

According to Table 2, positive and negative monetary policy surprises from the ECB, when significant, exert a positive influence on index returns across EMU EU-15 central and peripheral bond markets. However, in the case of FOMC policy surprises, only good news has an effect on these bond markets, producing a decrease in returns. This result suggests that a loosening of monetary policy by the Fed means bad news for central and peripheral bond markets due to portfolio rebalancing. In general, there is only a limited effect of ECB and Fed monetary policy surprises on non-EMU new EU bond market returns[10]. Finally, we find no evidence of a relation between non-EMU EU-15 bond returns and FOMC surprises. However, although these countries do not belong to the EMU, in line with the central and peripheral countries, in general, bad and good news announced by the ECB increases the returns of these markets.

[10] It should be borne in mind that these countries continue to implement their own monetary policy.

Turning to the volatility dynamics (Table 3), within EMU EU-15 central bond markets, monetary policy surprises announced by the ECB, regardless of their sign, raise the mean level of volatility of Austria and Belgium. In general, a loosening of monetary policy by the ECB increases the volatility of peripheral EU bond markets and, in the case of Portugal and Italy, a tightening of monetary policy reduces their volatility. Konrad (2009) also reports a heterogeneous response in government bond market volatility to monetary policy surprises issued by the ECB and the Fed in Germany, France and Italy. By contrast, FOMC monetary policy does not have any additional consequences for the mean level of volatility of the central and peripheral bond markets. ECB monetary policy surprises not only exert an influence on the mean level of volatility of central and peripheral bond markets but, in some cases, they also increase its persistence as shown by the significance and the positive sign of coefficients (ξ_i^{+ECB} and ξ_i^{-ECB}). Bad news issued by the Fed also increases the persistence of volatility. This evidence indicates that these bond markets incorporate monetary policy shocks more slowly than other shocks.

Although we do not find many statistically significant effects of monetary policy announcements on non-EMU new EU bond market returns, we do find an impact on their volatility.[11] A surprise associated with the tightening of ECB monetary policy raises the level of volatility of non-EMU new EU bond markets, whereas FOMC monetary policy surprises have a mixed effect. In general, bad news from the ECB and both good and bad news from the Fed reduce the persistence of volatility, indicating that these markets adjust to interest rate shocks more quickly than they do to other shocks. This could be related to the fact that, as mentioned above, these countries enjoy monetary policy flexibility. We observe that both the Fed and the ECB play a role in influencing these emerging bond markets. As pointed out by Gilmore *et al.* (2008)[12], this is somewhat surprising, considering the strong trade links with European Union countries and the decade-long process of alignment of EU-15 new members' economies, political and financial institutions with the European Union.

Once again, we find only weak evidence of a relation between the Fed's news releases and non-EMU EU-15 bond volatility and its persistence. However, the effect of ECB policy surprises on the volatility of these markets is stronger. Positive and negative surprises raise the level of volatility and we find a significant heterogeneity within this group in the response of persistence.

11 Andritzky *et al.* (2006) and Nowak (2009) also find that the effect of macroeconomic surprises on emerging bond markets volatility are more pronounced than those on prices.
12 The authors find that, despite the long process of alignment undergone by new EU-15 countries with the EU, any evidence of a steadily increasing convergence of their equity markets is lacking.

Table 4 shows that the effects of monetary policy shocks announced by the ECB and the Fed on the level of integration of each country with the euro area are more pronounced than those on returns and volatility. We find that the level of integration of EMU EU-15 central and peripheral bond markets with the euro area falls following good and bad news (regardless of its sign) by the ECB.[13] It seems that monetary policy surprises announced by the ECB increase uncertainty in these sovereign bond markets[14]. This uncertainty makes these markets react differently causing the return co-movement between these bond markets and the EMU to become less correlated.[15] The rationale behind these findings is that greater uncertainty increases investors' risk aversion and this in turn results in their restructuring their portfolios.[16]

In general, good news issued by the Fed also increases uncertainty and the reaction of these bond markets is similar to that recorded to ECB surprise announcements. Only a tightening of monetary policy by the Fed appears likely to increase the integration of some countries with the euro area suggesting that linkages are stronger when problems are perceived in the US. Rising rates may induce portfolio shifts from US Treasury bonds to European government bond markets and this would be good news for central and peripheral government bond markets.

The picture is somewhat different for non-EMU new EU members. The correlation weakens after bad news and strengthens after good news from the ECB. This result suggests that an accommodative monetary policy is associated with an increase in the level of integration while a tightening of monetary policy results in a reduction in the level of integration, indicating that these members adhere more closely to the EMU in an economic upturn. The Fed's monetary policy (tightening or loosening) strengthens the correlation of the Czech Republic and Hungary with the euro area, confirming that these markets pay particular attention to news from the US. As Andritzky *et al.* (2006) point out, investors in emerging markets tend to form their views of a country based on composite and, presumably, forward-looking indicators.

13 Brenner *et al.* (2009) also show that conditional return co-movement within US stock markets is most typically decreasing (rather than increasing, as commonly believed) in response to macroeconomic news releases.
14 As it has been pointed out in numerous studies (see Sgherri and Zoli, 2009; Favero *et al.*, 2010; Arghyrou and Kontonikas, 2012; among others) there exists a common risk factor that reflects investors changing attitudes towards risk. Even though it is widely agreed that such a factor of general risk attitude or appetite exists, there is still an ongoing debate on how to measure this factor, and what are the underlying causes of the changes in investors risk aversion. Manganelli and Wolswijk (2009) suggest that the ECB policy rate is the key issue driving the aggregate risk perception.
15 Note that news announcements from the ECB increase the returns of these bond markets, but in some countries the increase follows good news, in others it follows bad news while in others it can come after both good and bad news.
16 The idea that economic uncertainty may be important in understanding return dynamics seems related to the notion of "flight-to-quality". The notion of flight-to-quality suggests that during times of increased uncertainty investors will tend to move towards less risky assets and so the return co-movement between assets becomes less positively correlated (or even negatively correlated).

Finally, as found for central and peripheral bond markets, the integration of non-EMU EU-15 bond markets with the euro area weakens after good and bad news from the ECB (regardless of its sign). However, as found for non-EMU new EU members, when the effect of FOMC decisions is significant, there is an increase in the level of integration of these countries with the euro area. Similar to what is seen for the returns and volatility of these bond markets, our results suggest that, although they do not belong to the EMU, their relation with the euro area is stronger than that with the US. Interestingly, the UK's market is the one that is least affected by monetary policy surprises.

Overall, we find different effects of surprises on bond market returns, volatility and correlation. First, the effects of monetary policy announcements on the level of integration are higher than those on returns and volatility. Second, our results also show differences in the response to monetary policy surprises across groups of countries. Peripheral, central and non-EMU EU-15 bond market returns and volatility are more strongly influenced by ECB monetary policy than by that of the Fed. However, the Fed and the ECB's capacity to impact non-EMU new EU bond market returns and volatility is similar. It seems that their relation with the US is more intense than that of the rest of the bond markets analyzed (old EU members). As for the response of the level of integration, our results paint a complex picture of the effects of monetary policy news announcements. As displayed in Figures 2a to 2d, which show the estimated time-varying correlation of bond markets, our groups of countries can be classified according to two criteria. On the one hand, the evolution of the level of integration allows us to distinguish between old EU members, whose level of integration has sharply decreased over the sample period, and the new EU members, whose level of integration has slightly increased. On the other hand, if we consider the mean level of integration over the sample period, we can distinguish between the EMU members, whose mean levels of integration are high (0.89 and 0.75 for central and peripheral bond markets, respectively), and the non-EMU members, whose mean levels of integration are lower (0.58 and 0.06 for non-EMU EU-15 and non-EMU new EU, respectively). In line with these classifications, our empirical evidence suggests that the effect of ECB monetary policy differs across old and new members of the European Union, while the effect of FOMC monetary policy differs across EMU and non-EMU members.

5. Conclusions

The integration of European government bond markets has been the subject of various recent analyses in the literature given the convergence process that was set in motion with the launch of the EMU and the reversal of financial integration during the sovereign debt market crisis. Our paper contributes to this literature by providing an exhaustive analysis of the impact of *unexpected* monetary policy

announcements made by the ECB and the FOMC not only on European government bond returns but also on volatility and correlation. This analysis allows us to provide a more comprehensive picture of the effect of surprise monetary policy announcements on the behavior of European government bond markets.

Our setting provides interesting insights into the impact of surprise interest rate announcements on European government bond markets. When the effect of news released by the ECB (good and bad) is significant, it leads to an increase in the returns of the EU-15 members' bond markets (central, peripheral and non-EMU countries). However, news released by the Fed has limited impact on non-EMU new EU and no influence on non-EMU EU-15 members, while only good news results in a decrease in the returns of central and peripheral countries.

In the case of volatility, our results likewise show that central, peripheral and non-EMU bond markets are mainly affected by ECB surprise announcements. The effect of news released by the FOMC is less pronounced in these bond markets where only bad news increases the persistence of volatility. Finally, surprise news announcements from both the ECB and the Fed have a significant impact on non-EMU new EU members.

Our estimates reveal some heterogeneity in the effect of macroeconomic news releases on the level of integration of each bond market with the euro area. Interestingly, distinguishing between the respective effects of ECB and Fed monetary policies results in two country groupings depending on the criterion applied. On the one hand, if we consider ECB news announcements, a distinction can be drawn between new and old EU members. News releases from the ECB seem to generate uncertainty and have a destabilizing effect on old members' bond markets, reducing the level of integration of these countries with the EMU. However, the level of integration of the new members increases in response to good news from the ECB. On the other hand, if we consider Fed monetary policy news releases, a distinction can be drawn between EMU and non-EMU members. The level of integration of EMU members' bond markets decreases after good news from the Fed and is likely to increase in response to announcements of bad news. However, the level of integration of non-EMU bond markets increases following news releases from the Fed, regardless of their sign.

Finally, for all three characteristics (returns, volatility and integration), we find that, in general, monetary policy surprises have a similar effect within the groups of countries. Across the groups of countries three results should be stressed. First, central and peripheral bond markets follow a similar pattern in their reaction to ECB and Fed monetary policy. Second, surprisingly, non-EMU EU-15 members are

more strongly influenced by ECB news than they are by Fed news and, third, non-EMU new EU members are more strongly influenced by Fed monetary policy than would have been expected.

These results can help market participants to make effective investment decisions and to formulate appropriate risk management strategies. In a unified bond market, returns, volatilities and the correlations of bonds (at the same maturity) in different countries should respond similarly to the same information. However, our results suggest that diversification opportunities still exist across groups of countries and that European government bond markets are far from becoming close substitutes. Finally, our results can also help central banks in making effective monetary policy decisions.

6. References

Abad, P., Chuliá, H., and M. Gómez-Puig. EMU and European government bond market integration. Journal of Banking and Finance, 2010, 34, 2851–2860.

Abad, P., Chuliá, H., and M. Gómez-Puig. Time-varying integration in European Government Bond Markets. European Financial Management, 2013, forthcoming

Andersson, M., Overby, L. J., and S. Sebestyén. Which News Moves the Euro Area Bond Market?. German Economic Review, 2009, 10(1), 1–31.

Andritzky, J.R., Bannister, G.J. and Tamirisa, N.T. The impact of macroeconomic announcements on emerging market bonds. Emerging Markets Review, 2006, 8(1), 20-37.

Arghyrou, M. G. and Kontonikas, A. The EMU sovereign-debt crisis: Fundamentals, expectations and contagion. Journal of International Financial Markets, Institutions and Money, 2012, 22(4), 658-677.

Balduzzi, P., Elton, E.J. and Green, T.C. Economic news and bond prices: evidence from the US Treasury market. Journal of Financial and Quantitative Analysis, 2001, 36(4), 523–543.

Barr, D.G. and R. Priestley. Expected returns, risk and the integration of international bond markets. Journal of International Money and Finance, 2004, 23, 71–97.

Bernanke, B.S. and Kuttner, K.N. What explains the stock market's reaction to Federal Reserve policy? Journal of Finance, 2005, 60 (3), 1221–1257.

Bernoth, K., and J. Von Hagen. Euribor futures market: efficiency and the impact of ECB policy announcements. International Finance, 2004, 7, 1-24.

Bomfim, A. N. Pre-announcement effects, news effects, and volatility: Monetary policy and the stock market. Journal of Banking & Finance, 2003, 27(1), 133-151.

Bollerslev, T., and Wooldridge, J. M. Quasi-maximum likelihood estimation and inference in dynamic models with time-varying covariances. Econometric reviews, 1992, 11(2), 143-172.

Bredin, D., Hyde, S., Nitzsche, D. and G. O'Reilly. European Monetary Policy Surprises: The aggregate and sectoral stock market response. International Journal of Finance and Economics, 2007, 14(2), 156-171.

Brenner, M., Pasquariello, P. and Subrahmanyam, M. On the volatility and comovement of US financial markets around macroeconomic news announcements. Journal of Financial and Quantitative Analysis, 2009, 44(6), 1265.

Christiansen, C. Macroeconomic announcement effects on the covariance structure of government bond returns. Journal of Empirical Finance, 2000, 7, 479–507.

Christiansen, C., "Volatility-spillover effects in European bond markets", European Financial Mangement, Vol. 13(5), 2007, pp. 923-948. -

Christiansen, C., and A. Ranaldo. Realized Bond-Stock Correlation: Macroeconomic Announcement Effects. Journal of Futures Markets, 2007, 27(5), 439-469.

Christie-David, R., Chaudhry, M. and Khan, W. News releases, market integration, and market leadership. Journal of Financial Research, 2002, 25(2), 223-245.

Engle, R. Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models. Journal of Business & Economic Statistics, 2002, 20(3), 339-350.

Favero, C. A., Pagano, M., and von Thadden, E. L. How Does Liquidity Affect Government Bond Yields?" Journal of Financial and Quantitative Analysis, 2010, 45, 107-134.

Fleming, M.J., Piazzesi, M., 2005. Monetary policy tick-by-tick. Working Paper, Federal Reserve Bank of New York.

Fleming, M.J., Remolona, E.M. Price Formation and Liquidity in the U.S. Treasury Market: The Response to Public Information. Journal of Finance, 1999a, 54(5), 1901-15.

Fleming, M.J., Remolona, E.M. The Term Structure of Announcement Effects. Staff report, 1999b, Federal Reserve Bank of New York.

Forbes, K. J., and Rigobon, R. No contagion, only interdependence: measuring stock market comovements. The Journal of Finance, 2002, 57(5), 2223-2261.

Geyer, A., Kossmeier, S., and S. Pichler. Measuring systematic risk in EMU government yield spreads, Review of Finance, 2004, 8, 171–197.

Gilmore, C. G., Lucey, B. M. and McManus, G. M. The dynamics of Central European equity market comovements. The Quarterly Review of Economics and Finance, 2008, 48(3), 605-622.

Goeij, P. and Marquering, W. Macroeconomic announcements and asymmetric volatility in bond returns. Journal of Banking & Finance, 2006, 30(10), 2659-2680.

Gómez-Puig, M. The immediate effect of monetary union over EU-15's sovereign debt yield spreads. Applied Economics, 2009a, 41, 929–939.

Gómez-Puig, M. Systemic and idiosyncratic risk in EU-15 sovereign yield spreads after seven years of Monetary Union. European Financial Management, 2009b, 15, 971–1000.

Hardouvelis, G.A., Malliaropulos, D., and R. Priestley. EMU and European stock market integration. Journal of Business, 2006, 79, 365–392.

Hardouvelis, G.A., Malliaropulos, D., and R. Priestley. The impact of EMU on the equity cost of capital. Journal of International Money and Finance, 2007, 26, 305–327.

Konrad, E. The impact of monetary policy surprises on asset return volatility: the case of Germany. Financial Markets and Portfolio Management, 2009, 23-2, 111-135.

Kuttner, K. Monetary policy surprises and interest rates: evidence from the fed funds futures market. Journal of Monetary Economics, 2001, 47, 523-544.

Jones, C.M., Lamont, O., and R.L. Lumsdaine. Macroeconomic news and bond market volatility. Journal of Financial Economics, 1998, 47, 315–337.

Manganelli, S. and Wolswijk, G. What drives spreads in the euro area government bond market?. Economic Policy, 2009, 24, 191–240.

Nowak, S., Andritzky, J., Jobst, A. and Tamirisa, N. Macroeconomic fundamentals, price discovery, and volatility dynamics in emerging bond markets. Journal of Banking & Finance, 2011, 35(10), 2584-2597.

Pagano, M., and E.L. von Thadden. The European bond markets under EMU, Oxford Review of Economic Policy, 2004, 20, 531–554.

Sgherri, S., and Zoli, E. Euro area sovereign risk during the crisis. IMF Working Papers, 2009, 222, 1-23.

7. Tables

Table 1. Descriptive statistics for monetary policy surprises

	ECB	Fed
All surprises		
N	114	76
Mean	0.031	0.328
Standard deviation	0.042	0.597
Positive surprises		
N	51	34
Mean	0.030	0.486
Standard deviation	0.031	0.747
Negative surprises		
N	49	30
Mean	-0.032	-0.150
Standard deviation	0.035	0.225
Zero surprises		
N	14	12

Note: N refers to the number of surprises. In the case of all surprises, the mean is calculated from the absolute value of surprises.

Table 2. DCC model estimates for excess bond returns: Effects of surprises on returns

	μ_i	ρ_i	γ_i^{+ECB}	γ_i^{-ECB}	γ_i^{+FED}	γ_i^{-FED}
EMU	0.000[b]	0.073[a]	0.249	0.524[b]	0.250[c]	-0.497
	(0.028)	(0.001)	(0.247)	(0.031)	(0.063)	(0.109)
Panel a) EMU EU-15 Central						
Austria	0.000[b]	0.080[a]	0.301[c]	0.493[b]	0.153	-0.419[c]
	(0.015)	(0.000)	(0.062)	(0.041)	(0.215)	(0.088)
Belgium	0.000[c]	0.119[a]	0.200	0.435	0.185	-0.475[c]
	(0.054)	(0.000)	(0.293)	(0.105)	(0.130)	(0.071)
France	0.000[c]	0.084[a]	0.322[c]	0.460[c]	0.185	-0.523[c]
	(0.086)	(0.000)	(0.077)	(0.088)	(0.120)	(0.060)
Germany	0.000[c]	0.060[a]	0.208	0.583[b]	0.121	-0.612
	(0.078)	(0.005)	(0.277)	(0.018)	(0.293)	(0.112)
Netherlands	0.000[b]	0.065[a]	0.281	0.597[b]	0.189	-0.644[b]
	(0.041)	(0.003)	(0.106)	(0.012)	(0.138)	(0.035)
Panel b) EMU EU-15 Peripheral						
Ireland	0.000[b]	0.094[a]	0.254[a]	0.342	0.038	-0.152
	(0.043)	(0.000)	(0.009)	(0.272)	(0.726)	(0.518)
Italy	0.000[c]	0.086[a]	0.244[c]	0.432[a]	0.243[b]	-0.471[c]
	(0.090)	(0.000)	(0.058)	(0.006)	(0.047)	(0.058)
Portugal	0.000	0.077[a]	0.341[b]	0.384	0.157	-0.238
	(0.368)	(0.000)	(0.016)	(0.119)	(0.121)	(0.351)
Spain	0.000	0.116[a]	0.174	0.277	0.150	-0.555[c]
	(0.379)	(0.000)	(0.278)	(0.182)	(0.168)	(0.057)
Panel c) non-EMU new EU						
Czech Republic	0.000[b]	0.103[a]	-0.036	0.200	-0.203[b]	0.126
	(0.033)	(0.000)	(0.898)	(0.430)	(0.015)	(0.763)
Hungary	0.000	0.099[a]	-0.149	0.399	0.325[b]	-0.952[b]
	(0.120)	(0.000)	(0.791)	(0.362)	(0.013)	(0.033)
Poland	0.000[a]	0.066[a]	0.233	0.592[a]	0.073	0.480
	(0.002)	(0.004)	(0.496)	(0.006)	(0.427)	(0.419)
Panel d) non-EMU EU-15						
Denmark	0.000	0.049[b]	0.242	0.520[a]	0.041	-0.399
	(0.114)	(0.026)	(0.118)	(0.009)	(0.569)	(0.135)
Sweden	0.000	0.034	0.478[a]	0.327	0.157	-0.013
	(0.148)	(0.105)	(0.006)	(0.191)	(0.211)	(0.952)
UK	0.000	0.052[b]	0.602[b]	0.705[a]	-0.092	-0.353
	(0.981)	(0.015)	(0.023)	(0.002)	(0.516)	(0.410)

Note: [a], [b] and [c] indicates significance at the 1%, 5%, and 10% levels, respectively. Numbers in brackets are p-values. Coefficients γ_i^{+EA}, γ_i^{-EA}, γ_i^{+US} and γ_i^{-US} have been multiplied by 1,000.

Table 3. DCC model estimates for excess bond returns: Effects of surprises on variance

	ω_i	α_i	β_i	δ_i^{+ECB}	δ_i^{-ECB}	δ_i^{+FED}	δ_i^{-FED}	ξ_i^{+ECB}	ξ_i^{-ECB}	ξ_i^{+FED}	ξ_i^{-FED}
EMU	0.000[a]	0.109[a]	0.775[a]	0.002[a]	0.002b	0.001	0.000	0.046	0.011	0.051[a]	-0.007
	(0.000)	(0.000)	(0.000)	(0.000)	(0.024)	(0.546)	(0.901)	(0.176)	(0.649)	(0.003)	(0.846)
Panel a) EMU EU-15 Central											
Austria	0.000[a]	0.105[a]	0.821[a]	0.085[c]	0.158[c]	0.039	-0.050	0.062[c]	0.015	0.036[b]	-0.011
	(0.000)	(0.000)	(0.000)	(0.096)	(0.070)	(0.526)	(0.626)	(0.059)	(0.517)	(0.025)	(0.631)
Belgium	0.000[a]	0.136[a]	0.798[a]	0.192[a]	0.274b	0.016	-0.042	0.025	-0.006	0.042[b]	-0.018
	(0.000)	(0.000)	(0.000)	(0.002)	(0.022)	(0.851)	(0.740)	(0.435)	(0.776)	(0.011)	(0.378)
France	0.000[a]	0.105[a]	0.827[a]	0.052	0.137	-0.014	-0.059	0.064[b]	0.025	0.053[a]	-0.009
	(0.000)	(0.000)	(0.000)	(0.459)	(0.166)	(0.868)	(0.625)	(0.034)	(0.234)	(0.004)	(0.737)
Germany	0.000[a]	0.062[a]	0.910[a]	-0.019	0.076	0.044	-0.023	0.032	0.015	0.003	0.002
	(0.000)	(0.000)	(0.000)	(0.823)	(0.418)	(0.598)	(0.776)	(0.155)	(0.178)	(0.900)	(0.943)
Netherlands	0.000[a]	0.118[a]	0.811[a]	0.061	0.088	0.010	-0.096	0.035	0.026	0.050[a]	0.001
	(0.000)	(0.000)	(0.000)	(0.432)	(0.418)	(0.918)	(0.426)	(0.205)	(0.234)	(0.009)	(0.984)
Panel b) EMU EU-15 Peripheral											
Ireland	0.000[a]	0.171[a]	0.808[a]	0.006	0.268[a]	0.044	0.036	-0.021	0.094[a]	-0.004	-0.036[a]
	(0.000)	(0.000)	(0.000)	(0.913)	(0.002)	(0.390)	(0.723)	(0.419)	(0.000)	(0.770)	(0.007)
Italy	0.000[a]	0.164[a]	0.786[a]	-0.097[b]	0.391[a]	0.052	-0.040	0.102[a]	-0.033	0.033[b]	-0.014
	(0.000)	(0.000)	(0.000)	(0.039)	(0.000)	(0.492)	(0.762)	(0.006)	(0.170)	(0.026)	(0.681)
Portugal	0.000[a]	0.104[a]	0.852[a]	-0.186[a]	-0.050	-0.071	-0.063	0.235[a]	0.042[b]	0.030[b]	-0.022
	(0.000)	(0.000)	(0.000)	(0.009)	(0.529)	(0.406)	(0.678)	(0.000)	(0.017)	(0.046)	(0.206)
Spain	0.000[a]	0.131[a]	0.852[a]	-0.061	0.343[a]	-0.036	-0.097	0.060[b]	-0.015	0.051[b]	-0.013
	(0.000)	(0.000)	(0.000)	(0.424)	(0.000)	(0.694)	(0.330)	(0.036)	(0.200)	(0.025)	(0.554)
Panel c) non-EMU new EU											
Czech Republic	0.000[a]	0.097[a]	0.890[a]	1.072[a]	-0.010	-0.059[c]	-0.245[a]	-0.099[a]	-0.009	-0.012[a]	0.015
	(0.000)	(0.000)	(0.000)	(0.000)	(0.842)	(0.050)	(0.000)	(0.000)	(0.199)	(0.004)	(0.819)
Hungary	0.000[a]	0.138[a]	0.837[a]	1.293[a]	0.476	-0.066	0.769[c]	-0.030b	0.017	-0.006	-0.143[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.186)	(0.702)	(0.083)	(0.037)	(0.435)	(0.639)	(0.000)
Poland	0.000[a]	0.150[a]	0.830[a]	0.270[c]	-0.077	-0.037	0.252	-0.021[c]	0.023	-0.022[a]	-0.036
	(0.000)	(0.000)	(0.000)	(0.075)	(0.431)	(0.557)	(0.490)	(0.058)	(0.120)	(0.000)	(0.331)
Panel d) non-EMU EU-15											
Denmark	0.000[a]	0.120[a]	0.866[a]	0.103[c]	0.141[c]	0.041	-0.038	0.002	-0.005	-0.019	-0.008
	(0.000)	(0.000)	(0.000)	(0.080)	(0.096)	(0.461)	(0.613)	(0.917)	(0.675)	(0.110)	(0.788)
Sweden	0.000[a]	0.102[a]	0.877[a]	-0.075	0.351[a]	-0.052	-0.004	0.051[a]	-0.029[b]	0.040b	-0.002
	(0.000)	(0.000)	(0.000)	(0.290)	(0.000)	(0.290)	(0.977)	(0.003)	(0.015)	(0.029)	(0.939)
UK	0.000[a]	0.102[a]	0.868[a]	0.292[b]	0.026	0.091	0.149	-0.028[b]	0.070[a]	-0.008	-0.056[c]
	(0.000)	(0.000)	(0.000)	(0.020)	(0.844)	(0.329)	(0.341)	(0.027)	(0.004)	(0.134)	(0.051)

Note: [a], [b] and [c] indicates significance at the 1%, 5%, and 10% levels, respectively. Numbers in brackets are p-values. Coefficients δ_i^{+EA}, δ_i^{-EA}, δ_i^{+US} and δ_i^{-US} have been multiplied by 100,000.

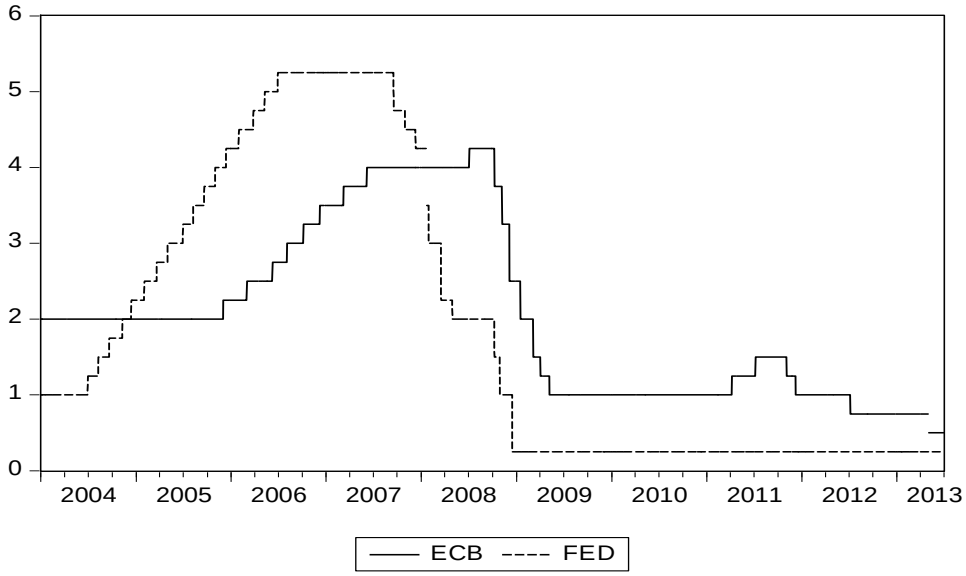
Table 4. DCC model estimates for excess bond returns: Effects of surprises on correlation

	λ_i	α_i^{+ECB}	α_i^{-ECB}	α_i^{+FED}	α_i^{-FED}
Panel a) EMU EU-15 Central					
Austria	0.945[a]	-0.062[a]	-0.041[b]	0.018	-0.108[a]
	(0.000)	(0.000)	(0.016)	(0.345)	(0.000)
Belgium	0.980[a]	-0.033[a]	-0.025[a]	-0.042[a]	-0.104[a]
	(0.000)	(0.001)	(0.003)	(0.000)	(0.000)
France	0.983[a]	-0.068[a]	-0.058[a]	0.095[a]	0.300[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Germany	0.936[a]	-0.055[a]	-0.056[a]	0.132[b]	-0.117[a]
	(0.000)	(0.000)	(0.000)	(0.035)	(0.000)
Netherlands	0.967[a]	-0.068[a]	-0.040[b]	0.157[c]	-0.114[a]
	(0.000)	(0.000)	(0.015)	(0.057)	(0.000)
Panel b) EMU EU-15 Peripheral					
Ireland	0.942[a]	-0.065[a]	-0.057[a]	0.262[a]	3.323[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Italy	0.939[a]	-0.025	-0.042[a]	0.124[a]	-0.115[a]
	(0.000)	(0.109)	(0.002)	(0.005)	(0.000)
Portugal	0.967[a]	-0.048[a]	-0.029[c]	-0.035[a]	-0.041
	(0.000)	(0.000)	(0.070)	(0.000)	(0.417)
Spain	0.979[a]	-0.068[a]	-0.054[a]	0.216[a]	-0.088[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Panel c) non-EMU new EU					
Czech Republic	0.945[a]	-0.067[a]	0.747[a]	0.304[a]	1.344[b]
	(0.000)	(0.000)	(0.000)	(0.003)	(0.012)
Hungary	0.970[a]	-0.072[a]	0.339[a]	0.226[a]	3.056[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Poland	0.979[a]	-0.039[b]	0.038	0.033	0.021
	(0.000)	(0.021)	(0.454)	(0.352)	(0.861)
Panel d) non-EMU EU-15					
Denmark	0.913[a]	-0.069[a]	-0.041[a]	0.794[a]	0.075
	(0.000)	(0.000)	(0.000)	(0.000)	(0.445)
Sweden	0.965[a]	-0.067[a]	-0.058[a]	2.687[a]	0.648[c]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.053)
UK	0.979[a]	-0.062[a]	0.071	0.062	-0.050
	(0.000)	(0.000)	(0.111)	(0.251)	(0.497)

Note: [a], [b] and [c] indicates significance at the 1%, 5%, and 10% levels, respectively. Numbers in brackets are p-values.

8. Figures

Figure 1. Evolution of monetary policy rates (January 2004-June 2013)



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