

News Releases, Credit Rating Announcements, and Anti-Crisis Measures as Determinants of Sovereign Bond Spreads in the Peripheral Euro-Area Countries*

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Abstract

This paper aims to contribute to the understanding of the determinants of the sovereign bond yields of the peripheral euro-area countries in recent years. We consider news releases, credit rating announcements, and anti-crisis measures undertaken by the ECB, for the EU/euro area as a whole as well as at the level of individual countries, as potential determinants. Our study is based on the daily sovereign bond spreads (with regard to German bunds) of Greece, Ireland, Italy, Portugal, and Spain in the years 2010–2016. We use the VARX-GARCH-BEKK model. Our results suggest that the spreads were most strongly influenced by the ECB's measures and bailout programs, while the initiatives undertaken at the EU/euro area level played a less significant role. Rating changes proved to be significant, but some discrepancies with the results of previous studies occurred. Different sets of news variables were received for each country. Nonetheless, similarities were also identified.

1. Introduction

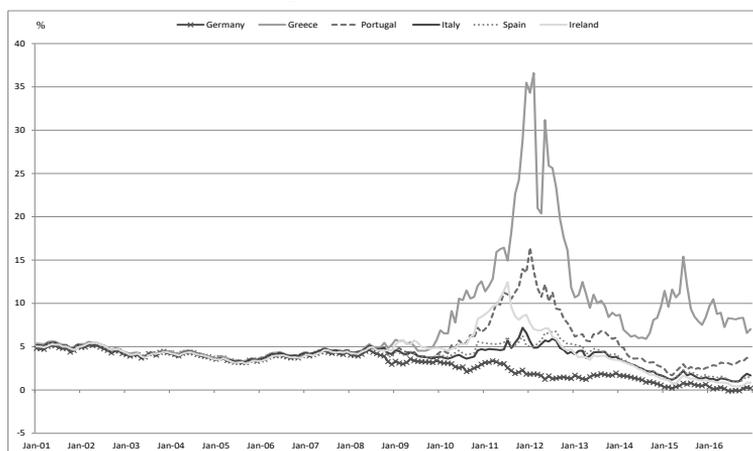
In the second half of 2009, when the global economic recovery gained momentum (in the third quarter of 2009, most countries recorded positive GDP growth), it seemed that the period of the most intense tensions associated with the global economic and financial crisis, initiated by the collapse of Lehman Brothers in September 2008, had ended. However, the sense of calm in the financial markets proved to be short-lived. At the turn of 2009/2010, the epicenter of the crisis moved from the United States to the euro area, where it took on the form of a debt crisis for some of its members. This was reflected in the fiscal instability of the so-called GIIPS countries, i.e., Greece, Ireland, Italy, Portugal, and Spain. In the years 2009–2013, those countries saw a sharp increase in the central and local government debt-to-GDP ratio. (In 2013, only in the case of Spain, the ratio was less than twice the reference

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value for the criterion of debt, which amounts to 60%.)¹ In the situation of fiscal instability, the sovereign bond yields of GIIPS economies rose significantly, reaching their highest levels since the launch of the euro. Most of the analyzed countries lost access to international financial markets. The sustained decline in the yields occurred only after the announcement by the European Central Bank (ECB) of the Outright Monetary Transactions (OMT) program, allowing unlimited purchases on the secondary market of short-term sovereign bonds, which took place in July 2012. At the end of 2014, there was a renewed increase in the market tensions of Greek government bonds, which, however, did not move to the bond markets of other peripheral euro-area countries. In the years 2015–2016—apart from the isolated case of Greece—the situation of the sovereign bond market in the analyzed group of countries seemed to be calm (see Figure 1).

Figure 1 Monthly 10-Year Sovereign Yields: 2001-2016



Source: Thomson Reuters Eikon.

Therefore, the question about the factors determining the evolution of sovereign bond yields in the euro area has become a key one. The extensive literature on the subject distinguishes three main lines of research.

First, some authors concentrate on the role of fundamental and non-fundamental factors in explaining the spreads in the two sub-periods—before the crisis and after its beginning. The results of many of these studies indicate that in the pre-crisis period, investors largely ignored the country-specific factors when pricing euro-area sovereign bonds. The importance of macroeconomic indicators changed considerably during the crisis. Market discipline became much stronger, and, as a consequence, the countries with worse fiscal fundamentals and external positions saw large increases in the differences in bond yields with regard to Germany (see, for example, Aßmann and Boysen-Hogrefe, 2012; Bernoth and Erdogan, 2012; Bernoth et al., 2012; Oliveira et al., 2012; Favero, 2013). Moreover, Beirne and Fratzscher

¹ In most of the countries in the analyzed group, the ratio of general government debt to GDP started to decrease in the subsequent quarters of 2014.

(2013) and Giordano et al. (2013) provide evidence for a “wake-up call” contagion, i.e., an increased market sensitivity to the fundamentals of other euro-area countries. This phenomenon was particularly strong in the group of GIIPS economies. Costantini et al. (2014) argue that market reaction to fiscal loosening was particularly pronounced in these euro-area economies that exhibited significant competitiveness gaps. In contrast to the above-discussed studies, De Grauwe and Ji (2013) show that a large part of the increase in the spreads of the peripheral euro-area countries at the height of the crisis was disconnected from their deteriorating fundamentals, fiscal condition in particular, and was due to time-dependent and self-fulfilling negative sentiment.

The second body of research concerns the sensitivity of the yields of the crisis-affected countries to macroeconomic and political news as well as credit rating announcements. Beetsma et al. (2013) find that since the outbreak of the Greek crisis, spreads for a given country in the GIIPS group grew concurrent with an increase in the number of news releases about that country. In addition, news releases related to a given country in the GIIPS group had an impact on the evolution of spreads in other peripheral euro-area countries, and the scale of this dependency was determined by the intensity of the links between their banking sectors. A similar study carried out by Beetsma et al. (2017) shows that an increase in news about the crisis in the euro area and the countries affected tended to raise variability in sovereign bond yields, and the covariance between them grew.

Afonso et al. (2012) find that announcements of change in the rating and its outlook had a significant impact on spreads. At the same time, this relationship emerged more clearly in the case of negative decisions, whereas the reaction of spreads to positive decisions was limited. The authors also identify spillover effects, particularly from lower-rated countries to higher-rated ones. In the work of De Santis (2014), flight to liquidity benefitting the German bund was identified. Furthermore, the study provides evidence for a spillover effect from Greece. This phenomenon contributed to the evolution of spreads, especially in the countries with weaker fiscal fundamentals, a higher need for foreign financing, and a lower level of competitiveness.

Third, a great deal of attention is devoted to the impact of the anti-crisis policy implemented by the institutions of the European Union (EU) during the euro-area sovereign debt crisis, with particular focus on the ECB’s measures. For example, Gödl and Kleinert (2016) find no significant impact of the announcements about aid schemes and austerity measures on the evolution of spreads in the peripheral euro-area countries. By contrast, Kilponen et al. (2015) point out that the announcements of financial assistance programs contributed to the reduction of the spreads in the countries receiving funding.

When it comes to the anti-crisis measures undertaken by the ECB, a large number of studies provide evidence that the announcements of the Securities Markets Programme (SMP) and the OMT played a key role in reducing the spreads in the peripheral euro-area countries (see, for example, Altavilla et al., 2014; Falagiarda and Reitz, 2015; Kilponen et al., 2015). For Italy and Spain, Dewachter et al. (2016) find that longer-term refinancing operations (LTROs) were also effective in lowering the yields. Afonso and Jalles (2019) highlight the relevance of the first covered bond purchase program (CBPP1), followed by the SMP and LTROs (for similar findings, see Afonso and Kazemi (2018)).

The results of a number of studies indicate that the ECB's OMT announcement turned out to be a game-changer for the evolution of the euro-area crisis. De Grauwe and Ji (2014) find that a strong decline in the spreads in the post-OMT period was totally dissociated from market fundamentals and was mainly driven by positive market sentiment related to the announcement of the OMT. The authors interpret this result as justification for the ECB to perform the role of a lender of last resort in the government bond markets; otherwise, the euro area will remain vulnerable to self-fulfilling liquidity crises fuelled by investors' fear and panic. This so-called "fragility hypothesis" was later supported in the studies of Saka et al. (2015) as well as Grabowski and Stawasz (2017). Ehrmann and Fratzscher (2017) find evidence that flight to quality, which was observed in the euro area at the height of the crisis, largely disappeared after the announcement of the OMT. Boysen-Hogrefe (2017) argues that since the announcement of the OMT, financial markets have paid less attention to the debt-to-GDP ratio when pricing euro-area sovereign bonds. At the same time, they have become more sensitive to countries' abilities to cope with economic crises and their willingness to cooperate with the institutions responsible for adjustment programmes and rescue funds. Afonso et al. (2018) identify a new bond-pricing regime following the announcement of the OMT (weakened relation between spreads and fundamentals, higher spreads, and higher redenomination risk in comparison to pre-crisis levels). By contrast, De Haan et al. (2014) argue that the continued decline in the spreads since the second half of 2012 cannot be ascribed to the OMT alone. Other unobservable factors such as the implicit decision to avoid Grexit or the establishment of the banking union must have played a role.

Finally, some authors concentrate on the role of the expanded asset purchase program (APP) in determining the spreads. De Santis (2016) provides evidence that the euro-area long-term sovereign bond yields were under the substantial influence of the APP, despite the fact that the program was launched during a period of relative stability. The most vulnerable countries saw the largest reductions in spreads. The study of Georgiadis and Gräß (2016) shows that the APP-related announcements contributed to a decline in euro-area sovereign bond yields, which was driven by the portfolio-rebalancing channel.

For an interested reader, the assumptions of the papers discussed here (sample period, countries considered, explanatory variables, methodology) are presented in detail in Appendix A. Needless to say, some of the studies could be included in more than one group.

Although the above-mentioned literature devoted to the issue of determinants of sovereign bond yields during the euro-area sovereign debt crisis is very extensive, to the best of our knowledge, there are no analyses that combine these three approaches. Thus, a gap has been identified, which this study tries to fill.

The aim of this study is to identify the determinants of sovereign bond spreads (with regard to German bunds) of five euro-area peripheral countries, i.e., Greece, Ireland, Italy, Portugal, and Spain. The study includes daily data for the years 2010–2016. The set of explanatory variables includes the following:

News releases acquired from the Eurointelligence database.

Decisions of the three main credit rating agencies (Standard & Poor's, Moody's, and Fitch).

Anti-crisis measures undertaken by the ECB, the EU/euro area as a whole, and individual countries in the analyzed group in cooperation with international creditors.

Control variables.

Second, we contribute to the existing literature by proposing a more detailed breakdown of news releases than the ones from the second line of research as presented above. On the basis of the analysis of all the news releases acquired from the 2010–2016 Eurointelligence database, we create thematic variables. Then we assign individual news releases to previously designated groups. In addition, we introduce the category of news releases concerning austerity measures, which to the best of our knowledge were only cursorily (e.g., as a subcategory of the general category of bad news) considered before. We see that a large portion of news releases from the years 2010–2016 dealt with the policy of cuts in public spending undertaken by euro-area countries and its socioeconomic effects.

Third, in the research dedicated to the impact of anti-crisis measures on the situation in the sovereign bond market, three programs for purchasing assets announced (OMT) and implemented by the ECB (SMP, quantitative easing) were primarily taken into consideration. Relatively little attention was paid to the initiatives undertaken at the level of the EU/euro area, such as the creation of two stability funds—the European Financial Stability Facility (EFSF) and the European Stability Mechanism (ESM)—and augmentation of their lending capacity, as well as the implementation of legal acts aimed at improving the fiscal discipline within the euro area or the EU as a whole (Six-Pack, Fiscal Compact, Two-Pack). In addition, a variable reflecting the key milestones related to the banking union, an initiative whose declared goal was to break the negative feedback loops between the condition of the banking sector and the situation of the public finance sector of the euro-area countries, is introduced.

The structure of the paper is as follows. The second section describes the data used in the study. The third section presents the methodology used, while the fourth section describes the results of the estimation of the parameters of the asymmetric VARX-GARCH-BEKK model. The fifth section provides a summary.

2. Variables Used in the Empirical Study

The study is conducted for GIIPS economies, and the sample period runs from January 2010 until December 2016. The dependent variable is the daily change in the spread between the 10-year sovereign bond yields of individual euro-area countries and the yields of the corresponding German sovereign bonds. The data on the yields is obtained from Thomson Reuters Eikon.

The set of explanatory variables consists of four main categories:

1. News releases.
2. Credit rating announcements.
3. Anti-crisis measures undertaken by the ECB, the EU/euro area as a whole, and individual countries in the analyzed group in cooperation with international creditors.
4. Control variables.

Below, the names and the definitions of variables constituting each category will be presented in detail.

2.1 News Releases

The study uses news releases acquired from the Eurointelligence database. Its selection was dictated by two main characteristics. First, this database is focused on events in the euro area, including political, financial, and economic developments. Second, the Eurointelligence database, in addition to its own analyses, comprises the most important information presented in the European and international press. This was of particular importance for our study, which is conducted for Greece, Ireland, Italy, Portugal, and Spain. The database allowed access to detailed information about these countries.

The process of selection and classification of news was conducted in the following stages:

1. First reading of all news releases from the period January 2010–December 2016.
2. Creation of a list of explanatory variables based on the news topics observed at the first stage and their intensity in the successive years.
3. Second reading of all news releases followed by selection and assignment to designated categories. The following types of releases were rejected:
 - News related to political events, as our research focus is on economic and financial developments in the euro area;
 - Communications that reflect opinion or interpretation rather than an objective statement of fact;
 - News that could not be definitively considered positive or negative (e.g., the news of April 20, 2012 that stated, “Spanish and French bond auctions went well, but at a larger cost”).

The principle was applied that one news item corresponds to at most one zero-one variable. In the case of news releases covering several threads, the one that best corresponded with the title of the news release was chosen. Altogether, 2,368 news releases are used in the empirical research.

The process of selection and classification of news releases described above yielded three main categories:

- News reflecting the macroeconomic conditions of the analyzed economies.
- News related to the policy of austerity implemented in the analyzed group of countries.
- News related to the social situation in the analyzed economies.
- These were then subjected to further division. The definitions of variables created in this way are shown in Table 1.

All of the variables based on macroeconomic news were divided into two categories: those that relate either to the euro area as a whole and those that relate to one of the analyzed countries. This division is introduced through subscripts GEN, EL, IE, IT, PT, and ES, which stand for euro area, Greece, Ireland, Italy, Portugal, and Spain respectively. Next, most of the variables were divided into positive or negative ones (marked by POS and NEG superscripts). In the case of Inflation, the division ran along the increase-decrease line (marked by UP and DOWN superscripts). In this way, for example, the variable GDP^{NEG}_{EL} adopts a value of 1 on days when unfavorable news regarding Greek GDP growth rate were released and 0 otherwise. Variables

based on news related to austerity policy and news related to social situation occur only in the variant with the individual countries in the analyzed group.

Table 1 Definitions of Binary Variables Based on News Releases

<i>Macroeconomic news</i>			
<i>Variable</i>	<i>Definition</i>	<i>Variable</i>	<i>Definition</i>
GDP	1 on the day of news release concerning GDP growth rate	<i>FGDP</i>	1 on the day of news release concerning forecast of GDP growth
Finpub	1 on the day of news release concerning the situation in the public finance sector	<i>Inflation</i>	1 on the day of news release concerning inflation processes
Labor	1 on the day of news release concerning the situation in the labor market	<i>Real</i>	1 on the day of news release concerning the situation in the sector of nonfinancial enterprises
Banking	1 on the day of news release concerning the situation in the banking sector	<i>Bond auction</i>	1 on the day of news release concerning bond auctions
Capital inflow/ Capital outflow	1 on the day of news release concerning inflow/outflow of capital	<i>CA</i>	1 on the day of news release concerning external equilibrium measured with the use of the current account balance
Compete	1 on the day of news release concerning economic competitiveness	<i>Sentiment</i>	1 on the day of news release concerning economic sentiment
<i>News related to austerity policy</i>			
<i>Variable</i>	<i>Definition</i>	<i>Variable</i>	<i>Definition</i>
Austerity	1 in the case of official announcements of the intention to take further steps in the area of austerity measures or when legal acts enforcing the said austerity policy were adopted	<i>Pressure</i>	1 in the case of pressure exerted by international creditors on a country covered by a bailout program in order to force it to increase efforts to implement the policy of austerity
Protest	1 in the case of the occurrence of mass protests against austerity measures	<i>Tension</i>	1 in the case of tension between national authorities and international creditors with regard to the further direction of reforms
On track	1 in the case of proper implementation of reforms in accordance with the economic adjustment program	<i>Behind schedule</i>	1 in the case of implementation of reforms not in accordance with the economic adjustment program
Bailout expectations	1 in the case of expressed expectations that a given country will need to apply for (more) financial assistance	<i>Anti-austerity</i>	1 when a given country has taken action to reverse the implemented austerity measures
<i>News related to social situation</i>			
<i>Variable</i>	<i>Definition</i>	<i>Variable</i>	<i>Definition</i>
Corruption	1 on the day of news release concerning increased corruption	<i>Social</i>	1 on the day of news release concerning deteriorating living conditions

Source: Author's own compilation.

Finally, a separate category of variables containing key words was created. Using this approach, we followed the study of De Santis (2016), who assessed the impact of the ECB's APP on sovereign bond yields of 10 countries in the euro area based on the intensity of news releases containing such words and their combinations

as quantitative easing, Draghi, or the euro area. The variables included in our study are presented in Table 2.

Table 2 Variables Containing Key Words

<i>Variable</i>	<i>Definition</i>	<i>Variable</i>	<i>Definition</i>
<i>Crisis</i>	1 when the title of the news item contains such words/phrases as <i>crisis</i> , <i>breakup of the euro</i> , <i>euro area disintegration</i> , etc.	<i>Crisis over</i>	1 when the title of the news item contains such words/phrases as <i>crisis over</i> or <i>normality returns</i>
<i>Grexit</i>	1 when the title of the news item contains the word <i>Grexit</i>	<i>Debt relief</i>	1 when the title of the news item contains such words/phrases as <i>debt relief</i> or <i>debt restructuring</i>
<i>Default</i>	1 when the title of the news item contains the word <i>default</i>		

Source: Author's own compilation.

The Crisis, Crisis over, and Default variables occur either in the euro-area variant or in the variant with the individual countries in the analyzed group. The other two variables relate to the specific Greek context.

Examples of the news items included in the specified four news categories are presented in Appendix B.

2.2 Credit Rating Announcements

The study also takes into account the decisions of three main credit rating agencies, i.e., Standard & Poor's, Moody's, and Fitch, to upgrade or downgrade credit ratings of GIIPS countries. (Changes in outlooks are not considered.) All credit rating announcements were obtained from Thomson Reuters Eikon.

For each country, two binary variables are constructed, $Rating^{UP}$ and $Rating^{DOWN}$, which adopt a value of 1 on the days of credit rating announcement of upgrade and downgrade, respectively. At the same time, the scale of rating changes is not accounted for. Thus, the following 0-1 variables were created: $Rating^{UP}_{EL}$, $Rating^{UP}_{IE}$, $Rating^{UP}_{IT}$, $Rating^{UP}_{PT}$, $Rating^{UP}_{ES}$, $Rating^{DOWN}_{EL}$, $Rating^{DOWN}_{IE}$, $Rating^{DOWN}_{IT}$, $Rating^{DOWN}_{PT}$, and $Rating^{DOWN}_{ES}$.

2.3 Anti-Crisis Measures

This category encompasses binary variables based on the following anti-crisis measures introduced in the period January 2010–December 2016.

1. ECB measures, including interest rate policy and nonstandard measures (cf. Table 3)
 2. Actions taken at the level of the euro area/EU
 - a) European stability funds—EFSF and ESM (cf. Table 4)
 - b) A package of legal acts—Six-Pack, Fiscal Compact, Two-Pack (cf. Table 4)
 - c) The successive stages of building the banking union (cf. Table 5)
 3. Bailout programs for euro-area countries (cf. Table 6)
- The binary variables adopt a value of 1 on the event days and 0 otherwise.

Table 3 ECB Measures

<i>Measure</i>	<i>Date</i>	<i>Event</i>	<i>Variable</i>
Interest rate policy	Nov. 3, 2011; Dec. 8, 2011; Jul. 5, 2012; May 2, 2013; Nov. 7, 2013; Jun. 5, 2014; Sep. 4, 2014; Dec. 3, 2015; Mar. 10, 2016	ECB decides to lower its key interest rates.	IR^{DOWN}
3Y LTRO	Dec. 8, 2011	ECB announces two LTROs with a maturity of 3 years.	$LTRO^{ANN}$
	Dec. 21, 2011	The first 3Y LTRO is allotted.	$LTRO(1)^{ALL}$
	Dec. 22, 2011 Feb. 29, 2012	The first 3Y LTRO is settled. The second 3Y LTRO is allotted.	$LTRO(1)^{SETTLE}$ $LTRO(2)^{ALL}$
SMP CBPP2	Mar. 1, 2012	The second 3Y LTRO is settled.	$LTRO(2)^{SETTLE}$
	May 10, 2010 Oct. 6, 2011 Nov. 3, 2011	ECB announces SMP. ECB announces CBPP2. ECB announces details of CBPP2.	SMP^{ANN} $CBPP2^{ANN}$ $CBPP2^D$
OMT*	Jul. 26, 2012	Mario Draghi gives "whatever it takes" speech.	OMT^{ANN}
	Sep. 6, 2012	ECB announces details of OMTs.	OMT^D
CBPP3 and ABSPP	Sep. 4, 2014	ECB announces CBPP3 and ABSPP.	$CBPP3_ABSPP^{ANN}$
	Oct. 2, 2014	ECB announces details of CBPP3 and ABSPP.	$CBPP3_ABSPP^D$
	Oct. 20, 2014	ECB starts to buy covered bonds under CBPP3.	$CBPP3^{START}$
	Nov. 21, 2014	ECB starts to buy asset-backed securities under ABSPP.	$ABSPP^{START}$
PSPP	Jan. 22, 2015 Mar. 9, 2015	ECB announces PSPP. ECB starts to buy public sector securities under PSPP.	$PSPP^{ANN}$ $PSPP^{START}$
	CSPP	Mar. 10, 2016 Apr. 21, 2016	ECB announces CSPP. ECB announces details of CSPP.
		Jun. 8, 2016	ECB starts to buy corporate sector bonds under CSPP.
TLTRO I	Jun. 5, 2014	ECB announces the first series of TLTROs.	$TLTRO(1)^{ANN}$
	Sep. 24, 2014; Dec. 17, 2014; Mar. 25, 2015; Jun. 24, 2015; Sep. 30, 2015; Dec. 16, 2015; Mar. 30, 2016; Jun. 29, 2016	The consecutive operations under TLTRO I are settled.	$TLTRO(1)^{SETTLE}$
TLTRO II	Mar. 10, 2016	ECB announces the second series of TLTROs.	$TLTRO(2)^{ANN}$
	Jun. 29, 2016; Sep. 28, 2016; Dec. 21, 2016	The consecutive operations under TLTRO II are settled.	$TLTRO(2)^{SETTLE}$

Notes: LTRO, CBPP, SMP, OMT, TLTRO, ABSPP, PSPP, and CSPP stand for longer-term refinancing operations, covered bond purchase program, Securities Markets Programme, Outright Monetary Transactions, targeted longer-term refinancing operations, asset-backed securities purchase program, public sector purchase program, and corporate sector purchase program, respectively.

In the case of asset purchase programs, when available, the dates of their announcement, announcement of technical details, and start of purchases are included.

*Since findings of many studies indicate that the effect of the OMT announcement was long-term (cf. Afonso et al., 2018), we include the OMTAFTER variable in order to evaluate this effect. This variable takes a value of 1 after the announcement of the OMT program.

Source: Author's own elaboration on the basis of <https://www.ecb.europa.eu/>.

Table 4 Measures Undertaken at the Euro Area/EU Level: Fiscal Strengthening

<i>Measure</i>	<i>Date</i>	<i>Event</i>	<i>Variable</i>
<i>EFSF and ESM</i>	Jul. 1, 2010	EFSF is established.	<i>EFSF</i>
	Mar. 11, 2011; Jul. 21, 2011; Oct. 27, 2011; Mar. 30, 2012	Firewalls are enhanced.	<i>EFSF/ESM</i>
	Jul. 11, 2011	First ESM Treaty is signed.	<i>ESM</i>
	Feb. 2, 2012	New ESM Treaty is signed.	
	Oct. 8, 2012	ESM board of governors holds its inaugural meeting.	
<i>Six-Pack</i>	Sep. 20, 2011	Council, Commission, and Parliament agree on Six-Pack.	<i>Six-Pack</i>
	Dec. 13, 2011	Six-Pack enters into force.	
<i>Fiscal Compact</i>	Mar. 2, 2012	Fiscal Compact is signed.	<i>Fiscal Compact</i>
	Jan. 1, 2013	Fiscal Compact enters into force.	
<i>Two-Pack</i>	May 30, 2013	Two-Pack enters into force.	<i>Two-Pack</i>

Source: Author's own elaboration on the basis of <https://www.esm.europa.eu/>.

Table 5 Measures Undertaken at the Euro-Area/EU Level: Banking Union Milestones

<i>Date</i>	<i>Event</i>	<i>Variable</i>
Jun. 29, 2012	European Council paves the way for the banking union.	
Nov. 4, 2014	Single Supervisory Mechanism becomes operational.	<i>BU</i>
Jan. 1, 2016	Single Resolution Board becomes operational.	

Source: Author's own elaboration.

Table 6 Bailout Programs

<i>Country</i>	<i>Date</i>	<i>Event</i>	<i>Variable</i>
Greece(1)	Apr. 23, 2010	Greece requests financial assistance.	<i>Bailout(1)^{APP}_{EL}</i>
	May 2, 2010	Agreement on the program is reached.	<i>Bailout(1)^{AGR, MOU}_{EL}</i>
	May 3, 2010	MoU is approved.	
Greece(2)	Feb. 21, 2012	Agreement on the program is reached.	<i>Bailout(2)^{AGR}_{EL}</i>
	Mar. 14, 2012	MoU is approved.	<i>Bailout(2)^{MOU}_{EL}</i>
	Feb. 20, 2015	The program is extended.	<i>Bailout(2)^{EXT}_{EL}</i>
	Jun. 30, 2015	The program for Greece expires.	<i>Bailout(3)^{END}_{EL}</i>
Greece(3)	Jul. 8, 2015	Greece requests financial assistance.	<i>Bailout(3)^{APP}_{EL}</i>
	Jul. 17, 2015	Greece is granted bridge financing.	<i>Bailout(3)^{bridge}_{EL}</i>
	Aug. 14, 2015	Agreement on the program is reached.	<i>Bailout(3)^{AEL}_{EL}</i>
	Aug. 19, 2015	MoU is approved.	<i>Bailout(3)^{MOU}_{EL}</i>
Ireland	Nov. 21, 2010	Ireland requests financial assistance.	<i>Bailout^{APP}_{IE}</i>
	Nov. 28, 2010	Agreement on the program is reached.	<i>Bailout^{AGR}_{IE}</i>
	Dec. 7, 2010	MoU is approved.	<i>Bailout^{MOU}_{IE}</i>
	Dec. 13, 2013	The program for Ireland ends.	<i>Bailout^{END}_{IE}</i>
Portugal	Apr. 7, 2011	Portugal requests financial assistance.	<i>Bailout^{APP}_{PT}</i>
	May 17, 2011	Agreement on the program is reached and MoU is approved.	<i>Bailout^{AGR, MOU}_{PT}</i>
	Jun. 12, 2014	The program for Portugal ends.	<i>Bailout^{END}_{PT}</i>
Spain	Jun. 25, 2012	Spain requests financial assistance.	<i>Bailout^{APP}_{ES}</i>
	Jul. 10, 2012	Agreement on the program is reached.	<i>Bailout^{AGR}_{ES}</i>
	Jul. 20, 2012	MoU is approved.	<i>Bailout^{MOU}_{ES}</i>
	Jan. 22, 2014	Program for Spain ends.	<i>Bailout^{END}_{ES}</i>

Notes: The successive programs for Greece are marked as 1, 2, and 3.

When a given event took place during the weekend, a relevant 0-1 variable adopts the value of 1 on the nearest working day.

Source: Author's own elaboration on the basis of <https://www.esm.europa.eu/>.

In the cases of Greece, Ireland, Portugal, and Spain, which constitute the analyzed group, the dates of the application for financial assistance, the dates of the launch of the programs ($Bailout^{AGR}$ and $Bailout^{MOU}$ variables), and the dates of the end of the programs are considered. Moreover, a binary variable $Bailout^{TR}$ is created for each country receiving funding in the years 2010-2016. It adopts a value of 1 on the days when loan disbursements were made at the euro-area level or by the IMF. The data were obtained from the ESM and IMF websites. To save space, the dates of loan disbursements are not presented in Table 6 and are available on request. Due to the specific situation of Greece, which was under three bailout programs, the dates of the extension of the second program and bridge financing granted under the third program are added to the list.

Finally, we decided to add a few one-time events to our set of explanatory variables. They are related to the anti-crisis policy implemented in the euro area. The list of those events is presented in Table 7.

Table 7 Binary Variables Associated with One-Time Events

<i>Date</i>	<i>Event</i>	<i>Variable</i>
Aug. 17, 2011	Merkel-Sarkozy summit: Eurobonds rejected as a short-term solution to the crisis	<i>Eurobonds rejection</i>
Sep. 7, 2011	Karlsruhe ruling on crisis measures: in line with the German constitution	<i>Karlsruhe approval</i>
Sep. 12, 2012	Karlsruhe ruling on ESM and Fiscal Compact: in line with the German constitution	
Mar. 16, 2013	Cyprus announces "one-off stability levy" on all deposits	<i>Levy</i>
Mar. 22, 2013	Cyprus introduces capital controls	<i>Capital control</i>
Jun. 16, 2015	European Court of Justice: OMT program compatible with EU law	<i>OMT legal</i>
Jun. 29, 2015	Greece imposes bank holiday and capital controls	<i>Bank holiday</i>

Source: Author's own elaboration.

2.4 Control variables

The study also includes a few control variables as potential determinants of spreads. These are as follows: the rate of return on the EUR/USD exchange rate, the rate of return on the EUROSTOXX50, and the volatility of this index (VSTOXX). All this data was obtained from Thomson Reuters Eikon. Our choice is based on the literature review and control variables used in other studies (cf. Fontana and Scheicher, 2016). Moreover, these control variables reflect linkages between bond market and other markets (stock market, currency market).

3. Methodology

In order to evaluate the impact of news releases, credit rating announcements, and anti-crisis measures on the daily changes in the sovereign bond spreads, we propose the estimation of the parameters of the following VARX(p)-GARCH-BEKK (see Kroner and Ng, 1998):

$$\Delta spread_t = \sum_{i=1}^p \Pi_i \Delta spread_{t-i} + \Lambda n_{t-1} + \Psi r_{t-1} + \mathbf{P}ac_{t-1} + \mathbf{\Omega}co_{t-1} + \varepsilon_t^2 \quad (1.a)$$

$\varepsilon_t \sim N(\mathbf{0}, \mathbf{H}_t)$,

² Bold letters are used in order to differentiate vectors and matrices from variables.

$$\mathbf{H}_t = \mathbf{C}\mathbf{C}^T + \mathbf{A}\boldsymbol{\varepsilon}_{t-1}\boldsymbol{\varepsilon}_{t-1}^T\mathbf{A}^T + \mathbf{B}\mathbf{H}_{t-1}\mathbf{B}^T + \mathbf{D}\boldsymbol{\zeta}_{t-1}\boldsymbol{\zeta}_{t-1}^T\mathbf{D}^T \quad (1.b)$$

where:

$$\Delta\mathbf{spread}_t = [\Delta\mathit{spread}_{EL,t} \ \Delta\mathit{spread}_{IE,t} \ \Delta\mathit{spread}_{IT,t} \ \Delta\mathit{spread}_{PT,t} \ \Delta\mathit{spread}_{ES,t}]^T. \quad (2)$$

Elements of this vector denote daily changes in sovereign bond spreads respectively for Greece, Italy, Portugal, and Spain; matrices $\mathbf{\Pi}_1, \mathbf{\Pi}_2, \dots$ measure the impact of lagged changes in spreads on actual ones; and $\boldsymbol{\varepsilon}_t$ is the vector of shocks coming from different markets. Matrix \mathbf{n}_t consists of variables based on news releases; matrix \mathbf{r}_t consists of variables associated with decisions of rating agencies; and matrix \mathbf{ac}_t consists of variables associated with anti-crisis measures undertaken by the ECB, the euro area/EU as a whole, and individual countries in the analyzed group in cooperation with international creditors. Matrix \mathbf{co}_t consists of control variables. Matrices $\mathbf{\Lambda}, \mathbf{\Psi}, \mathbf{P}$ and $\mathbf{\Omega}$ consist of consecutive parameters. The k -th element of the vector $\boldsymbol{\zeta}_t$ is defined as follows:

$$\zeta_{kt} = \min(0, \varepsilon_{kt}). \quad (3)$$

Matrix \mathbf{H}_t consists of variances of shocks and covariances among them. Elements of matrix \mathbf{A} measure the impact of lagged shocks on variances and covariances, while elements of matrix \mathbf{B} measure the impact of lagged covariances on current ones. Elements of matrix \mathbf{C} can be interpreted as constant parts of variances and covariances.

The estimation is based on daily data, and the sample period covers phases of higher and lower tensions related to the course of the crisis in the euro area. Therefore, the problem of volatility clustering occurs. Moreover, shocks from different markets may be correlated, and covariances among shocks may change over time. In order to take into account the impact of different variables on changes in spreads, time-varying variances of shocks and covariances among them as well as any asymmetric impact of shocks, the asymmetric VARX-GARCH-BEKK model seems to be an appropriate specification.

As the VARX-GARCH-BEKK model with asymmetry is considered, it must be tested to see whether such asymmetry exists. If an asymmetry does not exist, then the impact of positive shocks does not differ from the impact of negative shocks. In fact, this means that all elements of the matrix \mathbf{D} equal 0. Therefore, the following hypothesis should be tested using the Wald test:

$$\begin{aligned} H_0: \mathbf{D} &= \mathbf{0}, \\ H_1: \mathbf{D} &\neq \mathbf{0} \end{aligned} \quad (4)$$

If the transmission of shocks, covariances, and negative shocks occurs, then the use of the VARX-GARCH-BEKK model is justified. Alternatively, parameters of univariate GARCH models should be estimated for each country. In order to test whether a spillover among markets is present, the following hypothesis should be considered:

$$H_0: \forall_{i \neq j} (a_{ij} = 0 \wedge d_{ij} = 0 \wedge b_{ij} = 0), \quad (5)$$

$$H_1: \sim H_0$$

4. Results and Discussion

In order to find the optimal lag level in the VARX(p)-GARCH-BEKK model, a Bayesian Schwarz criterion is used. Table 8 presents values of this criterion for different lag levels.

Table 8 Selecting Optimal Lag Length

<i>Lag length</i>	<i>Value of Bayesian Schwarz criterion</i>
0	-5.668
1	-5.687
2	-5.671
3	-5.662
4	-5.663

According to the results presented in Table 8, the optimal lag length equals 1. Therefore, the parameters of the model (1.a)-(1.b) are estimated for $p=1$.

After having estimated the parameters of the asymmetric VARX(1)-GARCH-BEKK model, hypotheses (2) and (3) are tested. The results are presented in Table 9. They indicate that the impact of shocks on elements of the variance-covariance matrix is not symmetric and that transmission of variances and shocks occurs, so the choice of the asymmetric VARX-GARCH-BEKK model is justified.

Table 9 Results of Testing Hypotheses (2) and (3)

<i>Hypothesis</i>	<i>Wald statistic</i>	<i>p-value</i>
(2)	19.617	0.000
(3)	18.427	0.000

Tables 10.a-10.e present the results of the estimation of the parameters of model (1). Nonsignificant variables were excluded from the final specification. To save space, the results of the estimation of the parameters of model (1.b) are not shown, and time-varying elements of the variance-covariance matrix are not presented. However, these results are available upon request.

Different sets of news variables were received for each country. Nonetheless, the similarities can also be identified. For all the variables based on news releases that proved to be statistically significant, the expected signs for parameter estimates were received. The division of news releases into positive and negative ones shows that the former had a lesser impact on spreads. This finding supports previous results obtained by Beetsma et al. (2013). It is also in line with conclusions stemming from a large body of research that indicate that individuals and markets respond more strongly to negative information than to positive information (cf. Soroka, 2006).

Starting with macroeconomic news, for most countries, at least one variable associated with GDP growth (*GDP* or *FGDP*) turned out to be significant. This result is in line with expectations, as economic growth is conducive to the fulfilment of payment obligations. A higher GDP growth rate should positively affect a given country's public finances, causing a decline in its sovereign bond yields.

At the same time, some of the variables reflecting the course of the crisis in the euro area, such as the *Banking*^{NEG} variable, proved to be insignificant in determining

spreads in the analyzed group of countries. This seems economically counterintuitive, as negative feedback loops between the situation of the sovereigns and the national banking sectors were the underlying reason for the development of the crisis in the euro area. Breaking this dependency was the main objective of the establishment of the banking union. Based on the example of the *Banking*^{NEG} variable, it can be seen that investors might have seen the condition of the banking sector in the peripheral euro area countries as bad for most parts of the analyzed period. Therefore, unfavorable news releases appearing from time to time did not reflect the full picture. Finally, we do not identify contagion effects due to macroeconomic news releases. In other words, news reflecting the macroeconomic conditions on a given country had an impact only on the spreads of that country.

Table 10.a Results of the Estimation of the Parameters of Model (1.a). Impact of Variables Based on News Releases

<i>Explanatory variables</i>		<i>Dependent variables</i>				
		$\Delta spread_{EL}$	$\Delta spread_{IE}$	$\Delta spread_{IT}$	$\Delta spread_{PT}$	$\Delta spread_{ES}$
Macroeconomic news and news related to social situation	Bond auction ^{NEG} _{EL}	0.279*	-	-	-	-
	CA ^{NEG} _{IE}	-	0.050***	-	-	-
	Capital outflow _{ES}	-	-	-	-	0.091***
	FGDP ^{POS} _{IE}	-	-0.005*	-	-	-
	FGDP ^{POS} _{PT}	-	-	-	-0.055*	-
	Finpub ^{POS} _{IT}	-	-	-0.064***	-	-
	GDP ^{NEG} _{EL}	0.123***	-	-	-	-
	GDP ^{NEG} _{IT}	-	-	0.039***	-	-
	GDP ^{POS} _{EL}	-0.096***	-	-	-	-
	Labor ^{NEG} _{PT}	-	-	-	0.081***	-
	Real ^{NEG} _{PT}	-	-	-	0.114***	-
	Sentiment ^{NEG} _{PT}	-	-	-	0.021***	-
	Sentiment ^{POS} _{IT}	-	-	-0.026***	-	-
	Corruption _{EL}	0.173*	-	-	-	-
	Social _{IE}	-	0.071***	-	-	-
News related to	Antiausterity _{IT}	-	-	0.027***	-	-
	Antiausterity _{PT}	-	-	-	0.043*	-
	Antiausterity _{ES}	-	-	-	-	0.055***
	Austerity _{EL}	0.053#	-	-	-	-
	On track _{IE}	-	-0.072**	-	-	-
	Pressure _{IE}	-	0.052***	-	-	-
News with key words	Crisis _{EL}	0.081*	-	-	-	0.018*
	Crisis _{IT}	-	-	0.081*	-	-
	Crisis over _{IE}	-	-0.018***	-	-	-
	Crisis over _{IT}	-	-	-0.014***	-	-
	Default _{PT}	-	-	-	0.281***	-

Notes: #, *, **, *** Significance at the 0.2, 0.1, 0.05, and 0.01 levels.

Moving on to news related to the policy of austerity, the negative sign of the parameter estimate for the *Antiausterity* variable for Italy, Portugal, and Spain implies that investors did not approve the reverse of austerity measures in by then still fiscally vulnerable euro-area countries. In the case of Greece, which exited from its third bailout program only in 2018q3, there were no news on the retreat from the policy of austerity. In the case of Ireland, the insignificance of the *Antiausterity* variable might be due to its specific situation as compared to the situations of the rest of the GIIPS economies—its fast return to a growth path after the program completion. In addition, investors seemed to appreciate Ireland's proper implementation of reforms in

accordance with the program, which is reflected by the significance of the *On track*_{IE} variable.

News related to the social situation had little impact on the spreads in the analyzed group of countries. For Italy, Portugal, and Spain, none of those variables turned out to be significant. In the case of Greece, the *Corruption* variable exerted an upward pressure on the spreads. Nevertheless, it proved to be significant only at the level of 0.1.

Among the variables based on key words, the *Crisis*, *Crisis over*, and *Default* variables turned out to be statistically significant for at least one country. In particular, the importance of the first two seems to be intuitive, as the titles of news items containing those words clearly described the evolution of the crisis and economic condition in the countries under consideration.

Table 10.b Results of the Estimation of the Parameters of Model (1.a) for Variables Based on Credit Rating Announcements

<i>Explanatory variables</i>	<i>Dependent variables</i>				
	$\Delta spread_{EL}$	$\Delta spread_{IE}$	$\Delta spread_{IT}$	$\Delta spread_{PT}$	$\Delta spread_{ES}$
Rating ^{DOWN} _{EL}	0.068*	-	-	0.048*	0.037*
Rating ^{DOWN} _{IE}	-	0.078*	-	-	-
Rating ^{UP} _{IT}	-	-	-0.156***	-	-
Rating ^{UP} _{ES}	-	-	-	-	-0.027**

Notes: #, *, **, *** Significance at the 0.2, 0.1, 0.05, and 0.01 levels.

The decisions of the credit rating agencies had an impact on the evolution of Greek, Irish, Italian, and Spanish³ spreads, *ceteris paribus*. This impact proved to be asymmetrical for each of the four countries analyzed. The results for Spain and Italy (the significance of the upgrading of credit ratings) contradict the conclusion drawn from the research of Alsakka and ap Gwilym (2013) about the stronger impact of rating downgrades as compared to the impact of upgrades. The causes of this discrepancy can be linked to different research periods—the analysis of Alsakka and ap Gwilym (2013) primarily included the period of crisis in the euro area, when the credit rating agencies downgraded the credit ratings of the GIIPS countries. That trend was reversed in the years 2013–2014.

The positive signs of parameter estimates were received for the countries that experienced rating cuts of the largest scale to a non-investment level in a short period of time. Furthermore, downgrades on Greece’s credit rating also had a positive impact on Portuguese and Spanish spreads, *ceteris paribus*. This result is in line with the conclusion made from the research of Böninghausen and Zabel (2015), who identified the presence of negative spillover effects in response to credit rating downgrades and the lack of positive effects in the case of upgrades.

The results suggest that the spreads were under the strongest influence of the ECB’s anti-crisis measures—SMP, OMT, and quantitative easing, in particular. The announcement of the SMP in May 2010 played the biggest role for Greece, Ireland, Portugal, and Spain. These results can be interpreted as the effect of the initial expectation that, by taking this initiative, the ECB would become the lender of last

³ Portuguese spreads were affected by the decisions of the credit rating agencies on Greece.

resort for sovereigns, thus reducing the volatility in the euro area government bond market. The significance of the OMT^{AFTER} variable indicates the long-term impact of the announcement about the program on the spreads of the analyzed countries, as evidenced by the conclusions of previous studies (cf., for example, Saka, Fuertes, and Kalotychou, 2015; Grabowski and Stawasz, 2017; Afonso et al., 2018). Our findings also support the results obtained by De Santis (2016) that indicate that the spreads of the euro-area peripheral countries were under the substantial influence of the APP, despite the fact that the program was launched during the period of relative stability. Ireland is the only country for which the OMT^{AFTER} and $PSPP^{ANN}$ variables turned out to be insignificant. We interpret this result in terms of positive market sentiment towards Ireland due to its fast recovery from the crisis.

Table 10.c Results of the Estimation of the Parameters of Model (1.a) for Variables Based on ECB Measures and Anti-Crisis Measures Undertaken at the EU/Euro Area Level

<i>Explanatory variables</i>		<i>Dependent variables</i>				
		$\Delta spread_{EL}$	$\Delta spread_{IE}$	$\Delta spread_{IT}$	$\Delta spread_{PT}$	$\Delta spread_{ES}$
<i>ECB measures</i>	CBPP2 ^{ANN}	-	-	-0.059***	-	-0.062***
	CBPP2 ^D	-	-0.024***	-	-	-
	CBPP3_ABSPP ^{ANN}	-	-	-0.121***	-0.049***	-0.122***
	CBPP3_ABSPP ^D	-	-	-0.046***	-0.089***	-0.038***
	CSPP ^{START}	-	-	-0.036***	-0.043***	-0.043***
	LTRO(1) ^{ALL}	-	-0.237***	-	-0.113***	-
	LTRO(1) ^{SETTLE}	-	-0.054***	-	-	-
	LTRO(2) ^{ALL}	-	-	-0.227***	-	-0.111***
	LTRO(2) ^{SETTLE}	-	-	-0.239***	-0.080***	-0.120***
	LTRO ^{ANN}	-	-0.636***	-	-0.100***	-
	OMT ^{AFTER}	-0.073***	-	-0.006#	-0.014#	-0.008*
	PSPP ^{ANN}	-0.200***	-	-0.065***	-0.044***	-0.063***
	SMP ^{ANN}	-4.323***	-0.663***	-0.143***	-1.481***	-0.367***
	TLTRO(1) ^{ANN}	-	-0.007**	-0.014***	-	-
	TLTRO(2) ^{ANN}	-	-	-0.044***	-0.069***	-0.074***
<i>EU/ euro area level</i>	BU	-	-0.033***	-0.109*	-	-
	EFSF/ESM	-0.388*	-	-	-	-
	Fiscal Compact	-	-	-0.151*	-	-0.173**

Notes: #, *, **, *** Significance at the 0.2, 0.1, 0.05, and 0.01 level.

The spreads of Spain, Italy, Ireland, and Portugal were under the influence of the ECB's non-standard liquidity-providing operations, *ceteris paribus*. This result seems to reflect the fact that those countries were among the largest beneficiaries of two 3Y LTROs (cf. Krampf, 2014).

The measures announced in the years 2014-2016, other than PSPP, had the strongest impact on Portuguese, Italian, and Spanish spreads. The decline in Irish spreads at that time might have stemmed from its positive economic performance. The evolution of Greek spreads, in turn, might not have responded to the measures aimed at restoring the bank-lending channel of monetary policy (like TLTROs) due to the fact that Greek problems were mainly fiscal in nature.

The spreads of the analyzed group of countries were under little influence of the anti-crisis measures undertaken at the level of the EU/euro area. In view of the fact that the Stability and Growth Pact turned out to be ineffective at imposing fiscal discipline on the euro area countries, investors might have disbelieved the stabilizing role of the initiatives such as Six-Pack and Two-Pack. At the same time, the lending

capacity of EFSF/ESM was assessed as insufficient to prevent the spread of the crisis. Those arguments are reinforced by the significance of the SMP^{ANN} and OMT^{AFTER} variables: after the failure of the Eurobond project, the hope to end the crisis was associated only with the ECB's bond-buying programs. When it comes to the BU variable, it played a role in determining the Irish and Italian spreads. This might be due to the fact that "sovereign-bank nexus" was particularly strong in those two countries in the period under analysis (cf. Gómez-Puig et al., 2015; IMF, 2015).

Table 10.d Results of the Estimation of the Parameters of Model (1.a) for Variables Based on Bailout Programs and One-Time Events

Explanatory variables		Dependent variables				
		$\Delta spread_{EL}$	$\Delta spread_{IE}$	$\Delta spread_{IT}$	$\Delta spread_{PT}$	$\Delta spread_{ES}$
Bailout programs	Bailout(1)^{APP}_{EL}	-0.339***	-	-	-	-
	Bailout(1)^{TR}_{EL}	-0.386***	-	-	-	-
	Bailout(2)^{AGR}_{EL}	-0.558***	-	-	-	-
	Bailout(2)^{TR}_{EL}	-0.175*	-	-	-	-
	Bailout(3)^{APP}_{EL}	1.183***	-	-	-	-
	Bailout(3)^{AGR}_{EL}	-0.619***	-	-	-	-
	Bailout^{APP}_{PT}	-	-	-	0.078***	-
	Bailout^{END}_{PT}	-	-	-	0.033***	-
	Bailout^{APP}_{ES}	-	-	-	-	0.283***
	Bailout^{TR}_{ES}	-	-	-	-	-0.060***
	Bailout^{END}_{ES}	-	-	-	-	-0.027***
	Bailout^{APP}_{IE}	-	0.010***	-	-	-
Bailout^{END}_{IE}	-	-0.010***	-	-	-	
One-time events	Bank holiday	3.659***	-	0.223***	0.283***	0.192***
	Eurobonds rejection	0.149***	-	0.071***	0.060***	0.101***
	Karlsruhe approval	-	-	-0.160***	-	-0.116***
	Levy	0.389***	0.008***	0.013***	0.219***	0.017***
	OMT legal	-	-	-	-0.040***	-0.021***

Notes: #, *, **, *** Significance at the 0.2, 0.1, 0.05, and 0.01 levels.

The analysis of the assistance programs, from a given country's request for financial assistance to the exit from the program, indicates that they played a role in determining spreads. For each country the $Bailout^{APP}$ and $Bailout^{END}$ variables had a significant impact on spreads. At the same time, different signs of parameter estimates for those variables were received in individual countries. The $Bailout^{APP}$ variable exerted a negative impact on spreads only in the case of the first program for Greece. That might be interpreted as the initial belief of investors regarding the success of such programs. It soon turned out that the goals established within the framework of the program are difficult to achieve. Thus, the subsequent applications for financial assistance by the GIIPS countries were read as evidence of their weakening economic condition. Similar results (positive relation between bailout application and spreads for Portugal and Spain) were found by Kilponen et al. (2015). In the case of Ireland and Spain, the completion of the program led to a decline in spreads. This may be due to the fact that the exits of those two countries from their respective programs were accompanied by the atmosphere of success. Their return to the growth path was later reassured by their repayments of bailout loans ahead of schedule. The positive sign of the parameter estimate for the $Bailout^{END}$ for Portugal may be related to the opinions that appeared when Portugal was leaving the assistance program, which indicated that its economic condition remained weak. The opinions were accompanied by

expectations that the country would apply for another assistance program. In Greece, unlike in other analyzed countries, payments of subsequent tranches were accompanied by high tensions. The disbursements were often postponed due to Greece's lack of compliance with the terms of bailout programs. Thus, the mere fact of receiving subsequent loan installments could have been more noticeable as a form of progress in implementing necessary economic reforms. This is reflected in the negative signs of the parameter estimates for $Bailout(1)^{TR}_{EL}$ and $Bailout(2)^{TR}_{EL}$.

It is worth noting that our results contradict the findings of Gödl and Kleinert (2016), which pointed to the insignificance of assistance programs. In an attempt to find an explanation for this discrepancy, it can be pointed out that the above-mentioned authors took into account only the payment of tranches. The findings of our study as well the results obtained by Kilponen et al. (2015) indicate that adding variables associated with applications for bailout programs, agreements on the terms of programs, and their completions affected the evolution of spreads in the peripheral countries of the euro area.

Finally, the spreads in GIIPS countries were (*ceteris paribus*) influenced by one-time events that reflected strong tensions in other peripheral euro-area economies. This is demonstrated by the significance of the *Levy* and *Bank holiday* variables, which reflect the height of the Cypriot crisis and the failed negotiation on the terms of the third program for Greece, respectively. These results show that such events were not perceived as isolated ones and raised fears about intensification of the crisis and spill-over effects. The insignificance of the *Bank holiday* variable for Ireland only supports our previous conclusions about its unique status in comparison with other GIIPS economies.

For most countries, a positive sign of the parameter estimate for the *Eurobonds rejection* variable was obtained, which we read as disapproval on the side of investors that such a debt-mutualization mechanism in the euro area will not be established.

The *Karlsruhe approval* and *OMT legal* variables turned out to be significant for two countries from the group consisting of Italy, Portugal, and Spain. In the case of the first of these variables, its minor significance may be linked to the minor significance of the *ESM/EFSS* variables and indicate that the capacity of those stability funds was widely assessed as inadequate. The significance of the *OMT legal* variable is determined for two out of three countries that were believed to be potential beneficiaries of purchases under the OMT program. (Greece did not qualify at that time and Ireland had already taken advantage of low sovereign bond yields.)

Table 10.e Results of the Estimation of the Parameters of Model (1.a). Impact of Lagged Spreads and Control Variables

Explanatory variables	Dependent variables				
	$\Delta spread_{EL}$	$\Delta spread_{IE}$	$\Delta spread_{IT}$	$\Delta spread_{PT}$	$\Delta spread_{ES}$
Intercept	0.064***	0.000	0.006#	0.012	0.009**
$\Delta spread_{EL}(t-1)$	0.251***	-0.003	0.012***	0.021***	0.008***
$\Delta spread_{IE}(t-1)$	0.043	0.004	0.016	-0.014	0.019**
$\Delta spread_{IT}(t-1)$	0.230***	0.080***	0.004	0.041	0.083***
$\Delta spread_{PT}(t-1)$	0.046	0.046***	0.015***	0.102***	0.032***
$\Delta spread_{ES}(t-1)$	0.072	0.039	0.016*	0.118***	0.133***
$100^* i_t^{USD / EUR}$	4.652***	-	2.920***	2.034***	2.803***
$100^* \Delta es50_t$	-8.460***	-	-3.255***	-3.569***	-3.149***

Notes: #, *, **, *** Significance at the 0.2, 0.1, 0.05, and 0.01 levels.

Results for the lagged spreads indicate that during the euro-area sovereign debt crisis, dynamic linkages among spreads were present. Moreover, spreads in Greece, Italy, Portugal and Spain reacted to changes in the USD/EUR exchange rate and fluctuations of the EUROSTOXX50. *Ceteris paribus*, an increase in spreads was observed after depreciation of the euro against the dollar and after drops of the main stock index of the euro area, which is in line with expectations.

5. Conclusions

This study contributes to the understanding of the factors affecting the evolution of sovereign bond spreads in the peripheral countries of the euro area in the period 2010–2016. In contrast to previous research, which concentrated only on a given group of potential determinants (e.g., only the decisions of credit rating agencies), the study presented in this paper aimed to include a wide range of explanatory variables. Based on the estimation of the parameters of the asymmetric VARX-GARCH-BEKK model, it was possible to identify the impact of a number of news categories, credit rating announcements, and anti-crisis measures undertaken by the ECB, the euro area/EU as a whole, and individual countries in the analyzed group in cooperation with international creditors.

The results suggest that the spreads were under the strongest influence of the ECB's anti-crisis measures—SMP, OMT, and quantitative easing in particular—while the initiatives undertaken at the euro area/EU level (stability funds, a package of legal acts aimed at improving the fiscal discipline, banking union) played a less significant role. Bailout programs affected the evolution of the spreads, though their impact differed for individual countries.

The spreads in each of the countries considered were under the influence of different news categories. Nonetheless, similarities were also identified. The division of news releases into positive and negative ones shows that the former had a lesser impact on spreads. When it comes to rating changes, they turned out to be significant, but some discrepancies with the results of previous studies were identified.

APPENDIX

Table A1 Review of Literature Devoted to Determinants of Treasury Bond Yields

<i>Study</i>	<i>Period</i>	<i>Countries</i>	<i>Explanatory variables</i>	<i>Methodology</i>
<i>Group 1: focus on the role of fundamental and non-fundamental factors in explaining the spreads in the two sub-periods—before the crisis and after its beginning; the use of lower-frequency data</i>				
Assmann and Boysen-Hogrefe (2012)	January 2001–June 2010	Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal, Spain	forecast of debt-to-GDP ratio, forecast of budget balance-to-GDP ratio, forecast of CA balance-to-GDP ratio, outstanding amount of debt securities of the public sector, bid-ask spread	state-space model with ARCH effect
Bernoth and Erdogan (2012)	1999Q1–2010Q1	Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal, Spain	debt-to-GDP ratio, projected (12-months ahead) deficit-to-GDP ratio, bid-ask spread, spread between low-grade corporate bonds and government bonds	time-varying coefficient fixed effects panel data model
Bernoth et al. (2012)	January 1993–May 2009	“old EU” countries except Luxembourg	debt-to-GDP ratio, projected (12-months ahead) deficit-to-GDP ratio, debt service payments to total revenue, spread between low-grade long-term corporate bonds (Moody’s Baa) and 10-year government bonds in the US, time to maturity of the government bond issue, size of the bond issue, outstanding amount of securities of the issuer country	panel regression with time and country fixed effects
Oliveira et al. (2012)	January 2000–December 2010	Austria, Belgium, France, Italy, the Netherlands, Portugal, Spain	a set of common variables (e.g., returns based on the EURO STOXX50 stock index) and a set of country-specific variables (e.g., government debt, excluding debt interest payments, relative to GDP; industrial production index; CA deficit relative to GDP)	panel regression
Beirne and Fritzscher (2013)	1999–2011	31 advanced and emerging economies	debt-to-GDP ratio, fiscal balance/GDP ratio, real GDP growth, CA balance/GDP ratio, VIX, regional bond spreads	panel regression model allowing for a shift in parameters
De Grauwe and Ji (2013)	2000Q1–2011Q3	2 subgroups of the Eurozone (the core and the periphery) and 14 “stand-alone” developed countries	accumulated CA/GDP ratio, REER, government debt-to-GDP ratio (or fiscal space), GDP growth rate	panel regression
Giordano et al. (2013)	January 2000–December 2011	Austria, Belgium, Finland, France, Ireland, Italy, the Netherlands, Portugal, Spain	bid-ask spread, VIX, public debt/GDP, private debt/GDP, GDP growth, CA balance/GDP	panel DOLS
Favero (2013)	January 2000–December 2012	Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal, Spain	average for a 2-year ahead period of the expected budget balance-to-GDP ratio, average for a 2-year ahead period of the expected debt-to-GDP ratio, spread between long-term yields on US corporate graded Baa and Aaa	global VAR
Costantini et al. (2014)	January 2001–December 2011	Austria, Belgium, Finland, France, Greece, Italy, the Netherlands, Portugal, Spain	expected ratios of government budget balance to GDP and debt to GDP, bid-ask spread, US corporate Baa-Aaa spread, cumulated inflation	panel cointegration

Group 2: focus on the sensitivity of spreads to macroeconomic and political news as well as credit rating announcements; the use of high-frequency data	
Afonso et al. (2012)	24 EU countries Austria, Belgium, France, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, the UK sovereign rating announcements and rating outlook changes provided by rating agencies (Standard and Poor's, Moody's, Fitch) event study analysis
Beetsma et al. (2013)	12 July 2007–29 February 2012 Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal, Spain a set of common news variables, a set of country-specific news variables, variables approximating cross-country linkages, a set of control variables pooled least squares
De Santis (2014)	2 January 2006–4 December 2012 Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal, Spain VIX, KIW-Bund spread, fiscal balance-to-GDP ratio, credit ratings, bid-ask spread, news related to financial support to distressed countries and the introduction of unconventional ECB measures dynamic OLS
Beetsma et al. (2017)	29 November 2010–12 April 2013 Greece, Ireland, Italy, Portugal, Spain news variables, control variables, and SMP data pooled least squares
Group 3: focus on the impact of the anti-crisis policy implemented by the institutions of the EU during the euro-area sovereign debt crisis, with particular focus on the ECB's measures; different frequencies of data used	
Altavilla et al. (2014)	January 2007–February 2013 France, Germany, Italy, Spain OMT announcements, other relevant macroeconomic and financial news released at the time of these announcements standard regression techniques
De Grauwe and Ji (2014)	2000Q1–2013Q4 Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal, Spain accumulated CA-to-GDP ratio, government debt-to-GDP ratio (or fiscal space), REER, GDP growth rate fixed-effects panel model
De Haan et al. (2014)	January 2001–December 2013 17 advanced economies (11 euro countries and 6 non-euro countries) real GDP growth, inflation (CPI), government debt ratio, CA ratio (forecasts for these macro-economic fundamentals when available), a variable reflecting financial market conditions fixed-effects panel model with robust standard errors
Falagiarda and Reitz (2015)	1 January 2008–31 December 2012 Greece, Ireland, Italy, Portugal, Spain announcements of ECB unconventional monetary policy measures, control variables (a volatility index for the euro area, the total stock market index for the EU, the 3-month LIBOR rate less the US Treasury bill rate) OLS using Newey-West standard errors
Kilponen et al. (2015)	1 January 2007–30 September 2013 France, Germany, Greece, Ireland, Italy, Portugal, Spain macroeconomic news dataset (standardized differences between releases and forecasts), bid-ask spread, VIX, ITraxx Europe index, ECB interest rate decisions, a set of dummy variables related to fiscal and monetary policy decisions in Europe during the debt crisis OLS using Newey-West standard errors
Dewachter et al. (2016)	7 January 2000–24 June 2016 Belgium, France, Italy, Spain ECB's unconventional monetary policy announcements dynamic term structure models
De Santis (2016)	February 2004–October 2015 Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain bid-ask spread, government balance-to-GDP ratio, government debt-to-GDP ratio, 10-year break-even inflation rate, 3-month OIS rate, real GDP growth forecast 1-year ahead, euro area APP news, US QE news panel with country fixed effects; pooled least squares with robust within arbitrary cross-section residual correlation) standard errors
Georgiadis and Gräßl (2016)	1 January 2007–31 January 2015 euro-area countries, Japan, USA, 8 non-EA EU countries, 6 other advanced countries, 6 CEMEA countries, 3 Latin American countries, 10 Asian countries a set of dummy variables based on APP-related announcements, surprises in macroeconomic data releases OLS using robust standard errors
Gödl and Kleiner (2016)	2009–2013 Greece, Ireland, Italy, Portugal, Spain 3 categories of events: "economic forecasts," "fiscal assistance," "austerity measures" event study
Boysen-Hogrefe (2017)	January 2005–December 2014 Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal, Spain outstanding amount of government debt securities, GDP growth, CA balance relative to GDP, budget balance relative to GDP, gross debt-to-GDP ratio, governance indicators provided by the World Bank state-space model with ARCH effect

Ehrmann and Fratzscher (2017)	August 2008–1 September 2009; 1 March 2010–8 March 2012; 1 October 2012–23 October 2013	France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain	The aim of the study was to identify contagion, fragmentation, and flight-to-quality patterns during the euro-area sovereign debt crisis. Therefore, only day-of-the-week and hour-of-the-day dummies were used as exogenous variables.	structural VAR
Afonso et al. (2018)	January 1999–July 2016	Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal, Spain	bid-ask spread, Economic Sentiment Index, 1-year ahead expected gross government debt-to-GDP ratio, VIX	time-varying panel model
August 2009–July 2016	Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal, Spain	dummy variable taking value 1 since August 2012, securities held for monetary policy purposes by the ECB, the ECB main refinancing operations rate, European banking sector senior subordination CDS index	linear regression model with heteroscedasticity and autocorrelation consistent standard errors explaining TVP coefficients	
Afonso and Jallies (2018)	January 1999–July 2016	Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal, Spain	VIX, bid-ask spread, REER, industrial production, expected government debt (% of GDP), share of long-term government debt (in total debt), expected government budget balance (% of GDP), credit rating, credit outlook, standard and non-standard ECB's policy measures	Weighted-Average Least Squares (WALS) is used in order to select a model, country specific time-varying coefficients model

Table A2 Examples of news items included in the specified news categories

<i>Variable</i>	<i>Examples</i>
<i>Macroeconomic news (1262)*</i>	
GDP	Eurostat confirms 1% growth for eurozone in Q2 (Sep. 3, 2010) Portuguese economy contracted 0.3% in Q4 2010 (Feb. 15, 2011)
FGDP	Bank of Spain improves its GDP outlook as quarterly GDP growth accelerates (Jul. 24, 2014)
Finpub	IMF revises Spanish growth forecasts downwards (Jul. 8, 2010) Greek 2012 budget deficit better than expected (Jan. 4, 2013) Eurostat found new budget hole in Greece (Mar. 30, 2011)
Inflation	Rise in inflation to 2.4% in February prompts speculation of early rate rise (Mar. 2, 2011) That incredibly deflating feeling (Feb. 3, 2014)
Labor	Spain's positive labour markets trend continue (Nov. 4, 2015) Spanish unemployment reaches new heights (Jan. 6, 2010)
Real	Eurozone industrial output up (Jun. 13, 2013) Spanish company bankruptcies soar (Apr. 9, 2013)
Banking	Alpha and Eurobank recapitalise successfully (Nov. 20, 2015) How NPLs weigh on Italian banks (Aug. 24, 2016)
Bond auction	Portugal back to the market with 15y bond (Sep. 3, 2014) Spain's latest debt auction disappoints (Sep. 2, 2011)
Capital inflow	Foreign investors are returning to the Spanish government debt market (Mar. 27, 2013)
Capital outflow	Capital flight from Italy continues (Nov. 29, 2012)
CA	Europe's current account surplus going strong (Aug. 26, 2016)
Compete	Spain still losing competitiveness in the Eurozone (Feb. 9, 2011)
Sentiment	Eurozone economic sentiment improves (Jan. 8, 2010) Eurozone consumer confidence plunges (Jul. 24, 2014)
<i>News related to austerity policy (627)*</i>	
Austerity	Zapatero announces draconian social cuts (May 13, 2010)
Pressure	Greece under pressure to get reforms back on track and to fill €3 bn budget hole (Jul. 11, 2012)
Protest	Strikes in Greece escalate (Feb. 5, 2010)
Tension	Troika and Greek government stuck over dismissals (Apr. 10, 2013)
On track	IMF review: Ireland on track to exit bailout programme this year (Jun. 20, 2013)
Behind schedule	Troika inspectors frustrated over delayed tax system overhaul
Bailout expectations	Spain on the verge of an ESM programme (Mar. 28, 2012)
Anti-austerity	The Spanish government's anti-austerity turn (May 10, 2016)
<i>News related to social situation (172)*</i>	
Corruption	The eternal return of Spanish corruption cases (Sep. 14, 2016)
Social	Italian middle-class destroyed by the crisis (Jan. 23, 2013)
<i>Variables containing key words (307)*</i>	
Crisis	Merkel hides behind procedures, leaving eurozone on the brink of collapse (Jul. 15, 2011)
Crisis over	Normality returns to the capital markets (Sep. 20, 2012)
Grexit	Can the "geuro" save us from "grexit"? (May 22, 2012)
Default	German government prepares for bank rescues in case of a Greek default (Sep. 15, 2011)
Debt relief	IMF pushes EU towards another debt restructuring for Greece (Jun. 7, 2013)

Notes: No. of news items.

For news that have been classified either as positive or negative two examples are given.

Source: Eurointelligence.

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