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# **Relevance of Sovereign Bond Valuations Topic in the Speeches of ECB Officials**

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Linas Jurkšas  
(Bank of Lithuania)<sup>1</sup>

Vitalijus Klinevičius  
(Strata)

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<sup>1</sup> Email: [ljurksas@lb.lt](mailto:ljurksas@lb.lt).

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Gedimino pr. 6, LT-01103 Vilnius, Lithuania

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## **ABSTRACT**

The aim of this paper is to assess how relevant is the topic of sovereign bond valuations in official ECB Executive Board member speeches and, in particular, under what circumstances do ECB officials begin communicating the driving factors of sovereign bond pricing. For this purpose, we downloaded over 2000 public ECB Executive Board member speeches and applied various text mining techniques. The visual analysis revealed that the importance of the topic of sovereign bond pricing and related risk factors in ECB officials' speeches has greatly fluctuated over time. The main structural break points were linked to the financial market turbulences, but this topic, possibly due to the introduction of sovereign bond purchases, remained relatively popular even after stress episodes. The linkages between the publicly communicated terms of sovereign bond pricing and related risk factors were rather complex and change in respect to the market situation. Meanwhile, the sentiment balance of the credit risk factor was usually on the negative side, while the ones of other terms were much more neutral.

Keywords: ECB Executive Board, speeches, sovereign bonds, risk factors, correspondence analysis, sentiment analysis.

JEL codes: C80, E43, E58, G12.

## 1. INTRODUCTION

What risk factors are driving sovereign bond valuations? For instance, is the credit risk, liquidity or other market risks affecting sovereign bond markets? Do these relationships change during different phases of financial and business cycles? These and other related questions have been investigated by many researchers (Kyle, 1985; Manganelli & Wolswijk, 2009; Favero et al., 2010; and others) who mostly analysed the financial and macro data with various econometrical models. Still, the final answers to these complicated and multifaceted research questions are far from being conclusive and unanimously agreed on.

Another way to approach this issue is by examining the speeches of policymakers, i.e. officials whose every word is attentively scrutinized by mass media and financial market participants. This is especially true for central banks as they are often regarded as independent and trustworthy institutions whose relative importance has increased substantially since the onset of the global financial crisis of 2007-2008. For instance, the famous words of Mario Draghi, President of the ECB, "to do whatever it takes to preserve the euro"<sup>2</sup>, has highly affected overall market sentiments and thus impacted the dynamics of sovereign bond markets. As a result, the speeches of central bank officials provide rich material that can help reveal how monetary policymakers assess the current state of the sovereign bond market development (for instance, whether it is overvalued or not) and what risk factors are driving bond valuations.

The direct concern of sovereign bond market functioning from the monetary policy implementation perspective arose due to the introduction of quantitative easing programmes in advanced economies. After reaching the zero lower bound during the aftermath of the global financial crisis, the focus shifted towards influencing long term yields. Significant efforts were made by central banks in communicating their intentions to keep rates at zero for an extended period of time and conduct large scale asset purchases. In January 2015, the Eurosystem's version of quantitative easing was announced (ECB, 2015).<sup>3</sup> This statement implied that the Eurosystem would become a dominant investor and would affect the functioning of euro area sovereign bond markets. It is well accepted that central bank purchases impact bond yields, but it is highly debatable through which channels these yields are affected. The speeches of "insiders" provide further useful explanation on this issue.

The aim of this paper is to assess the relevance of the sovereign bond valuation topic in ECB Executive Board (EB) member speeches. In particular, it is important to determine what risk factors, according to ECB communication, are related to euro area sovereign bond valuations. We applied various methods to discover the dynamics, correspondence and sentiments of this relevant and important topic.

The application of different text mining techniques for the speeches of ECB officials helped us find out what risk factors were considered by monetary policymakers as the most related to sovereign bond valuations during different market regimes. The first set of visual analysis data revealed that the sovereign bond pricing topic was used by ECB EB members several times more often during the European sovereign debt crisis of 2010-2012 (compared to pre-crisis times) when the yield spreads spiked substantially. Meanwhile, the risk factor terms were relatively more often used during the global financial crisis of 2007-2008 when yield

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<sup>2</sup> Full quote from the speech in London on July 26, 2012: "Within our mandate, the ECB is ready to do whatever it takes to preserve the euro. And believe me, it will be enough."

<sup>3</sup> The Public Sector Purchase Programme (PSPP) was announced on 22 January 2015. Together with purchases of private-sector assets (asset-backed securities and covered bonds), which had been ongoing since September 2014, the PSPP constituted the ECB's so-called Expanded Asset Purchase Programme. Complementing a series of policy rate cuts (eventually into negative territory) and other non-standard monetary policy measures, the asset purchases were intended to help bring euro area inflation back to the ECB's desired level of close to, but below, 2%.

increases were rather muted in the euro area, possibly due to the substantial decrease of ECB policy rates. The correspondence analysis showed that sovereign bond pricing and risk factor terms were used unequally by different ECB officials: ECB EB members responsible for market operations have been touching on these topics much more frequently. The collocation analysis revealed that the risk factor terms were often mentioned without explicit referral to sovereign bond pricing, meaning that the sovereign bond price changes are often not linked by ECB EB members to the selected risk factors. The sentiment analysis showed that the view on credit risk and market liquidity deteriorated since the onset of the global financial crisis, while the sentiments on sovereign bond pricing topic were the lowest during the European sovereign debt crisis.

The better understanding of (changing) relations between sovereign bond valuations and risk factors in official speeches is beneficial for various interested parties. Firstly, market analysts can gain insights about current ECB officials' view on the sovereign bond market conditions both in relation to previous communication and on driving risk factors. This is especially the case during the period from 2007 to 2012, when the euro area experienced two crises with different contributing factors. ECB EB members deliberated much more about market liquidity and, in particular, about credit risk, and less often about overall pricing of sovereign bonds during the global financial crisis of 2007–2008, while the focus changed significantly throughout the European sovereign debt crisis of 2010–2012 when yield spreads spiked. Secondly, bond market investors can make more substantiated decisions by understanding policy makers' shifting sentiments. For instance, although overall sentiments deteriorated significantly during both crises, the timing of shifting sentiments was not like the ones for different risk factor and bond pricing terms. Also, after reaching the zero lower bound, ECB decided to increasingly communicate their intentions to keep extremely low rates for an extended period of time and conduct sovereign bond purchases. Thirdly, the relations between bond valuations and risk factors are not yet fully known from the academic perspective, and thus this analysis complements event and econometrical studies. The risk factors were mentioned without explicit referral to the sovereign bond pricing term during some periods, meaning that changing prices are often not linked to the sampled risk factors. As a result, a dynamic rather than static analysis of sovereign bond pricing and risk factors is necessary. Fourthly, better comprehension of the effects of officials' speeches is beneficial for the policy makers themselves because this helps them to improve public communication in order to achieve the desired goals more efficiently. For instance, ECB EB members stress particular asset valuation risks (e.g. due to emerging financial stability risks) or shift their focus / tone about a specific issue. This is predominantly important during times when central banks around the world are employing various forms of forward guidance to affect the markets and improve the transmission channels.

The remainder of this paper is organised as follows. Section 2 provides a review of literature on the related topic. Section 3 briefly describes the methodological aspects of the analysis. Section 4 provides a visual representation of the results as well as the discussion of main finding. Section 5 concludes.

## **2. LITERATURE REVIEW**

To our knowledge, there is no similar study that focuses on the sovereign bond pricing factors extracted from central bank speeches. However, some strands of literature touch on this topic. Below in this section we review studies related to the text mining of central bank communication as well as sovereign bond pricing.

There are only several papers analysing public ECB EB speeches, possibly due to technical difficulties in obtaining data. Minutes or press conferences held after monetary policy meetings are analyzed quite often

(e.g. Ehrmann & Fratzscher, 2009). Personal diaries of ECB officials are also analyzed by some analysts (e.g. Badinger & Nitsch, 2019). Still, Hartmann & Smets (2019) have used almost 2000 inter-meeting ECB EB member speeches to analyse the main themes and how they evolve during time. By using the latent Dirichlet allocation method, the authors identified 50 specific topics and then group them to nine general themes. For instance, they found that the theme of public debt and sovereign risk increased in importance since the start of the European sovereign debt crisis. Ferrara (2019) also analyzed the ECB EB member speeches with automated text classification tools to detect the evolution of different economic ideas. By concentrating on a relatively narrow topic of fiscal policy and sovereign debt issues, the author revealed that after an initial emphasis on fiscal discipline, EB members gradually shifted their focus to the systemic risks, in line with major ECB unconventional measures. Kuesters (2018) analyzed ECB EB member speeches between 2007 and 2015. He found that speeches containing references to historical lessons constituted only 5% of the overall corpus, while the German school of economic thought has regained prominence during the euro area crisis. Tortola & Pansardi (2018) analyzed only ECB presidential speeches and found that the charismatic content of ECB's presidency corpus emerged after the financial crisis of 2007-2008.

Several researchers used natural language processing techniques and dictionaries to find the sentiments of central bankers' speeches. In an interesting study, BBVA (2019) used natural language processing techniques to evaluate the tone and sentiments from the speeches of two ECB chief economists: Peter Praet and recently appointed Philip Lane. The authors also employed several dictionaries (e.g. Fed dictionary for financial stability) and found, for instance, that Lane's (when he worked at the Central Bank of Ireland) tone has become more dovish than Praet's tone since the Brexit referendum. Lane was also found to be more focused on financial and global issues. Although the majority of the other researchers (e.g. Musard-Gies, 2006, Brand et al., 2010, Hansen et al., 2016) cover most developed countries, Iglesias et al. (2017) analyze the statements and minutes of the Central Bank of Turkey. They reveal that the sentiments have been fluctuating over time as the economic conditions change and that monetary policy complexity has increased markedly since the global financial crisis.

Turning to sovereign bond valuations, this topic has been analysed from various perspectives. Many central bankers as well as academic scholars analyse sovereign yield curves and their developments with Nelson & Siegel (1987) or similar-type methods. Following the state-space specification, the shape of the yield curve can be decomposed to three main elements: the level, slope and curvature. However, such models are mostly used to represent and fit the shapes of yield curves by finding different parameters and thus less applicable in the case of this study, i.e. analysis of ECB speeches that are linked with sovereign bond pricing and related factors.

From a theoretical standpoint, various risk factors are often included in securities pricing models (Kyle, 1985; Vayanos and Wang, 2012). For instance, the sovereign bond yields are often found to be positively linked with the debt / deficit dynamics, agents' risk-aversion, and etc. There is also a wide range of empirical studies linking macroeconomic factors with bond valuations: Chen (1991), Ameer (2007), Ludvigson & Ng (2009), Gerlach et al. (2010), Arghyrou & Kontonikas (2012), Jurkšas & Kropienė (2014), and many others. However, not many authors come to the conclusion that low frequency indicators, such as GDP, inflation and debt, constantly affect dynamics of bond valuations.

As sovereign bonds are regarded as an almost riskless asset, yields can be decomposed into risk-free rate (RFR) and additional yield spread that emerges due to the risk that investors assume by investing in sovereign

bonds. In theory, the RFR is not a separate risk factor, but rather the minimum return that the investor would expect for any available investment as he would not accept additional risk if the probable rate of return is greater than the RFR. However, in practice the RFR does not exist as even the safest assets – sovereign bonds – carry additional risks. The relationship of the sovereign bond yield with RFR and various risk factors (RF) is often illustrated by the following equation:

$$yield = RFR + RF_{credit} + RF_{market} + RF_{liquidity} + RF_{other}$$

The additional risk factors are often grouped to credit, liquidity and common market risk as well as bond- or market-specific components. Manganelli & Wolswijk (2009) and Afonso et al. (2015) state that the credit risk component is usually found to be the most important factor in explaining government yield spreads as even government bonds are not fully riskless assets – thus the credit risk component reflects the financial compensation that investors require to cover government default risk. Therefore, a rise in the country-specific riskiness indicator should naturally increase the yield spread over the risk-free rate. Favero et al. (2010), Borgy et al. (2011) and Alessandrini et al. (2012) find that common market risk (often expressed as financial stress indicator) is highly linked to yield spreads. This risk factor entails the possibility that all investors would bear losses due to non-favourable dynamics in all financial markets, and thus this risk usually cannot be eliminated through diversification. The relative importance of the liquidity component embedded in yields is less trivial. For instance, Alquist (2010) found that liquidity is a prominent, economically large and durable feature of the sovereign bond yields. When markets become more stressed, the market makers are less willing to take the additional risk, and thus usually widen the difference between submitted ask and bid prices and/or reduce the quoted quantities. However, Ejsing & Sihvonen (2009) and Afonso et al. (2015) highlight that the liquidity component is usually insignificant during normal market conditions. Bernoth & Erdogan (2010) add that liquidity premium never plays a significant role after the entrance of a given country to the European Monetary Union. Other factors are also often used to determine yield dynamics, e.g. Afonso et al. (2015) additionally add the euro effective exchange rate, Alonso et al. (2002) add lags of yield spreads as they often exhibit mean-reversion properties. Research of the euro area sovereign bond market is often complicated as there are 19 different markets and thus market fragmentation might appear in different periods for different countries.

Bridging these two separate strands of literature – text mining of central bank communication and sovereign bond pricing factors – helped us detect how often and in what circumstances sovereign bonds are mentioned in ECB EB member speeches.

### 3. METHODOLOGY

In this study we have used the publicly available ECB EB speeches<sup>4</sup>. These speeches provide rich material that helped reveal, in regards to the objective of this study, what risk factors were considered by monetary policymakers as most related to sovereign bond valuations. Overall, we have downloaded over 2000 different speeches that were delivered in the period between 1997 and April 2019. We removed non-English language speeches as well as speeches that were relatively short. The remaining speeches (2075) were saved in one file. For these tasks, R packages called "XML" and "textcat" were used.

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<sup>4</sup> As ECB is the de facto successor of the European Monetary Institute (EMI), the speeches of officials from both institutions that are available on the ECB website are employed in this study. The EMI was established in 1994 to handle the transitional issues of states adopting the euro, while the ECB formally replaced the EMI on 1 June 1998. However, the public speeches of EMI are available only since 1997. All speeches are available on ECB website: <https://www.ecb.europa.eu/press/key/>.



*Text cleaning.* The texts of downloaded speeches have a lot of meaningless elements that could negatively affect analysis results. For example, punctuation, numbers and *stop words*<sup>6</sup> create unnecessary noise for further analysis, thus such words were removed. Additionally, footnotes and references were also removed as they are more often of a technical nature.

*Combination of words.* In order to identify specific terms which might consist of several words, it was necessary to link words. First of all, we split text into consecutive sequences of words to find out what word combinations appear most frequently in the context related to our research. Although these sequences of words provide significant amount of information, it can sometimes be misleading as the word appearing together might be accidental. In order to avoid this, we additionally used the procedure of the so-called *word collocations*. Like in the case of consecutive sequences, word collocations allow us to identify word pairs, but it additionally measures statistical significance of such combinations, using *chi-square* test and *p-value*. Therefore we used an R package called *key word in context* ("kwic") to analyze context of specific phrases and to identify possible combinations of words. For the sake of this research, we have concentrated on four main terms: sovereign bond pricing, credit risk, market liquidity, and market risk. The specific combinations of words under these four terms are provided in Annex 1. After extracting all word pairs that we are interested in, we again used word collocations, only this time for the combined terms.

*Correspondence analysis.* In our research we also used the so-called *correspondence analysis* that helps to identify possible relations between qualitative variables, i.e. speakers and key terms of interest. Correspondence analysis is often presented as a model-free technique, since the data "speaks for itself" (Benzecri, 1973). Such analysis provides a solution for summarizing and visualizing a data set in a two-dimensional plot (Kassambara, 2017). For example, it is self-evident that various ECB EB members use specific key terms (i.e. sovereign bond pricing, credit risk, market liquidity, market risk) at different frequencies. But it is also important to determine the *x* and *y* axis coordinates that could help to visualize graphically several different associations. R package "factoextra" and others were used for this task.

*Sentiment analysis.* Sentiment analysis, also known as opinion mining, allows to overview attitudes behind certain topics, in this study – the speeches of ECB EB members. There are multiple approaches for sentiment analysis, but we used R packages "quanteda" and "janeaustenr" as well as "NRC" lexicon, which contains positive and negative expressions. The detection of such expressions in ECB EB speeches allows us to compute the overall sentiment indicator (positive minus negative ones) for the full time period. It is important to mention that there are several limitations for sentiment analysis. For instance, it is not possible to distinguish sarcastic or similar expressions that usually mask negative sentiments. Also, it is possible that text data contains some irrelevant information, which can disturb the lexical approach of sentiment analysis, or sentiments would not be related to the key areas that we are interested in. In order to minimize such biases, additional text preprocessing was implemented. Speeches were tokenized into paragraphs, leaving only those with key terms under interest (i.e. sovereign bond pricing, credit risk, market liquidity, market risk). Also, we grouped speeches into different quarters of the year – by doing this, we could compute quarterly averages that are less prone to outliers and misleading dynamics.

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<sup>6</sup> *Stop words* are the most often used words, such as "a", "was" "if" and etc. Although there is no universal list of such words, we used a list of *stop words* in R package ("tm"); at the moment of writing this paper consist of 175 different words.

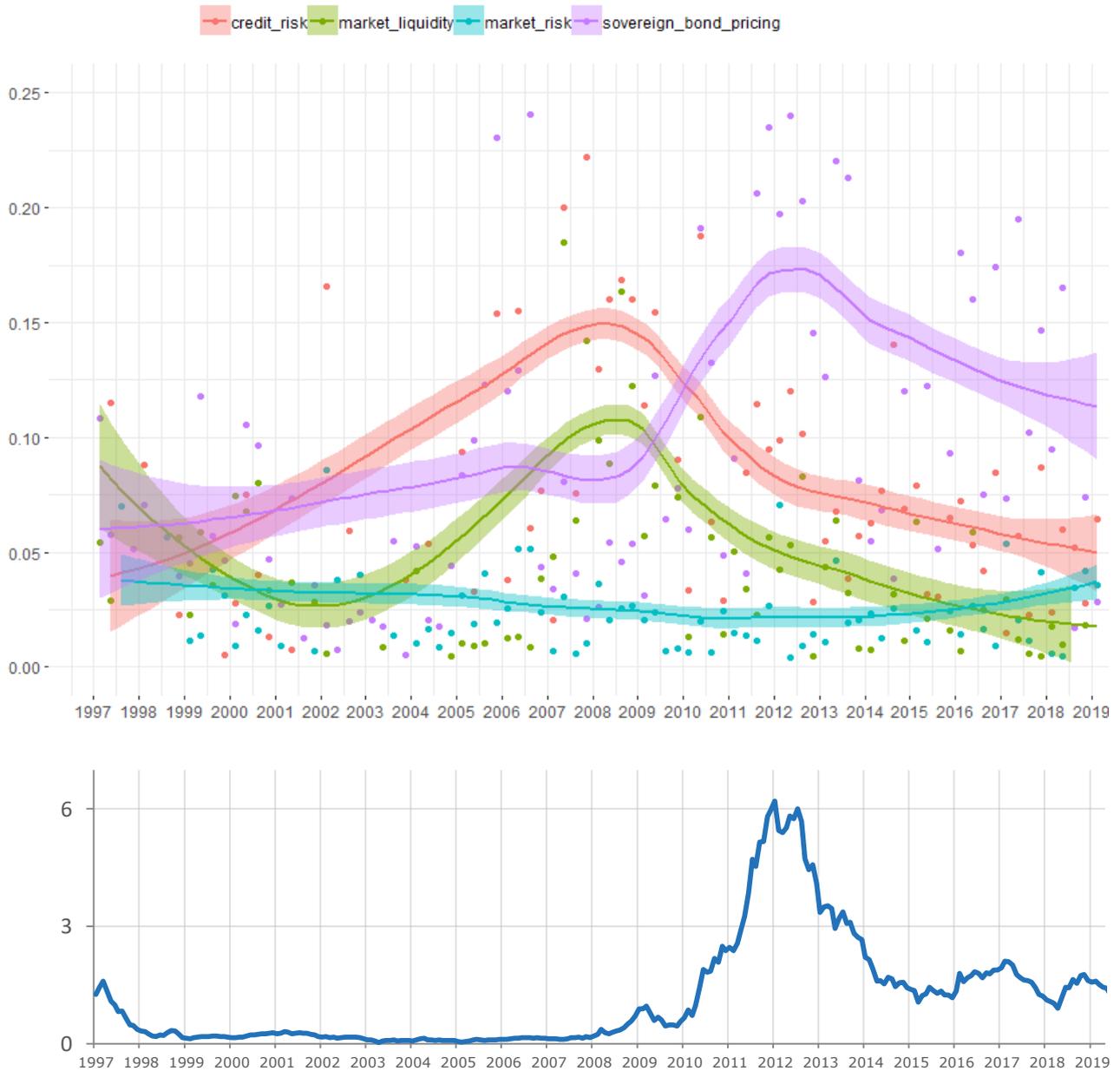
## 4. RESULTS

The first set of the visual inspection results revealed that the terms related to sovereign bond pricing and risk factors were used rather rarely by ECB EB members, but its' relative importance was changing under various market regimes (see Figure 2). In order to understand fundamental and long-term changes in ECB officials' speeches, the highly volatile quarterly usage of such terms was processed with geometric smoothing procedure. By doing this, the main structural shifts of the topics used by ECB EB members become much clearer.

The break points of the sovereign bond valuation topic were highly linked to the turbulences in financial markets. The usage of the sovereign bond pricing topic increased in tandem with a commonly constructed indicator for financial risk: yield spreads of euro area sovereign bonds. This is particularly visible during the European sovereign debt crisis in 2010-2012 when yield spreads spiked together with the usage of the sovereign bond pricing term. When the risks in euro area sovereign bond market abated, this topic naturally became less relevant and thus EB members used it less often, although the decline was quite gradual. This finding is in line with Hartmann & Smets (2019) result that the theme of sovereign risk increased since the start of the European sovereign debt crisis. Still, the usage of this term remains higher than before the sovereign debt crisis, possibly because Eurosystem has been conducting large scale asset purchases since March 2015, thus directly interfering in the euro area sovereign bond markets.

It is important to note that the usage of this term did not increase during the global financial crisis in 2007-2008. In some sense, it is quite natural: there were very few signs of fragmentation in euro area sovereign bond market in 2007-2008 as the rise of yield spreads remained relatively muted. Therefore, ECB EB members did not speculate much about this issue through their official communication. Also, then the ECB had not employed significant sovereign bond purchases, but substantially decreased interest rates, i.e. by 3.25 p.p. in one year. However, the situation has changed dramatically during the European sovereign debt crisis of 2010-2012, when yield spreads spiked and the ECB decided to introduce several measures to reduce the fragmentation in the euro area sovereign bond markets, for instance, the Securities Markets Programme in 2010 and Outright Monetary Transactions in 2012. After approaching the zero lower bound in 2009, the focus of policymakers shifted towards influencing long term yields. As a result, the increasing usage of terms related to sovereign debt pricing is also noticeable in ECB EB speeches.

Figure 2. Number of times a particular term is used out of all words used in the ECB EB member speeches (upper chart, in %) and euro area yield spreads (lower chart, in %)



Notes: One dot in the upper chart depicts how many times a particular term is used in relation to all other words in the speeches of ECB officials during a three month period. The lines are drawn from the geometric smoothing parameters (from loess method with 0.5 span) of how much a particular term is used during time. Bands around the central line indicate the level of confidence interval (95%). The lower chart depicts the dynamics of the average euro area sovereign bond yield spread, calculated from these major markets:  $(Yield_{Italy} + Yield_{Spain} + Yield_{Portugal})/3 - (Yield_{Germany} + Yield_{France} + Yield_{Netherlands})/3$

The ECB communication about terms of risk factors related to sovereign bond pricing has been also fluctuating highly over time<sup>7</sup>. Naturally, the most widely used term was credit risk, i.e. the factor that investors mostly concentrate on when pricing bonds. Manganelli & Wolswijk (2009) and Afonso et al. (2015) also stated that it is the driving factor for sovereign bond valuations. Not surprisingly, the usage of this term in ECB EB speeches peaks during the global financial crisis of 2007-2008 when there was a lot of speculation about the solvency of the issuers. Similarly, albeit on a lower scale, market liquidity becomes an acute concern during turbulent periods, but was less used under more liquid market conditions. As a result, the credit risk and market liquidity terms have on average been much less-used recently. Overall, the increase of the usage of credit risk and market liquidity terms coincided with the ECB presidency of Jean-Claude Trichet. Meanwhile, the market risk term has been used much more consistently and rather rarely during the full sample period, although the usage of this term has increased recently. These findings somewhat relate to the results of Ferrara (2019) that ECB EB members shifted their focus to systemic risks when the ECB started employing various unconventional measures.

The dynamics of the usage of risk factor terms didn't always coincide with the interest of sovereign bond pricing topic. For instance, the usage of risk factor terms did not increase during the turbulent period of 2010–2012, while the topic of sovereign bond pricing reached its peak during the same period. As it was explained before, the sovereign bond pricing topic was very acute during the European sovereign debt crisis as then euro area yield spreads increased dramatically and the ECB had to introduce new measures. At that time, ECB EB members mostly focused on the issue of fragmentation among member states and the broader term of sovereign bond pricing. Possibly, ECB EB members did not speculate much about particular risk factors driving market yields as not all euro area countries suffered increasing yields (e.g. Germany, the Netherlands, and Finland) – the main issue was more about the diverging paths of sovereign bond prices among different member states. Meanwhile, the situation was the opposite during the global financial crisis of 2007–2008, when euro area sovereign bond yields increased only marginally compared to the period of 2010–2012, partly due to the rapid decrease of ECB key policy rates. However, there were relatively more speculation about deteriorating market liquidity and increasing credit risk in overall euro area and global markets. Besides, there was no particular Eurosystem purchase program during the global financial crisis that could help alleviate market liquidity and credit risks. Another possible reason explaining the difference between various periods is the changing composition of the communications: all ECB EB members have changed in 2010–2012, so naturally the topics under interest have somewhat changed.

The sovereign bond pricing and related risk factor terms were used unequally by different ECB EB members. As can be seen from Table 1, there is a stark difference between the usages of such terms. In particular, ECB EB members responsible for market operations (e.g. Benoît Cœuré, José Manuel González-Páramo) emphasized various terms related to sovereign bond valuations much more frequently. Meanwhile, several ECB EB members almost never used such terms in their public speeches. It is also important to note that the usage of different risk factor terms was unequal even for particular members: for instance, Lucas Papademos and Jean-Claude Trichet highlighted credit risk much more frequently than the market liquidity and, in particular, market risk, possibly because their terms in office coincided with the global financial crisis of 2007-2008.

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<sup>7</sup> Another risk factor – exchange rate risk – was also often distinguished by other researchers and by ECB officials. However, this factor is much less important when sovereign bond prices are analysed only from local (euro area) market perspective. So it was decided not to include it in the final figure.

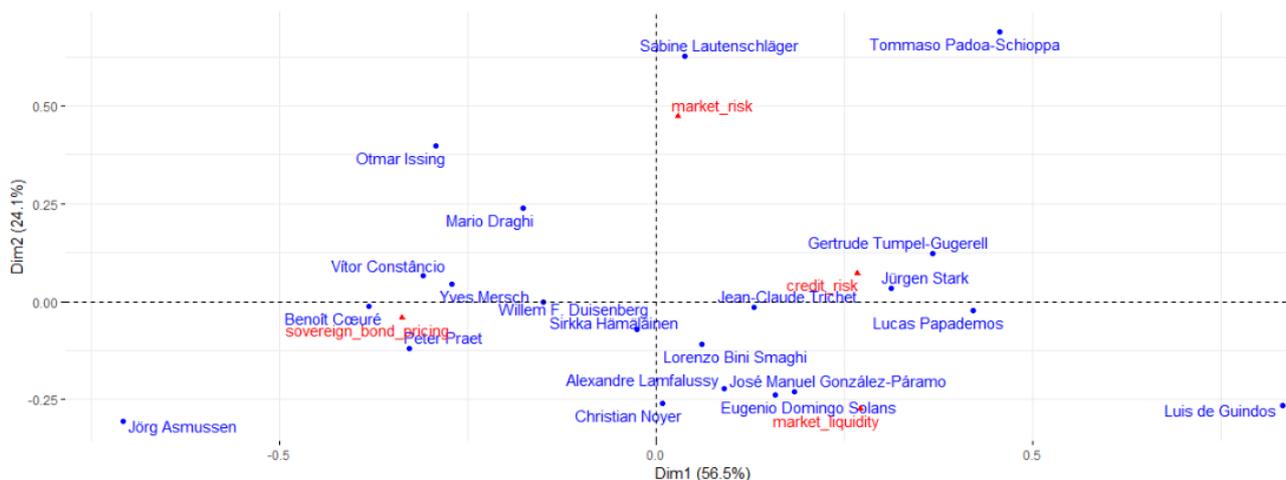
Table 1. Number of times a particular term is used by each ECB EB member

Speaker	Sov. bond pricing	Credit risk	Market liquidity	Market risk	Total
Alexandre Lamfalussy	4	4	2	0	10
Willem F. Duisenberg	39	16	19	12	86
Christian Noyer	28	14	22	6	70
Eugenio Domingo Solans	15	14	15	4	48
Otmar Issing	29	13	4	12	58
Sirkka Härmäläinen	31	9	26	14	80
Tommaso Padoa-Schioppa	7	43	10	20	80
Lucas Papademos	78	238	79	22	417
Gertrude Tumpel-Gugerell	29	112	32	19	192
Jean-Claude Trichet	159	221	79	29	488
José Manuel González-Páramo	125	184	102	17	428
Lorenzo Bini Smaghi	97	158	58	20	333
Jürgen Stark	35	81	24	9	149
Vítor Constâncio	148	145	22	21	336
Peter Praet	96	42	26	11	175
Mario Draghi	89	95	10	23	217
Jörg Asmussen	30	4	6	1	41
Benoît Cœuré	243	175	51	37	506
Yves Mersch	82	82	10	8	182
Sabine Lautenschläger	23	43	4	18	88
Luis de Guindos	0	5	4	1	10

Note: The more vivid the colour, the more a particular term is used compared to usage of the same topic among all ECB EB members.

The visual correspondence analysis showed that different EB members focus on different topics (see Figure 3). The first two dimensions explain a relatively high proportion of the total variance, while the *chi-square* test result ( $p$ -value  $< 2e-16$ ) confirmed that particular speakers and key terms are statistically significantly associated. Moreover, there seems to be clusters of terms used by different ECB EB members, although several officials used various terms rather equally, e.g. Willem F. Duisenberg, Sirkka Härmäläinen, Lorenzo Bini Smaghi. It is also visible that market risk term was used more in isolation from other terms.

Figure 3. Correspondence of different ECB EB members and the risk factors



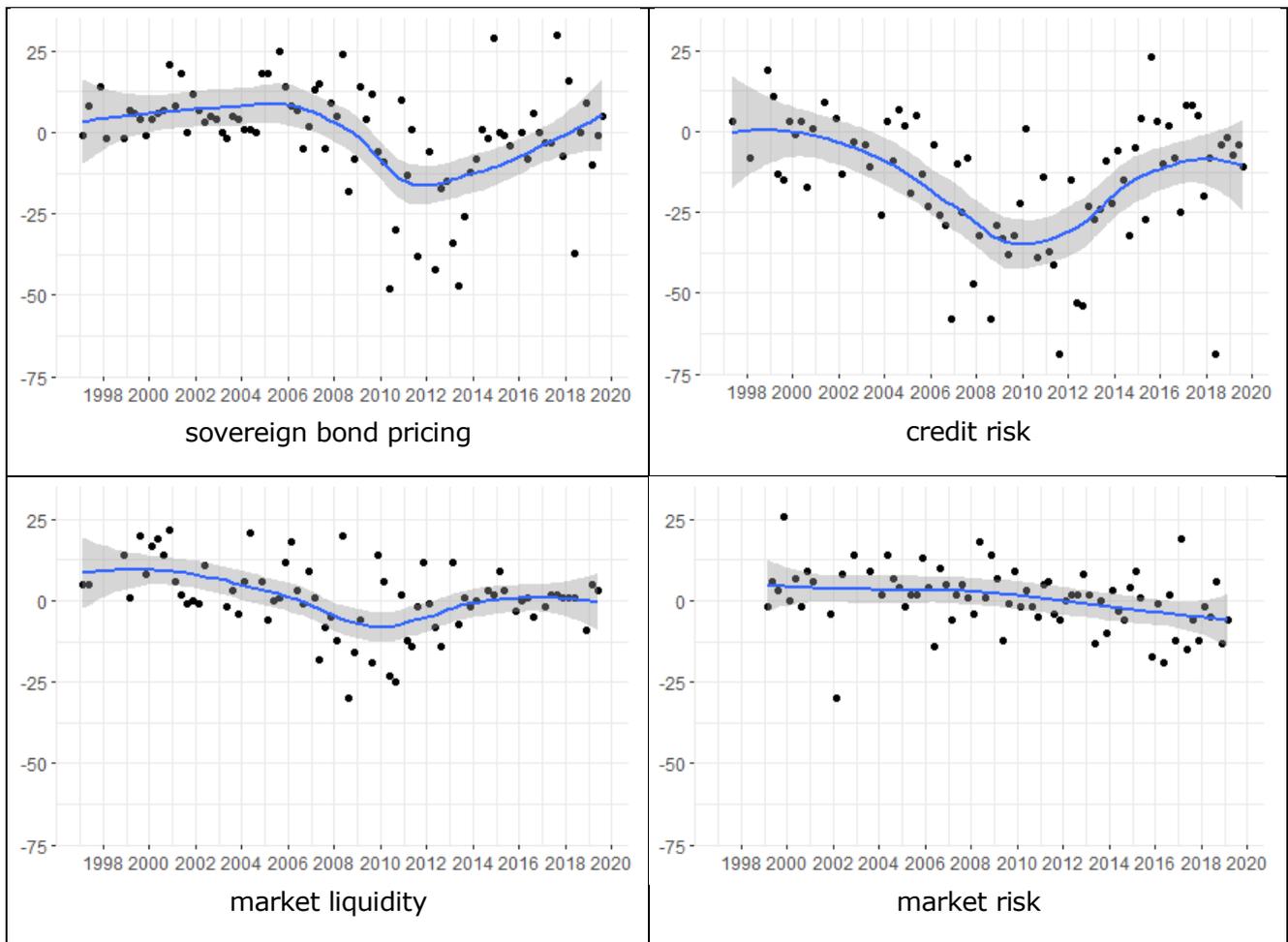
Notes: The two dimensions from X and Y axis explain 80.6% of variance, while the third dimension – 19.4%.

The visualisation of collocations revealed the complex linkages of the terms of sovereign bond pricing and related risk factors in ECB EB member speeches (see Figure 4). The risk factors connect directly (i.e. through one straight line) to the term of sovereign bond valuations. ECB EB members (e.g. Papademos, 2010; Constâncio, 2014) state that the financial crisis highlighted such drivers of euro area sovereign bond pricing as credit and liquidity risk premia, as well as market risk. However, other terms were also often used together with sovereign bond pricing and risk factor terms. For instance, credit risk is linked to sovereign bond pricing through “debt”, “bank”, “crisis”, i.e. terms implying solvency problems and thus relating to both sovereign debt and credit risk. Term of market liquidity connect to sovereign bonds through such terms as “low”, “high”, “increase”, “spread” and etc. This implies that changes of sovereign bond prices were often related to the level of market liquidity. The term of market risk relates to sovereign bonds through the terms “capital”, “asset”, “euro”, “financial”, i.e. refer more to market characteristics. Naturally, risk factors were often mentioned in ECB EB member speeches together without explicitly referring to sovereign bond pricing. However, standalone picture of relations between different terms gives only a subjective interpretation of the ECB officials’ sentiments – thus further automated text mining analysis is required.

The additionally performed analysis on the opinion in the ECB officials’ speeches indicates that sentiments were rather different across risk factors and during time (see Figure 5). The sentiments on sovereign bond pricing deteriorated during the European sovereign debt crisis, while sentiments on related risk factors – somewhat earlier. The overall sentiments seem to have improved when the ECB started increasingly using non-standard monetary policy measures and directly interfering in bond markets. Iglesias et al. (2017) also found that policy makers’ sentiments change in relation to the evolution of economic conditions. Sovereign bond pricing and, especially, credit risk terms seem to be the most volatile ones, while market risk and liquidity factors fluctuated in a relatively narrow range. Although dynamics of sentiments of credit risk and market liquidity were rather similar, sentiments of the credit risk factor were usually on the negative side (i.e. below 0), meaning that this term was often attributed by ECB officials to undesirable occasions. Meanwhile, the sentiments of market risk seem to decrease gradually, although it usually remained on a positive side.



Figure 5. Sentiment index of a particular term used in the ECB EB member speeches



Notes: One dot depicts the sentiment index of a particular term during a three month period. The min/max value is -100/100. The lines are drawn from the geometric smoothing parameters (from loess method). Bands around the central line indicate the level of confidence interval (95%).

## 5. CONCLUSIONS

The speeches of ECB officials provide rich material about what risk factors were considered by monetary policymakers as the most related to sovereign bond valuations during different market regimes. The application of various text mining techniques let us find out the dynamics, sentiments and correspondence of the euro area sovereign bond topic in ECB EB member speeches.

The first set of visual analysis revealed that the usage of sovereign bond pricing and related risk terms fluctuated highly over time. The ECB communication shifted to sovereign bond valuations during the European sovereign debt crisis of 2010-2012 when yield spreads spiked, but this term remained relatively popular even later on, possibly due to the start of large scale asset purchases since March 2015. The usage of related risk factors did not increase during the European sovereign debt crisis, possibly due to the fact that market fragmentation, including very high yields in particular markets, was more acute topic during that period. The situation was very different during the global financial crisis of 2007-2008 when the usage of different risk factor terms peaked. Then the most widely used risk factor was credit risk as bond market investors began reassessing the solvency of the issuers. Similarly, market liquidity became an acute concern during the global

financial crisis and was less used when markets were regarded as rather liquid. As the euro area yield spread remained relatively muted in 2007-2008, partly due to the substantial decrease of ECB policy rates, the communication of policymakers about pricing issues was also quite silent. These findings are broadly in line with the results of other researches. Meanwhile, the market risk term has been used much more consistently and rather rarely during the full sample period.

The correspondence analysis showed that sovereign bond pricing and risk factor terms were used unequally by different ECB officials and stressed different risk factors in their public communication. In particular, ECB EB members responsible for market operations have been touching the topic of sovereign bond valuations and related risk factors much more frequently. The changing composition of ECB EB in 2010-2012 has highly affected interest in the topic of sovereign bond pricing. However, concrete guidance of how to interpret different emphasis of ECB officials on particular terms is beyond the scope of this research.

The collocations of the terms of sovereign bond pricing and related risk factors in ECB EB member speeches were rather complex. The risk factors were linked directly to the term of sovereign bond valuations, but, on the other hand, risks were often mentioned without explicit referral to sovereign bond pricing. Moreover, other terms were also often used together with sovereign bond pricing and risk factor terms. The linkages between different terms can help market participants to better gauge how ECB officials relate sovereign bond valuations with risk factors. Policy makers can publicly stress particular risks and channels to inform market participants in advance and thus achieve their desired goals. This is particularly useful during different market situations as was the case during the global financial crisis of 2007–2008 versus the European sovereign debt crisis of 2010–2012.

The sentiment analysis revealed that the view on sovereign bond valuations deteriorated during the European sovereign debt crisis, while sentiments on related risk factors – somewhat earlier. The sentiment balance of the credit risk factor was usually on the negative side, while balance of other terms was much more neutral. The sentiments improved somewhat when the ECB started conducting non-standard monetary policy measures, i.e. by directly interfering in bond markets. Better understanding of current policy makers sentiments in relation to past perspective can help bond market participants make more substantiated decisions. However, the results should be assessed with caution as there are some well-known limitations for text sentiment analysis.

In future research, it would be worthwhile to investigate the topic of sovereign bond pricing for other central banks, e.g. FED, the Bank of Japan and then compare the results. Interesting findings could be obtained by linking sentiments of bond prices and risk factors with related high-frequency financial market data. Also, the shifting relations between the sovereign bond pricing term and related risk factors are also worthwhile to investigate.

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## **ANNEX.**

### **Key words covering multiword terms:**

Sovereign bond pricing: government bond price, pricing of sovereign debt, sovereign yield, government bond yield, government bond spread, yield government bond, spread government bond, rate government bond, spread sovereign bond, yield sovereign bond, rate sovereign bond; and etc.

Credit risk: credit risk, risk credit, credit default, credit market, default risk, default; and etc.

Market liquidity: market liquidity, liquidity bond, liquidity market, liquidity financial market, liquidity traded instrument, liquidity asset, market illiquidity, liquidity risk premium, (il)liquidity premia (-ium), market depth, bid(-)ask, bid(-)offer; and etc.

Market risk: international risk, market risk, international market, common market; and etc.