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// Friedrich Heinemann (ZEW Mannheim), Jan Kemper (ZEW Mannheim)

Inflation of Objectives Instead of Focus on Inflation?

Evidence on the ECB Objective Function from a Textual Analysis

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EXECUTIVE SUMMARY

In this analysis, we investigate ECB communication by analyzing more than 3,800 speeches from 1999 until 2022. The study measures the attention which ECB Council members pay to various implicit and explicit monetary policy objectives. While price stability, according to the Maastricht Treaty, is the primary objective, other societal objectives can play a role for monetary policy reflections and decisions as well. A changing emphasis on alternative objectives over time but also cross-sectional differences between ECB Council members are an insightful source for current monetary policy debates. In these debates it is discussed to which extent central bank decisions may increasingly be constrained by objectives other than price stability. In addition to price stability, our analysis considers the following dimensions of a possible central bank objective function: financial stability, sovereign bond market stability, public debt, climate protection, and distribution.

We use a computational text analysis approach to detect the salience of these objectives in speeches. First, we develop a new dictionary by combining a machine learning technique and expert knowledge. Second, we apply our central bank specific dictionary to quantitatively measure the development of the above stated objectives over time, across countries and across individual Council members. Our main findings are the following:

Central banks of the Eurosystem differ vastly with respect to their involvement in the monetary policy debate. ECB Council members from the largest euro countries Germany, France, Italy and Spain deliver by far the most speeches. The governors of the smaller and Eastern European member states, in particular, are less visible in the public debate. Voting rights in the ECB Council, with its system of vote rotation, only differ slightly between larger and smaller central banks. Our results point to a de facto larger influence of the bigger countries through their power of words and their much higher visibility in the monetary policy discourse.

Since the euro introduction, there have been significant changes in the relative emphasis on the various objectives. To some extent, these changes correspond clearly to a changing economic environment (as in the financial and euro area debt crisis) or a changing societal awareness (with respect to climate change in the last few years). The attention to price stability tends to fall in times when the inflation rate is close to the ECB objective. Detailed results for changes over time are as follows:

- The debate on financial stability has become more prevalent starting with the financial crisis.
- During the euro area debt crisis, the discussion on sovereign bond market stability and public debt has started to receive a lot of attention and has shown a continuous presence since then.
- Climate protection was completely ignored until 2015. Since 2017, it has started to rise up as the most prominent issue besides price stability in ECB speeches. In 2021, more than 50 percent of all speeches already included at least one reference to climate protection.
- Distributional concerns have slowly entered the discourse of ECB central bankers over recent years but still play a minor role.
- Recently, the discussion on price stability is, again, receiving more attention in central bankers' speeches as a reaction to the on-going increase in inflation. Before that, in the 2010s, price stability had somewhat receded in importance in ECB speeches.

Another set of results refers to the cross-sectional differences across countries and the ECB board. These differences are visible across all objectives:

- There is a division in the verbal attention for price stability in the speeches between the euro area regions. Governors from Southern European countries tend to speak less about price stability as compared to most of their colleagues from other regions.
- Central bankers from Portugal are particularly vocal in the discussion on financial stability.
- Germany along with Greece most frequently participates in the debate on sovereign bond market stability, followed by the ECB board and Italy. Governors from Greece and Portugal talk more frequently about public debt than other Council members.
- Greece is very present in the monetary policy discourse on climate protection, where Germany is positioned in the middle.
- Distributional topics play a relatively larger role in speeches from Lithuania, Portugal, and Finland.

Finally, the analysis explores differences in emphasis between individual Council members. This part of the analysis focuses on the more recent years since 2015. Individual results show the following:

- Individuals in the ECB board tend to talk more about price stability than national governors. This functional difference also shows up, when individuals switch positions. Philip Lane who did not show much interest in price stability topics in his speeches as Irish governor has discussed inflation-related issues extensively as a board member.
- Also on the individual level the North-South difference is pronounced for the price stability topic with Southern European governors showing relatively low scores.
- Christine Lagarde has talked less often about price stability than her predecessor Mario Draghi. For climate policy, it is the opposite. Lagarde leads the whole ECB Council with her strong emphasis on climate policy while these issues were hardly ever mentioned in Draghi's speeches. Isabell Schnabel also actively participates in the climate debate while the other board members are less engaged.

From the presence of a topic in speeches we cannot directly infer central bankers' positions regarding their objective or how these objectives influences monetary policy decisions. However, the study concludes that there is a risk of current ECB communication. From the perspective of critical ECB observers, the higher salience of other (implicit) objectives beyond price stability over recent years could indicate a loss of focus. With the current unprecedented rise both of the euro area inflation rate and inflation expectations there is therefore a case that the ECB should reconsider its communication. Emphasizing a broad set of various policy objectives could be taken as a signal that the ECB is increasingly willing to accept compromises once trade-offs are emerging between price stability and those other objectives.

1. INTRODUCTION

The European Central Bank (ECB) is operating in a challenging economic and political environment today. On the one hand, a whole series of economic disruptions since the financial crisis has defied conventional approaches to monetary policy. Like other central banks, the ECB has reacted with various innovative monetary policy instruments including the conduct of massive asset purchase programs (Havlik and Heinemann, 2021; Krishnamurthy et al., 2018). On the other hand, the ECB has taken over new tasks and has to position itself to emerging European political requests. Since the financial crisis the ECB has taken over decisive responsibility for banking supervision (Howarth and Quaglia, 2014). Afterwards, in the euro area debt crisis and pandemic, the ECB established itself more and more as a lender of emergency liquidity to governments (Wyplosz, 2019) . As a reaction to the EU Green Deal, ECB representatives increasingly started discussing a greening of monetary policy (Schnabel, 2021). Finally, central bankers began regularly reflecting on the responsibility of monetary policy for social inclusion (Dossche et al., 2021).

This increasing range of issues and societal objectives with potential implications for monetary policy raises difficult questions for the ECB. The Maastricht Treaty has defined an objective function in which price stability is the priority and must not be traded off against any other objectives. However, the increasing Eurosystem involvement as the largest investor into the euro area sovereign bond market has fueled the debate on the risks of "fiscal dominance" (Hinterlang and Hollmayr, 2020; Schnabel, 2020; Wyplosz, 2019). There is a concern that the ECB may be reluctant to fight inflation pressure in a determined way due to the possible negative repercussions of higher interest rates or ending bond purchases for high-debt euro countries. Recently, the ECB Council has established the "Transmission Protection Instrument" (TIP), which signals the Council's persistent focus on spread containment in the euro sovereign bond market, also beyond the pandemic crisis situation. From this perspective, the potential increase of numerous other de facto central bank objectives could endanger the priority for price stability in the ECB objective function as defined by Art. 127 TFEU. On various further societal objectives like climate protection and social inclusion, critics point to the risks of a wider set of policy objectives for the legitimacy of ECB independence (Kronberger Kreis, 2021; Wyplosz, 2019). The more monetary policy decisions follow societal objectives beyond price stability, the more central bank independence may come under threat (De Haan and Eijffinger, 2016).

Our contribution does not delve into this normative debate. Instead, we inform this debate and study how the salience of different objectives has developed over time in the speeches of the members of the ECB Council. Based on textual analysis, we show which of the above mentioned objectives have started to play a more prominent role in central bank communication, and since when. We pay attention to major crises (financial crisis, euro area debt crisis, pandemic) and how they may have provoked a change in emphasis. Moreover, we look into differences across ECB Council members. We discuss the observed differences in the light of possible varying perspectives and (national) interests, e.g. related to dissimilar levels of public debt.

In our analysis, we develop a new central bank specific textual analysis dictionary with the help of a machine learning technique in a semi-supervised manner. The dictionary measures the prevalence of five explicit or implicit objectives of the ECB. We use the dictionary to automatically analyze over 3800 speeches of ECB bankers in the period from 1999 until 2022. This method allows us to compare the evolution of these objectives over time, across countries and across individual Council members. Our

analysis focuses on the following main explicit and implicit objectives that might play a role in a central bank's objective function:

- **Price stability**: This objective refers to the ECB's primary objective as it is defined in Art. 127 TFEU.
- **Financial stability**: The second objective we include is financial stability. The financial crisis 2008/09 had brought the imperfections of European banking and financial market regulation to the forefront. Subsequently, the ECB had to accept major responsibility for banking supervision with its leading role in the Single Supervisory Mechanism and its direct supervision of significant banks since 2014 (ECB, 2014).
- **Fiscal objectives**: The Maastricht Treaty aimed at a strict separation of monetary and fiscal policy through its ban of monetary financing and the independence of the central bank. And even though a central bank, almost by definition, has no explicit fiscal objectives, it may nevertheless pay a large attention to fiscal issues. Fiscal policy is highly relevant for the conduct of monetary policy as it influences growth and inflation and it may also has an impact on financial stability. This is the case if high public debt levels cause a crisis of confidence as it was the case in 2010/2012 with the euro area debt crisis. We decompose the central bank's "fiscal objectives" into two sub-dimensions:
    - **Public debt**: Central bankers discuss public debt and deficit issues e.g. in the context of debates on an appropriate macro-policy mix. Equally, they may refer to the level and the dynamics of public debt to discuss sustainability risks that are relevant for the conduct of monetary policy as these risks may impact the real economy or financial stability.
    - **Sovereign bond markets**: A somewhat different dimension of fiscal issues relates to the market for sovereign bonds. Sovereign bond market tensions with rising interest rate spreads have been at the center of the euro area debt crisis in 2010/12. In the pandemic, ECB representatives have increasingly emphasized that rising sovereign spreads may impede the monetary transmission mechanism. Recently, the ECB has even established a permanent "Transmission Protection Instrument" (TPI) that explicitly wants to counteract "excessive" spreads. Critics would see an increasing prominence of these topics in central bank communication as indication of an increasing risk of fiscal dominance.
- **Climate protection**: In recent years, the debate on the role of the ECB in tackling climate change seems to have received growing attention (e.g. Christine Lagarde, 2021). The ECB also employs increasingly more resources to cover climate policy topics. For instance, in 2021 a climate change center within the ECB was established that directly reports to Christine Lagarde (ECB, 2021).
- **Distribution**: Monetary policy, through its impact on growth, employment, inflation and (real) asset returns, may have distributional consequences. Central banks may pay more or less attention to these repercussions.

In the next section, we describe the corpus of ECB speeches that is the foundation for our analysis. In section three we explain our dictionary methodology. Finally, in section four to six, we present our results on the prominence of the above defined objectives over time, across countries and across individual central bankers.

2. DATA AND DESCRIPTIVES

In order to detect differences and changes in the topic salience of the ECB Council members, a large speech corpus is required. The most extensive sources available are the central bank speech collection from the Bank of International Settlements (BIS) and the official speeches data set from the ECB (ECB, 2019; Bank for International Settlements, 2022). The BIS uploads speeches from nearly all national central banks around the globe on a daily basis and dates back until 1997. It includes speeches from the executive board and from the national governors in the ECB governing council. For every euro member state at least one speech of their respective governor is available but there are significant differences in the frequencies, which will be discussed in detail below. Moreover, data from the official ECB speeches data set is used which includes all speeches from ECB board members from 1997 until today.

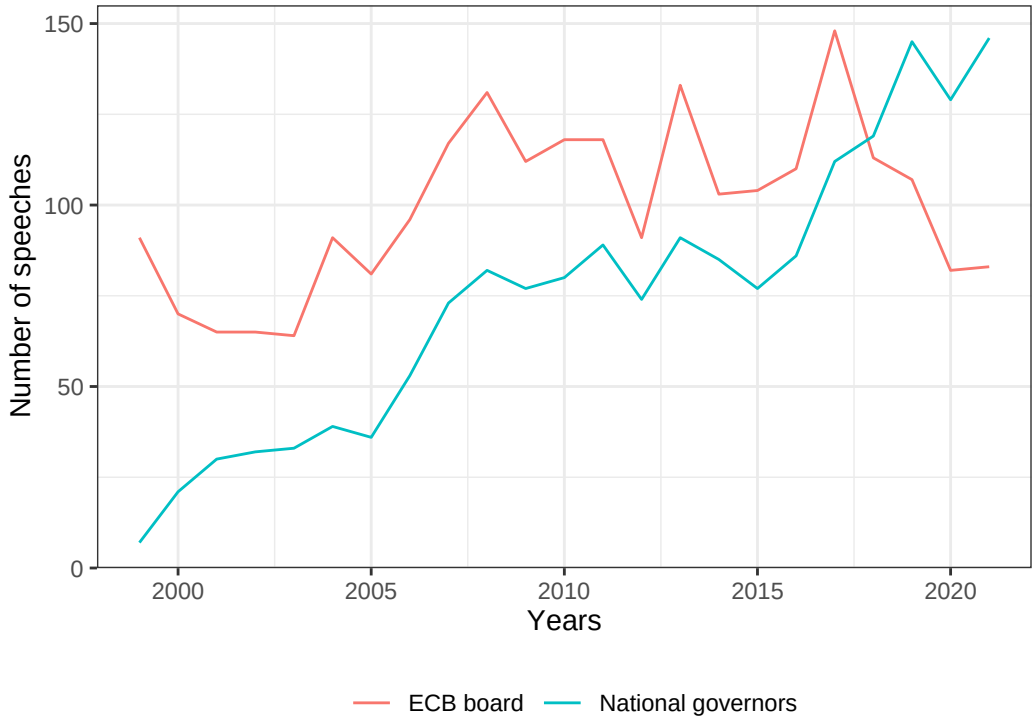
The analysis is restricted to English speeches because we are interested in the euro area discourse which is mainly held in English or where at least an English transcript is available. Furthermore, English speeches are better captured by the BIS website and the analysis is more comparable across states. The main caveat of the BIS data base is that it does not cover the whole universe of speeches. There are two sources of missing data. First, speeches are only available if an official transcript exists. Second, some of the speeches are not detected by the BIS, hence they are missing in the data base. In order to estimate the magnitude of the problem, we compare the BIS speeches with the official ECB data set. For example, the BIS data base contains 42 speeches from Christine Lagarde, whereas the ECB data set entails 50 speeches. For national governors, we compare the speeches uploaded at the Bundesbank website with the BIS sample. For Germany's former national governor Jens Weidmann, 216 transcripted speeches are available, while the BIS data base reports 161. Considering that several speeches on the Bundesbank website are only in German and thus not included in the BIS data base, the BIS sample seems to be a good approximation of the total number of speeches given to an international audience and we assume that the BIS sample is fairly representative for all speeches. As the BIS sample is very close to the total amount of speeches and there is no evidence that the BIS selects speeches based on content, this assumption seems to be justified.

The speeches were automatically retrieved through web-scraping methods from the BIS website and then a series of pre-processing steps were taken to enable statistical analysis of the text data. The final data set entails 4,918 speeches and covers the period from August 1999 until March 2022. 1,004 speeches were held by executive board members (excluding presidents and vice presidents), 782 are speeches by the presidents, 297 are from the vice presidents and 1781 originate from the national governors. Additionally, there are 1,054 speeches which do not belong to any of the above mentioned groups. These are speeches from national deputy governors, national board members and other participants in the euro central bank discourse. We disregard the latter and base our analysis on the 3,864 speeches from ECB Council members.

In Figure 1, the amount of published speeches by year and position is plotted. The red line depicts ECB board member speeches and the blue line displays the yearly amount of speeches. Overall, the amount of speeches increased over time. From 2006 until 2008 there was a steep rise which coincides with the beginning of the financial crisis. Afterwards the amount of given speeches remained high in comparison to the early phase of the euro. Since 2015, there was another steep increase in speeches for both national governors and ECB board members, but this trend only maintained for the governors.

During the Corona crisis fewer speeches were held by ECB board members. On the other side, this downward trend was less pronounced for national governors.

Figure 1: Number of speeches per year



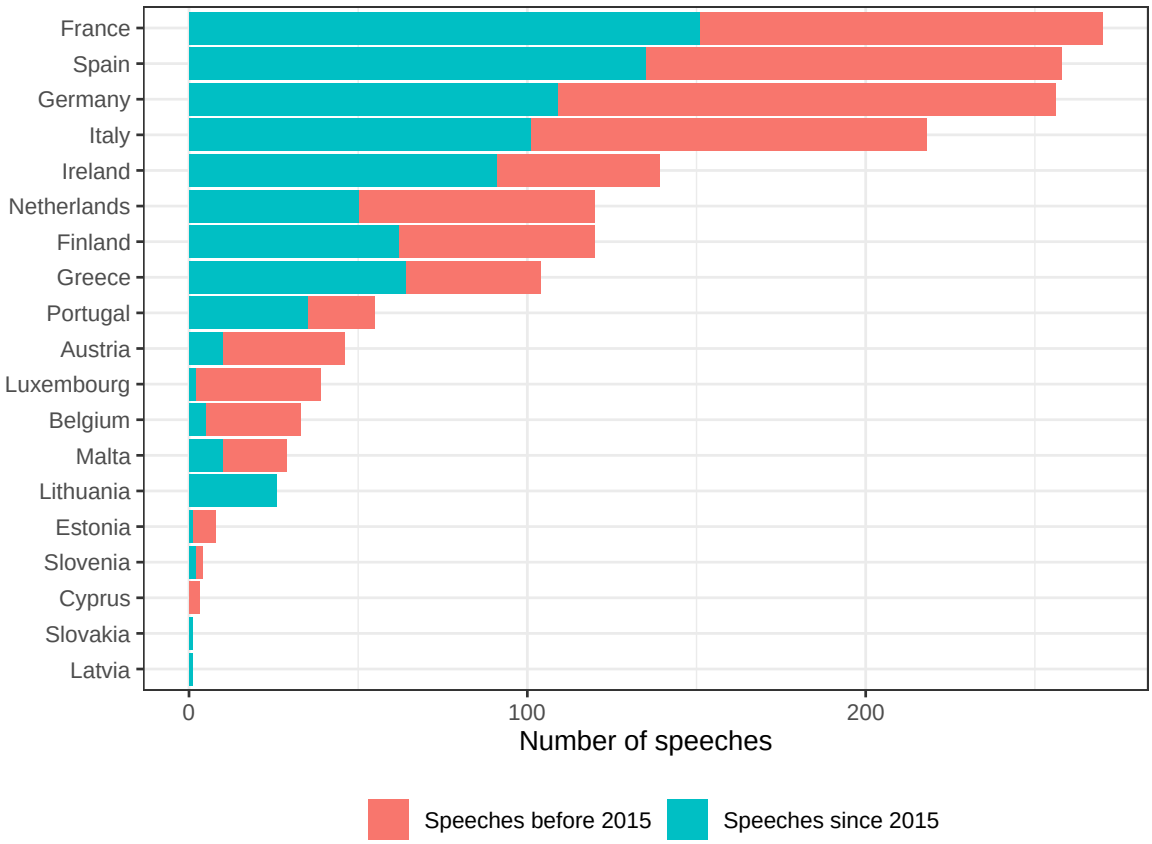
Notes: The data for the ECB board member stems from the official ECB speeches data set. The national governor sample originates from the BIS data set. It is important to note that the speeches from the ECB data set cover the whole universe of speeches from the board members while for the national governors some speeches are missing. Therefore, comparisons between the two lines should be interpreted with caution.

The distribution of speeches is not uniform across countries. In Figure 2, the recorded speeches of the national governors are plotted by country. The red bar shows the total number of speeches since 2000 while the blue bar indicates the share of speeches that were released after 2015. Not surprisingly, the four biggest euro countries Germany, Spain, Italy and France are by far the most vocal ones whereas the smaller Eastern European countries have the lowest number of published speeches. There is a positive correlation between the size of the country and the number of released speeches. This correlation is also robust when just speeches of the last eight years are included which guarantees that all countries had already adopted the euro over the full period under analysis. It shows that the larger euro countries are at least quantitatively dominating the public discourse in the euro area. In the ECB Council itself, the larger countries officially have only slightly more power through the rotating voting right system. But unofficially, larger countries have more impact as most of the executive board members originate from one of the four largest euro states (Germany, France, Italy and Spain).[1] The high frequency of speeches indicates another channel how these states can exercise power. Through their speeches they are shaping the public discourse. One potential explanation for the overweight of

[1] 19 out of the 25 executive board members since 1998 came from Germany, France, Italy or Spain (76 %)

national governor speeches from larger states is that they are equipped with more resources from their national central banks which enable them to set up more speeches. For example, the Bundesbank is multiple times larger than the Estonian central bank Eesti Pank. In the year 2020 the Bundesbank had 10,407 full time employees, while the Eesti Pank had only 221 (Esti Pank, 2021; Bundesbank, 2022). For the statistical analysis on the country level, units with too few observations have to be dropped because there is not sufficient data to draw reliable conclusions.

Figure 2: Number of speeches from national governors by country

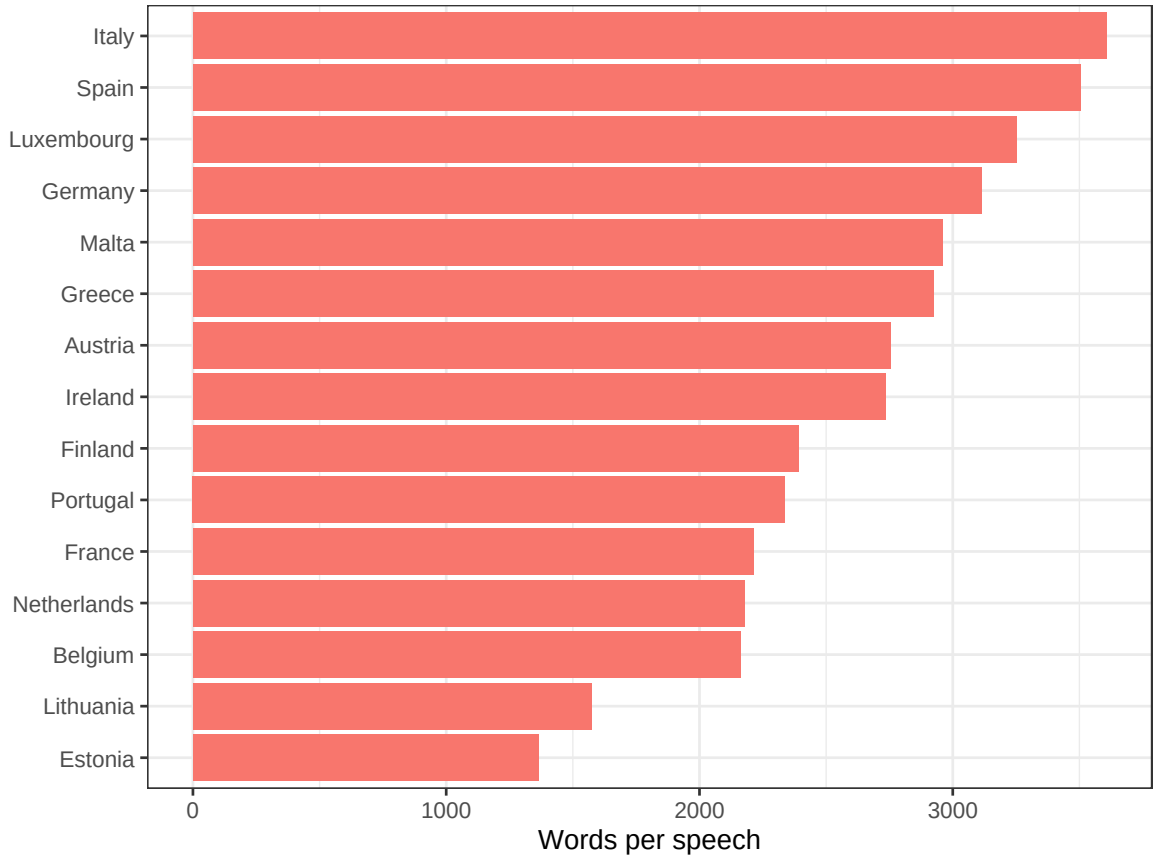


Notes: The plot is based on data from the BIS.

Another important dimension is the length of the speeches. Over the last 20 years, the length of an average speech has not changed in our data set. But there are differences across countries for the national governors. Figure 3 depicts the number of national governor speeches by country. On average, the speeches of Italian and Spanish governors are the longest, while speeches from the smaller Eastern European countries are the shortest. The average speech from an Italian governor with 3000 words is more than twice as long as an average speech from an Estonian governor. This result is not driven by individual outliers, as the ranking remains almost the same when the median value is taken. One explanation for this phenomenon is the occasions where speeches are held. A qualitative analysis shows that the governors of the large Southern euro countries hold long speeches in front of the parliament (e.g. Spain) or extensively present an annual report (e.g. Italy and Spain). Moreover, these speeches are also translated into English. For the smaller Eastern European countries, such long

speeches directed to an international audience rarely occur. Apart from institutional reasons, resources, personal decisions or the cultural background could play a role.

Figure 3: Length of National governor speeches by country



Notes: The plot is based on data from the BIS database and includes only countries where more than five speeches are available.

After having introduced the data set and presented first descriptive patterns based on meta information of the speeches, the next section explains how the content of the speeches can be quantitatively analyzed by using computational text analysis methods.

3. DICTIONARY METHOD

The objective of this paper is to identify what objectives central bankers discuss in their speeches and how frequently they mention these. Assuming that central bankers talk more about objectives that they consider important, we could use the frequencies to infer how relevant a certain objective is in the central bank discourse and how this has changed over time. As described in the introduction, we concentrate on the following five possible explicit or implicit objectives which play an increasing role in the monetary policy discourse in academia and among central banks: “price stability”, “financial stability”, “public debt”, “sovereign bond markets”, “climate change” and “distribution” (see section 1).

Qualitatively reading 4900 speeches and classifying the text into topics is extremely resource intensive. Therefore, we apply computational text analysis methods which are designed to (semi-)automatize the analysis.

For identifying the salience of topics in speeches from the ECB Council members, we develop and apply a central bank specific dictionary. A dictionary includes a list of words that belong to specific concepts or topics which they should measure. For example, a dictionary category that should measure the topic "climate change", probably consists of terms like "climate crisis" and "climate change" itself. These among many more terms describe the topic "climate change", therefore, they are included in this category. After a dictionary has been defined, it is applied to the text data. In a dictionary approach, all term frequencies of a respective category are counted and then summed up on the speech level. The last section has shown that the speech length between different speakers varies by a lot, therefore, the frequencies have to be normalized by the number of words per speech. The following formula describes the normalization process:

$$Topic\ score_{sc} = \frac{Dictionary\ terms_{sc}}{Total\ terms_{s}}$$

s indicates a speech and *c* stands for a dictionary category. The topic score is just the frequency of the counted dictionary terms of category *c* in speech *s* divided by the total terms in speech *s.* In other words, it is the share of dictionary terms in a given speech. In the realm of text analysis, so called "stopwords" which are words that carry no distinctive meaning (e.g. "a", "the") are removed. We follow this procedure and also remove stopwords, which usually reduces the number of total words by about 30 percent. The $Total\ term_s$ component does also not include stopwords.

A dictionary approach requires a high quality and context specific dictionary which correctly measures the intended concept. To ensure valid results, we develop our dictionary in a multi-stage semi-supervised procedure combining machine learning methods and qualitative expertise (for an exact description see Box 1).

Box 1: Development of a central bank specific dictionary

A dictionary approach requires a high quality and context specific dictionary which correctly measures the intended concept. To ensure valid results, we develop the dictionary in a multi stage semi-supervised procedure combining machine learning methods and qualitative expertise. Furthermore, we conduct several validation tasks where we compare the dictionary classifications to human annotated data and unsupervised topic modelling results.

The dictionary development is initiated by deriving relevant topics from the academic and public discourse on the ECB's objective function. Then, we identify key terms which capture the respective topic and take them as a starting point. For example, in the case of the "climate protection" category "climate change" and "global warming" were among the initial terms. A common critique of dictionary approaches is their subjectivity in the term selection. When a dictionary is just based on expert knowledge, the potential bias of the expert can be translated into the dictionary. Furthermore, important terms can just be forgotten in the creation process. To tackle these coverage issues, we train a deep neural network on the speeches data set which returns sophisticated word embeddings (Pennington et al., 2014).

Computer scientists and computational linguists achieved a breakthrough in quantitative text analysis by coming up with machine learning models that can learn the meaning of words and express it mathematically (see e.g.

Pennington et al., 2014; Gentzkow et al., 2019). These models use the surrounding of a word to learn about its semantics. For example, the word "inflation" is likely to co-occur in a context where "prices" are also mentioned. Based on the assumption that words with similar meaning are closer to each other, these models can calculate n-dimensional vectors for every word in their training set. Intuitively these vectors can be thought of as location parameters with very useful characteristics. Research has shown that words which have a similar meaning are close to each other in the vector space. For instance, the words "inflation" and "prices" are in a close proximity which can simply be calculated by cosine similarities (Pennington et al., 2014). Word embeddings are generated through an iterative process on a large corpus of text. One can either use pre-trained word embeddings or train them on a specific form of text. As central bank speeches are very different from other text sources where these models are usually trained at (e.g. Wikipedia), we train our own embeddings based on the complete set of speeches in our data set. Baumgärtner and Zahner (2021) have shown that Glove word embeddings return meaningful results when they are trained on central bank speeches. Therefore, we follow their approach and also train GloVe embeddings (Pennington et al., 2014).

With these word embeddings, we can check which words have a similar meaning to our initial dictionary terms. Then, we qualitatively examine if the words with a similar vector fit into the dictionary. This has the great advantage, that words which were overseen in the initial phase can be detected technically. For example, we start with the word "climate" for the climate dictionary and the word "risk" has a similar vector to "climate", hence, it is likely that "climate" and "risk" often appear together. Hence, the expression "climate risk" is a potential candidate for the "climate change" category. In the next step, we examine if the new found expression appears frequently in our data set. If the term is just used once in the whole corpus, which is often the case for two word combinations, the inclusion makes no real difference for the results of the analysis. On the other side, terms which are frequently used have a substantial weight on the final results. For this reasons, we want to guarantee that these expression really represent the underlying topic. Therefore, we do a key-word in context analysis, where we define a window of five words before and after the expression. Then, we first qualitatively check if the context fits to the topic. Afterwards, the most frequent terms in this window across all occurrences are computed. If the most common words are still related to the topic, the new term is incorporated into the dictionary. Furthermore, through this approach more related terms are detected and after testing included in the dictionary. Following this data-driven approach the list of new terms is examined by a domain expert and refined if necessary. Finally, the dictionary is validated by human annotation in order to test if the automated dictionary topic classification and a human assessment agree. A second robustness check is the comparison of results from unsupervised LDA topic models.

In Table 1, the resulting dictionary is presented. It consists of six categories (five objectives with the differentiation of the fiscal category into public debt and sovereign bond market) and only the first ten terms of each category are shown here. In the first column, the objective "price stability" is depicted. The first term which describes this topic is "inflation*". The asterisk ("*") is an escape character which implies that whatever follows the previously defined series of characters is counted until a space occurs. So "inflation*" includes also the term "inflationary". Further terms in this category are "deflation*" and "price stability". In the Appendix in Table 2, the frequency of the top ten terms for every category is presented. For price stability, the dictionary item "inflation" is used 25,503 times in all speeches and "price stability" occurs 11,692 times. These both terms are the main driver of this category. The fourth column of Table 2 in the Appendix shows in how many speeches the top ten terms appear at least once. The word "inflation" is used by central bankers in more than 2,600 speeches which is equivalent to a percentage share of over 50 percent.[2]

The second column in Table 1 shows the first ten terms which measure the presence of the financial stability topic in the speeches. The most unambiguous term is "financial stability" itself which is also

[2] There are 4918 speeches in total and 2649 include the term "inflation" at least once.

by far the most frequent term in the category (10,969 occurrences). Other terms like "banking stability" and "banking crisis" capture the banking dimension within the financial stability category. In the third column, the two components of our fiscal category are stated. The public debt dimension comprises terms like "national debt*" or "public deficit*". This sub-category measures the saliency of the debate on public debt. The term "public debt" is with 1,774 cases the most frequent term within this sub-category. The second component of the fiscal category is the sovereign bond market stability topic. It includes expressions like "bond market stress" or "market fragmentation" which captures the attention for the stability of sovereign bond market in a central banker's speech. The fourth category is climate protection which describes the discussion on "climate change" and also the respective financial market considerations like "green bonds" and "green investments". The term "climate change" with 1,918 occurrences is most frequently used to debate about climate protection. Finally, the fifth category captures distributional concerns of central bankers through terms like "income distribution" and "inequality" where "inequality" is the main driver with 838 instances.

Table 1: Central bank objectives dictionary

		Fiscal issues			
Price stability	**Financial /banking stability**	**Public debt**	**Sovereign bond market stability**	**Climate protection**	**Distribution**
inflation*	financial stability	national debt*	bond market stress	climate change	income distribution
deflation*	banking stability	public debt*	fiscal space	global warming	wealth distribution
price stability	banking union	government debt*	sovereign yield spread*	green bonds	profit distribution
primary mandate	banking crisis	government's debt	market segmentation	green finance*	inequality
price developments	deposit protection	public deficit*	market fragmentation	green bond*	re-distribution
consumer price*	capital buffer*	government deficit*	bond market stress	green deal	redistribution
energy price*	bank equity	debt sustainability	debt market stress	green investment*	equality of opportunity
commodity price*	credit risk*		sovereign risk	green economy	inclusive growth
hicp	systemic bank*		national bond*	green transition	
price*	systemic risk*		government bond*	green asset*	

The validity of a dictionary approach rests on several important assumptions. First, the concept has to be measurable by term frequencies, which is difficult for very subtle concepts. The here used objectives are clearly defined and at least partly consist of expressions which unambiguously identify them. Therefore, this assumption is likely to be fulfilled. Second, the so called "bag of word" assumption is required (Grimmer and Stewart, 2013). This assumption states that the word order of a document does not matter for the measurement of the underlying concept. Thus, dictionaries do not work well for fine-grained content analysis. But our topics are mostly broad concepts, hence it is possible to capture them by simple term frequencies. To illustrate, once a sentence includes the term "inflation" it is very unlikely that the position of the word changes the fact that the sentence is somehow related to the topic "price stability" in speeches from central bankers. Nonetheless, it is unrealistic to assume that a dictionary can capture a topic completely because complex content depends on the exact context of words that are ignored in dictionary modeling. Therefore, the results of a dictionary analysis should be considered as an approximation rather than an exact value. Furthermore, dictionaries are context specific. A dictionary that was developed for psychology would not work very well on central bank speeches. To resolve this issue, we have developed a central bank specific dictionary. Finally, our

dictionary measures topics and not central bankers' positions. We cannot directly infer from the dictionary results if a central banker supports certain polices or not.

4. OBJECTIVES OVER TIME

In the first analysis, the saliency of the six dictionary topics over time is examined. In Figure 4, the results for all different categories are displayed together. The black line shows the price stability category which is the most frequently used dictionary category. In 2000, the discussion on price stability hit its peak with an average share of one percent price stability terms in speeches after the removal of stopwords. In 2006, before the outbreak of the financial crisis, a second spike in the discussion about price stability emerged. During this period, the inflation rate was above the two percent target rate of the ECB (World Bank, 2022). In 2009, the prevalence of price stability declined drastically while the discourse on financial stability was on the rise. This result fits very well with the events unfolding during that time. From 2007 until 2009 the global financial crisis hit the world and at the same time, the discourse on financial stability became more prominent. In 2009, the inflation rate fell down to 0.4 percent (World Bank, 2022). During the following years, price stability remained a salient topic although less dominant than in the early 2000s. In the year 2015, the inflation rate reached the zero percent threshold; this coincided with a steep increase in central bankers' public discourse on price stability. In the following years, terms from the price stability dictionary occurred on average approximately eight times per speech, thus it continuously was a very prominent topic in the central bankers' speeches. Furthermore, in Figure 8 in the Appendix, the median counts for all years and categories are presented. The median value of the price stability topic is always above one which implies that more than 50 percent of the speeches at least once refer to price stability. Although the sample recording stops in March 2022, the data already shows a steep up-rise in the debate on inflation for the year 2022. Considering this year's all-time high inflation rate for the euro area since the introduction of the currency, this observation was to be expected.

For the other categories, there are three main findings. First, the financial stability category becomes more prevalent in the discourse after the outbreak of the financial crisis. Before the crisis, financial stability was already regularly mentioned in central bankers' speeches but on average the level doubled after the outbreak of the crisis. During the financial crisis, the financial stability debate reached its first peak in 2009 and then a second peak in 2013 following the euro area debt crisis crisis. The two crises seem to have shaped the discourse of the ECB Council which fits to the institutional changes emerging from the lessons of the crisis with the ECB taking over major responsibility in the emerging European Banking Union.

The second main finding is that the discussion on public debt and sovereign bond market stability received a more prominent role during the euro area debt crisis. The upward trend in both categories began already in the financial crisis but only became a major theme after the first signs of the sovereign debt crisis. As high levels of public debt and exploding interest rates for Southern European and Irish bonds played a central role in the course of the crisis, it is expected to find this trend reflected in the public discourse of the Council members. Before the euro crisis, both categories were rarely mentioned. For example, during the year 2007, the public debt dictionary terms were only used 49

times, whereas, in 2010, there were already 232 hits.[3] Following the peak of the crisis, the discussion on public debts quickly became less visible but overall remained on a slightly higher level in comparison to the very low pre-crisis levels. For the sovereign bond market stability category, there was also a steep increase at the beginning of the euro crisis. Similar to the public debt category, we also find a lasting level increase after the crisis. But in contrast to the public debt category, this increase is stronger and remains on a higher level. This could indicate that the ECB Council's attention has shifted from a general public debt concern to a greater focus on the stability of sovereign bond markets in the euro area.

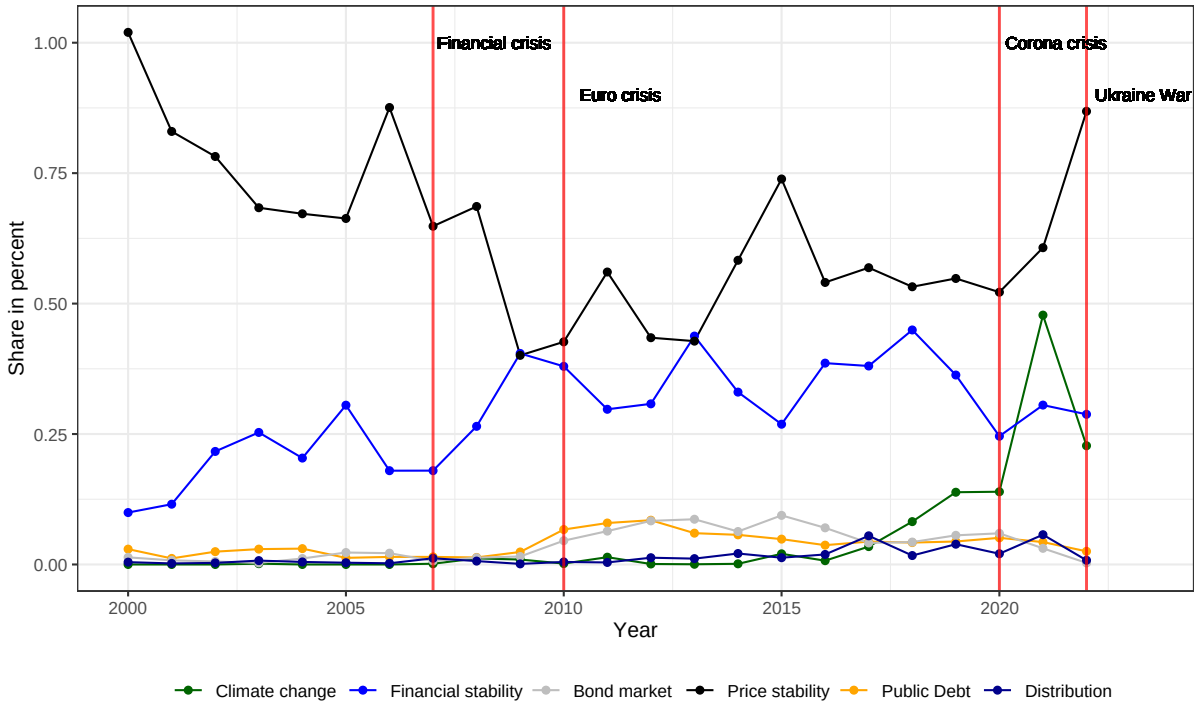
Third, the topic climate protection entered the public discourse only in the more recent years and then quickly became one of the main themes in the ECB Council speeches. In 2014, ECB representatives, with only three occurrences in the "climate protection" category, still almost fully ignored the implications of climate policy for monetary policy. Seven years later, in 2021, the picture has completely changed; terms from the climate protection category were raised 800 times and on average five times per speech. In 2021, the Council members referred in 53.7 percent of the speeches at least once to the climate change category.[4] That does not necessarily mean that all of the Council members would agree that the ECB should play an important role in climate policy; but it clearly shows that the issue of green monetary policy is on the agenda and intensively discussed. Although, different categories should only be compared to each other with caution, it is striking to see that the climate protection category has reached the same range in speech attention as the financial stability topic. Thus, at least rhetorically, a substantial shift has happened within only a few years.

Finally, also the inequality category shows some dynamic over time. In the early years of the ECB, terms relating to inequality rarely occurred. Since 2011, there was an upward trend in this category and in recent years there were several upward spikes. Anecdotal evidence shows that speeches in the first decade often refer to the topic of inequality in a general sense. For example, Lorenzo Smaghi, former executive board member held a speech in 2007, where he discussed the repercussions of globalization for inequality (Smaghi, 2007). In recent speeches, inequality is often discussed in the light of actual monetary policies, primarily quantitative easing. For instance, in 2021 Jens Weidmann delivered a full speech on inequality, where he discusses the effects of monetary policies on inequality (Weidmann, 2021). Although, being still a minor topic, it seems that Isabel Schnabel was right, when she stated that inequality cannot be ignored anymore by central bankers (Schnabel, 2021). At least the data indicates that more awareness for the topic is prevalent in recent speeches. Future research should further look into this new development.

[3] In 2007 and 2010 the total words of all speeches are very similar, therefore, it is valid to compare the counts directly.

[4] 225 speeches are included in our sample for the year 2021 and 121 included at least one term of the climate protection category.

Figure 4: Objective over Time



To summarize, the discourse within the ECB is a dynamic process and has undergone several changes since the introduction of the euro. To some extent, the change in the relative emphasis of issues reacts to current developments and crises. However, there seems to be a clear tendency that the price stability objective, which used to receive the top attention in the first decade of the euro, is facing increasing competition from other implicit monetary policy objectives. Also, the topic composition has evolved and completely new themes like climate protection and distributional issues have become part of the public discussion in central bank speeches.

5. CROSS-COUNTRY DIFFERENCES

The euro member states are a heterogeneous group of countries which vary across many political and economic dimensions. Also their national central banks have a diverse history and reacted differently to challenges in the pre-euro era (Cukierman et al., 1992). Therefore, it is very likely that the euro member states bring in different traditions and agendas regarding their preferred monetary policy. In this section, we test this proposition by analyzing the heterogeneity across member states and the ECB board in their speech content.

In Figure 5, the dictionary score for every category is presented for each member state and the ECB board. The score is averaged over the total observation period (1999-2022) and includes only member states where at least 15 speeches are available in order to avoid unrepresentative results. In the upper-left corner, the price stability category is depicted. The ECB board (including president and vice-president) talks the most about price stability in their speeches and they do so more than national governors. The board's average score over the total time horizon is 0.73 which indicates that 0.73 percent of an average board member's speech, after the removal of stopwords, consists of terms from

the price stability dictionary. Board members often present recent inflation numbers, discuss inflation forecasts and explain monetary policy decisions. All this is all discussed in the light of price stability, which might explain the high share of this objective in their speeches.

For national governors, there is a clear division visible. At the top are Belgium, Finland, France, Germany, and Luxembourg. Austria and the Netherlands are also close to this group of countries whose national governors speak frequently about price stability. With a clear distance governors from Spain, Greece, Ireland, Italy, Portugal, and Lithuania cluster at the bottom of the distribution and pay less rhetorical attention to price stability issues. It is remarkable that most of Europe's southern countries' speeches show a lower prevalence of the price stability topic as compared to most Northern and Central European member states. For the majority of Eastern European countries, an insufficient number of speeches was available, therefore they are missing. Lithuania is the only country from this region represented in the result and has the lowest prevalence of the price stability category.

Within the scope of this paper, we cannot provide a sufficient explanation why there is such a clear division between the member states in regard to the prevalence of the price stability topic in their speeches. There are a series of potential explanations for this division in topic composition among the Council members. First, there might be an economic or political explanation behind this finding. Several economic factors like the debt-to-GDP level, the geographic location, or former inflation experiences correlate with the price stability score distribution. Second, the reason might be found in the structure or type of the speeches. There might be stylistic, cultural or institutional reasons why the speeches differ. For example, there might be different traditions on how detailed a central banker is required to publicly explain his/her policy.

In the upper right corner, the results for the financial stability category are depicted. Portugal's national governors are most vocal in this category. Austria's national governors have the lowest score. Apart from these two outliers, all member states, including the ECB board, seem to talk in a similar range about financial stability.

The two fiscal dimensions sovereign bond market stability and public debts are located in the middle row of the panel. For the sovereign bond market stability category, Germany has the highest score with some distance to the others. This reveals that the debate on sovereign bond market stability receives a lot of attention in speeches from German governors. To further examine this phenomenon, we qualitatively analyzed speeches with the highest score for this category held by Bundesbank governors. Germany's high score is driven mainly by Jens Weidmann's speeches where he criticized the ECB's bond purchases (see e.g. Weidmann, 2014). Apart from Germany, Greece, Italy and the ECB board are at the top of the sovereign bond market stability category. On the public debt dimension, Greece and Portugal have the highest scores. Thus, overall central bankers from high-debt euro area countries in Southern Europe and the ECB board show a larger interest in bond market and public debt topics than most of the other Council members (Eurostat, 2022).

In the lower left corner the results for the climate protection category are shown. Lithuania and Greece are at the top of the ranking for climate protection with a major gap to France, Finland and Italy. Lithuania's outcome is slightly misleading because the earliest speech by a Lithuanian governor occurred in 2017, which was already in a period where climate protection entered the stage of central banking (see Figure 4). On the other side, Greece seems to be a frontrunner of the debate on climate change and monetary policy in the Euro area. Already in 2011, the national governor of the Bank of

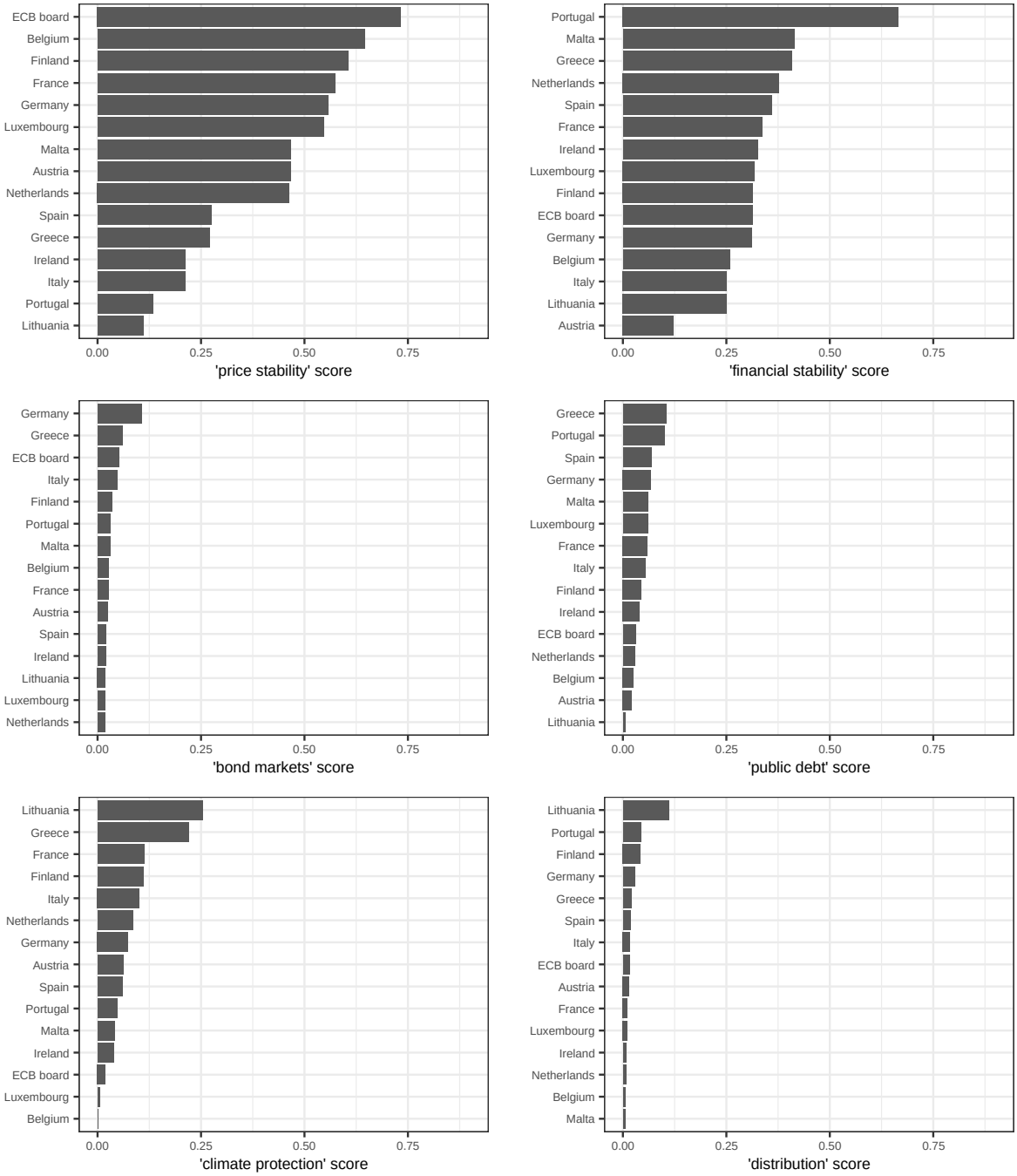
Greece George Provopoulos presented a report on the impact of climate change and devoted a whole speech to this topic (Provopoulos, 2011). Greece is followed by France, Finland and Italy. Germany is located in the middle of the distribution. The first time that any of the climate protection dictionary terms appear in our sample of a German national governor is in 2016 by Jens Weidmann, one year later he held his first speeches solely devoted to the topic (Weidmann, 2017). Later on, several speeches on the topic followed. The ECB board, Luxembourg and Belgium are at the bottom of the distribution. These results should be carefully interpreted because climate protection is an emerging topic and for Belgium and Luxembourg only few speeches are included for the relevant observation period. More surprising is the finding that the ECB board scores very low. Considering that climate change was directly addressed with a "climate change action plan" in the ECB 2021 strategy review, one would expect to see a more active role in the climate domain. The individual analysis in the next section provide an explanation for this puzzle.

Finally, in the bottom right panel the distribution category is displayed. Lithuania has again the highest score which is mainly driven by one speech from Vitas Vasiliauskas on income inequality in Lithuania. It is followed by Portugal, Finland and Germany. But overall the prevalence of the topic is still very low and only a few speeches explicitly targeting distributional issues have been held (see e.g. Rehn, 2021).

To conclude, there are substantial differences for several of our categories across countries and the ECB board. For Southern euro member countries the price stability category was less prevalent than for the Central European members. With regard to the debate on sovereign bond market stability, Germany under Jens Weidmann was very vocal, fiscal topics received a relatively large coverage in Southern Europe. For climate protection, Greece got engaged early.

In the next section the individual dimension is analyzed and the time focus also zooms in on the more recent years.

Figure 5: Heterogeneity across member states and the ECB board



6. CROSS-SPEAKER DIFFERENCES

Another important source of variation in speech content is related to the individual central banker dimension. In Figure 6, all six dictionary categories for all Council members who held at least ten speeches since 2015 are depicted. This time horizon was chosen to enable a graphical representation of the development in recent years. The results for previous cohorts are attached to the appendix in Figure 9 and Figure 10.

In the upper left corner the dictionary score for the price stability category for every Council member is presented. The bars are colored to indicate the function of an individual within the ECB Council. If the position changed over time, the Council member is separately included for each position. For example, Philip Lane was Ireland's national governor until 2019, afterwards he switched roles and became an executive board member as the chief economist of the ECB. For both periods, sufficient data is available, therefore he appears twice in the plots.

Together with the executive board member Peter Praet and the former ECB president Mario Draghi, Philip Lane, since he has joined the board, was at least quantitatively the most present figures in the discourse on price stability. Executive board members often present inflation developments and discuss the current situation on a regular basis, therefore, there might be institutional reasons why the board members are most salient in the realm of price stability. Interestingly, Lane was in the bottom range of the distribution on the price stability dimension before he joined the board as the ECB chief economist. After 2019, inflation has returned to the euro area which could explain this increase but the position change might also have played a role. The first national governor is Finland's representative Olli Rehn with a score of just above one, followed – with a larger distance – by Christine Lagarde. Until our sample stops recording in March 2022, it seems that Lagarde talked quantitatively less about price stability than her predecessor Draghi. Among national governors, Klaas Knot (Netherlands), Erkii Liikanen (Finland) and Jens Weidmann (Germany) devote a large share of their speeches to the topic price stability. As one could already see in the country analysis, the central bankers from the Southern European countries like Mario Centeno (Portugal), Ignazio Visco (Italy) and Yannis Stournaras (Greece) spent a lower share of their speeches on the discussion on price stability. One should be cautious with premature conclusions on the price stability orientation because the differences could also be caused by the speech format or the personal communication style. Furthermore, the plot shows a lot of variation among the executive board members which probably underline the different roles which they play in the executive board.

In the upper right corner of the panel, the financial stability category is depicted. Carlos da Silva Costa (Portugal) has a high score of almost one which implies that after the removal of stopwords on average one percent of the words consist of the financial stability dictionary terms. In the price stability category, he had a very low score, thus it seems that he set his focus on financial stability in his speeches. Afterwards, the executive board members Luis de Guindos, Sabine Lautenschläger und Vitor Constâncio follow. Then, the national governors Mario Centeno (Portugal), Erkki Liikanen (Finland) and Yannis Stournaras (Greece) also have a high score for in the financial stability category. Mario Centeno and Yannis Stournaras both had low scores for price stability but are more active in the realm of financial stability. The rest of the governors are all located in the middle of the distribution, with the exception of Jens Weidmann who seems to talk less about financial stability. Mario Draghi and

Christine Lagarde were both on the lower end but Lagarde seems to refer less often to financial stability than Draghi.

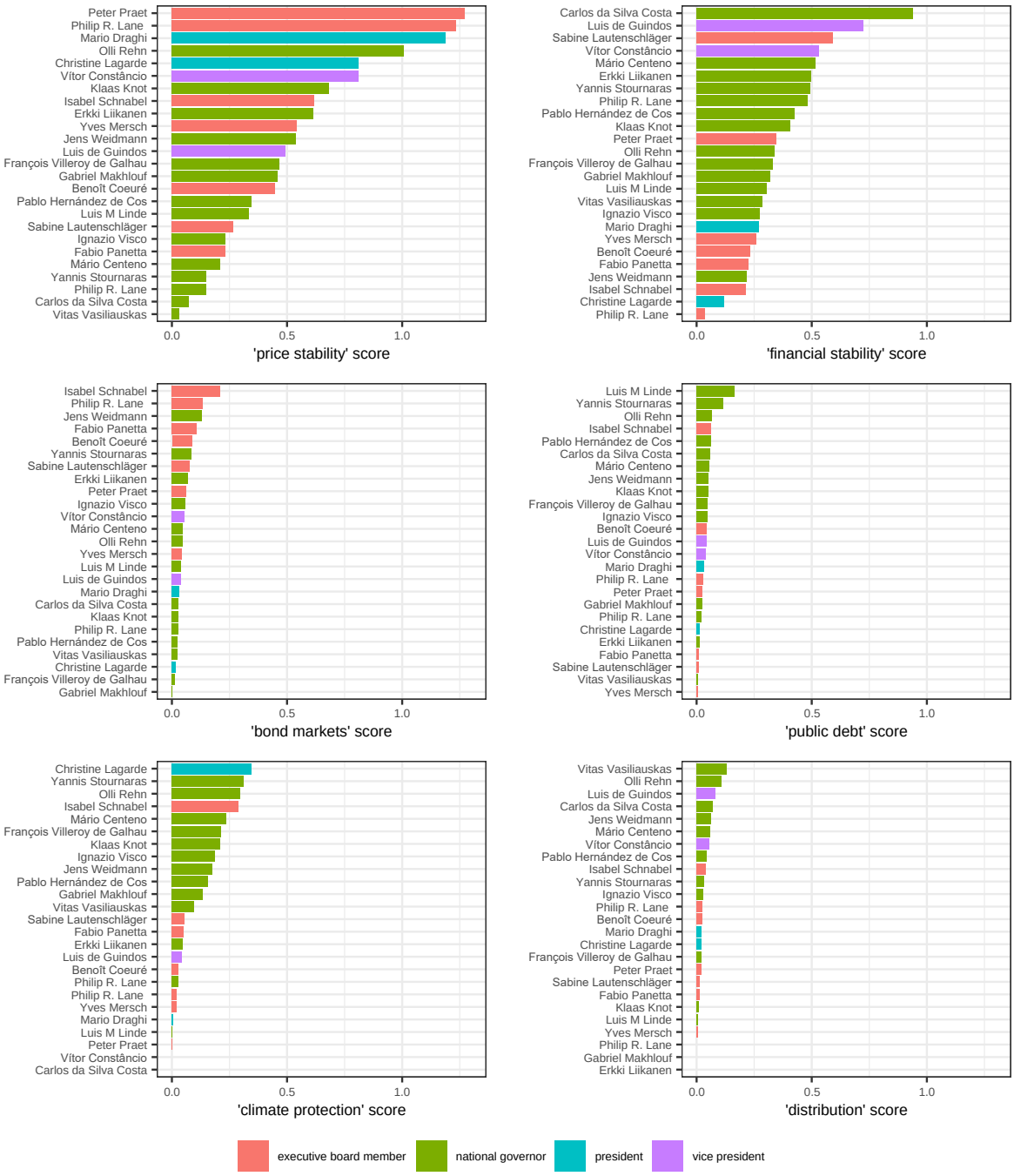
The two fiscal categories are located in the middle row of the panel. On left side is the bond market stability category displayed. Isabel Schnabel has the highest score in this category, followed by Philip Lane. Most remarkable is Jens Weidmann at position three. Among the national governors, Jens Weidmann was the most vocal one. As briefly mentioned above, the main driver of this effect are Jens Weidmann's speeches where he expressed skepticism on the bond market interventions of the ECB. It seems that the top positions in the attention of bond market stability are shared by both proponents for (Lane, Lagarde) and opponents to (Weidmann) a more active role for the ECB for sovereign bond market stabilization. On the right hand side, the public debt category is depicted which is led by Luis M. Linde (Spain) and Yannis Stournaras (Greece). Both countries have a high debt-to-GDP ratio which might play a role why they refer more often to public debt than other central bankers. On the other hand, Ignazio Visco, also representing a country with a high debt-to-GDP ratio, has just an average value in this category.

In the lower left panel, the climate change category is shown. Here a clear change between the two presidents becomes visible. Lagarde has so far been the most active ECB representative in the climate protection debate while Draghi rarely ever mentioned any climate related terms. It seems that Schnabel is supporting Lagarde in her climate protection communication as she also uses a lot climate protection vocabulary in her speeches. The rest of the active executive board was less involved in the debate on climate protection until the end of our observation period in March 2022. The national governors who were in office at least until 2020 seemed to have all joined the public debate on climate change. Yannis Stournaras and Olli Rehn have the highest climate protection scores among the national governors.

The final panel in the lower right corner shows the results for the distribution category. Vitas Vasiliauskas (Lithuania) and Olli Rehn have the highest score. In general the plot shows that Council members seem to recognize distributional concerns in their speeches but it is still a minor topic.

All in all, there is also a lot of heterogeneity across the individual central bankers in the ECB Council. Christine Lagarde plays an important role in the climate protection debate which is jointly embraced by all governors who were active in the recent two years. Furthermore, there are vast differences in the coverage of the price stability category with the presence of a North-South divide (governors from Northern Europe with a higher attention for price stability than their Southern colleagues).

Figure 6: Heterogeneity across individuals 2015-2022



7. CONCLUSION

In this report, we analyzed 3,864 speeches from ECB Council members. In order to quantitatively measure the evolution of the public discourse, we developed a central bank specific dictionary in a semi-supervised manner.

We find that the discourse is a dynamic process and has become more diverse in recent years. The financial and the euro crisis left their footprints on the public debate as financial stability, public debts and the sovereign bond market stability category received more attention afterwards. Up until 2015 climate considerations were almost completely ignored by the Council members. Since 2017, this topic quickly caught up attention and became an important topic in the public discourse. The rising inflation has also affected the public discourse. Although, our data sample records speeches only until March 2022, there is already a steep increase visible for the discussion on price stability.

Furthermore, our analysis showed that there is substantial heterogeneity between different member states and individuals in respect to their public discussion of the here analyzed objectives. Our central bank specific dictionary offers a method to measure these differences quantitatively and compare the Council members to each other. We find that representatives from Southern European member states mention terms relating to price stability less often than their Central European partners. On the individual level, we find that Christine Lagarde is very active in the discussion on climate change but talks slightly less about price stability than her predecessor Mario Draghi. Jens Weidmann was very vocal in the debate on sovereign bond market stability, Yannis Stournaras is actively engaged in the discussion on climate change in central banking and Carlos da Silva Costa most frequently referred to financial stability.

Our findings have to be interpreted cautiously because we measure the relative term frequency which capture how often central bankers mention certain topics. From the relative frequency, we cannot directly infer central bankers' position regarding the objective or how this objective influences monetary policy decisions. Moreover, a low score for one category is not a proof that the respective central banker puts little weight on this dimension as other factors can also affect the speech composition of Council members.

However, some more critical overall conclusions are justified. Our results document that, over the last decade, various explicit and implicit objectives have received an increasing attention in the public statements of ECB Council members. While this kind of central bank awareness for current challenges has its obvious merits there could be a downside. The credibility of a central bank's stability promise hinges on a well-defined objective function and a credible priority for price stability. From the perspective of critical ECB observers, the high salience of other (implicit) objectives beyond price stability in ECB communication over recent years could indicate a loss of focus. With the current unprecedented rise of both the euro area inflation rate and inflation expectations there is a case that ECB representatives should reconsider their communication. Emphasizing a broad set of various policy objectives could otherwise be taken as a signal that the ECB is increasingly willing to accept compromises once trade-offs are emerging between price stability and those other objectives.

AUTHORS
Prof. Dr. Friedrich Heinemann
ZEW – Leibniz Centre for European Economic Research
L 7, 1
Tel.: +49 621 1235-149
68161 Mannheim
Germany

friedrich.heinemann@zew.de

Jan Kemper
ZEW – Leibniz Centre for European Economic Research
L 7, 1
Tel.: +49 621 1235-144
68161 Mannheim
Germany
jan.kemper@zew.de

8. REFERENCES

Bank for International Settlements, 2022. Central Bankers' speeches. https://www.bis.org/cbspeeches/index.htm?m=1123.

Baumgärtner, M., Zahner, J., 2021. Whatever it Takes to Understand a Central Banker – Embedding their Words Using Neural Networks.

Bundesbank, 2022. Geschäftsbericht 2021. https://www.bundesbank.de/resource/blob/885928/03c4d5ef122612e4b8cd3d63c0c49369/mL/2021-geschaeftsbericht-data.pdf.

Christine Lagarde, 2021. Keynote speech by Christine Lagarde, President of the ECB, at the ILF conference on Green Banking and Green Central Banking. https://www.ecb.europa.eu/press/key/date/2021/html/ecb.sp210125~f87e826ca5.en.html.

Cukierman, A., Web, S.B., Neyapti, B., 1992. Measuring the Independence of Central Banks and Its Effect on Policy Outcomes. World Bank Econ Rev 6 (3), 353–398. 10.1093/wber/6.3.353.

De Haan, J. de, Eijffinger, S.C.W., 2016. The Politics of Central Bank Independence. SSRN Journal. 10.2139/ssrn.2888836.

Dossche, M., Slačálek, J., Wolswijk, G., 2021. Monetary Policy and Inequality.

ECB, 2014. ECB assumes responsibility for euro area banking supervision. https://www.ecb.europa.eu/press/pr/date/2014/html/pr141104.en.html.

ECB, 2019. Speeches dataset. https://www.ecb.europa.eu/press/key/html/downloads.en.html.

ECB, 2021. ECB sets up climate change centre. https://www.ecb.europa.eu/press/pr/date/2021/html/ecb.pr210125_1~3fc4ebb4c6.en.html.

Esti Pank, 2021. Annual report 2020. https://haldus.eestipank.ee/sites/default/files/2021-07/eesti%20pank%20annual%20accounts%202020.pdf.

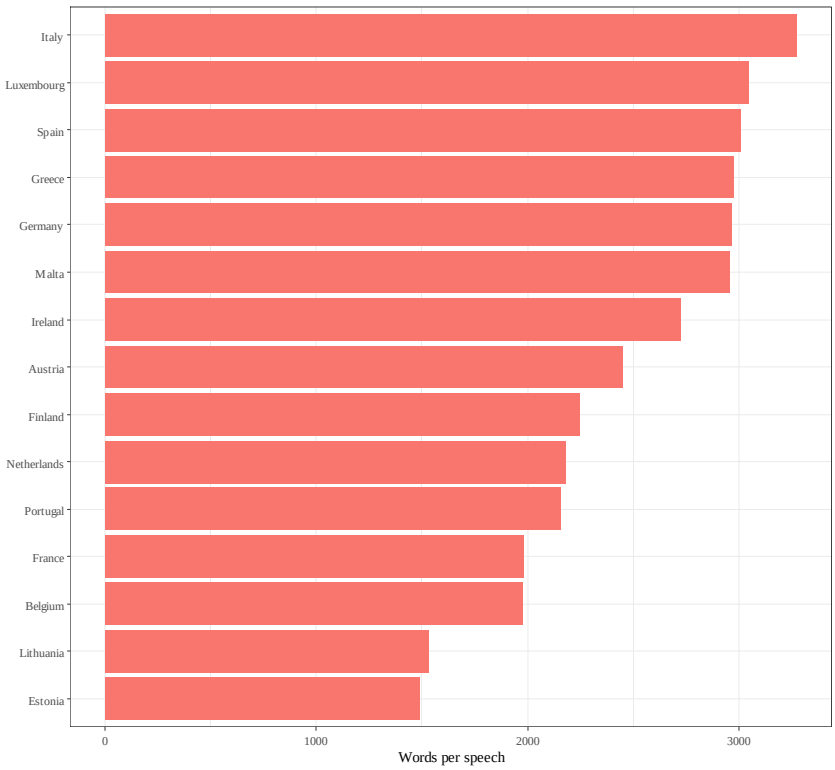
Eurostat, 2022. General government gross debt - annual data. https://ec.europa.eu/eurostat/databrowser/product/page/TEINA225.

Gentzkow, M., Kelly, B., Taddy, M., 2019. Text as Data. Journal of Economic Literature 57 (3), 535–574. 10.1257/jel.20181020.

Grimmer, J., Stewart, B.M., 2013. Text as Data: The Promise and Pitfalls of Automatic Content Analysis Methods for Political Texts. Polit. anal. 21 (3), 267–297. 10.1093/pan/mps028.
Havlik, A., Heinemann, F., 2021. Credit and Capital Markets – Kredit und Kapital: Volume 54, Issue 2. Credit and Capital Markets – Kredit und Kapital 54 (2), 173–197. 10.3790/ccm.54.2.173.
Hinterlang, N., Hollmayr, J., 2020. Classification of monetary and fiscal dominance regimes using machine learning techniques. Deutsche Bundesbank, Frankfurt am Main.
Howarth, D., Quaglia, L., 2014. The Steep Road to European Banking Union: Constructing the Single Resolution Mechanism. J Common Mark Stud 52, 125–140. 10.1111/jcms.12178.
Krishnamurthy, A., Nagel, S., Vissing-Jorgensen, A., 2018. ECB Policies Involving Government Bond Purchases: Impact and Channels*. Review of Finance 22 (1), 1–44. 10.1093/rof/rfx053.
Kronberger Kreis, 2021. The monetary policy strategy of the European Central Bank: Review and recommendations.
Pennington, J., Socher, R., Manning, C., 2014. GloVe: Global Vectors for Word Representation, in: . Proceedings of the 2014 Conference on Empirical Methods in Natural Language.
Provopoulos, G., 2011. The impact of climate change in Greece. https://www.bis.org/review/r110614a.pdf.
Rehn, O., 2021. A European and Rawlsian view on inequality, inclusive growth and monetary policy. https://www.bis.org/review/r210713b.pdf.
Schnabel, I., 2020. The shadow of fiscal dominance: Misconceptions, perceptions and perspectives. https://www.suerf.org/docx/f_40615970e07d91a15cf42214ae5f4847_17607_suerf.pdf.
Schnabel, I., 2021. From Green Neglect to Green Dominance?
Smaghi, L., 2007. Dinner speech: Globalisation and public perceptions. https://www.bis.org/review/r071206g.pdf.
Weidmann, J., 2014. Dinner speech at 20th Dubrovnik Economic Conference. https://www.bis.org/review/r140613a.pdf.
Weidmann, J., 2017. Green bond issuance and other forms of low-carbon finance. https://www.bis.org/review/r170728c.pdf.
Weidmann, J., 2021. Will Covid-19 increase economic inequality. https://www.bis.org/review/r210429c.pdf.
World Bank, 2022. Inflation, consumer prices (annaul %) - Euro area. https://data.worldbank.org/indicator/FP.CPI.TOTL.ZG?locations=XC.
Wyplosz, C., 2019. Limits to the independence of the ECB. Rev World Econ 155 (1), 35–41. 10.1007/s10290-018-0328-2.

9. APPENDIX

Figure 7: Median Speech length of national governors by country



Notes: Data is based on speeches retrieved from the BIS

Table 2: Top ten term frequencies by topic

Term	Frequency	Rank	Document frequency	Category
climate change	1916	7	407	climate protection
climate risks	220	31	95	climate protection
green finance	178	34	77	climate protection
green bonds	145	36	76	climate protection
climate risk	130	37	72	climate protection
climate policy	96	41	39	climate protection
global warming	88	42	59	climate protection
green bond	69	49	36	climate protection
climate policies	56	54	30	climate protection
climate action	48	58	34	climate protection
government bonds	1333	11	632	sovereign bond market
government bond	675	17	383	sovereign bond market
sovereign bonds	442	21	259	sovereign bond market
fiscal space	271	27	188	sovereign bond market
sovereign risk	268	28	175	sovereign bond market
sovereign bond	240	30	165	sovereign bond market
market fragmentation	125	38	90	sovereign bond market
sovereign yields	85	43	56	sovereign bond market

sovereign bond yields	67	51	55	sovereign bond market
market segmentation	37	64	36	sovereign bond market
issuing bonds	19	80	19	sovereign bond market
inequality	838	15	259	distribution
redistribution	260	29	176	distribution
income distribution	108	39	74	distribution
inclusive growth	74	48	47	distribution
wealth distribution	42	61	22	distribution
equality opportunity	20	79	13	distribution
profit distribution	11	97	8	distribution
re-distribution	4	119	4	distribution
inflation	25503	1	2649	price stability
price stability	11692	2	2342	price stability
inflationary	1578	9	812	price stability
price developments	1138	12	575	price stability
deflation	1005	13	521	price stability
deflationary	414	22	306	price stability
primary mandate	158	35	131	price stability
inflation-linked	60	52	39	price stability
inflation-targeting	52	55	32	price stability
inflation-indexed	27	71	9	price stability
inflation-	23	75	20	price stability
public debt	1774	8	748	public debt
government debt	748	16	487	public debt
debt sustainability	326	25	203	public debt
government deficit	190	33	140	public debt
government deficits	81	44	70	public debt
public debts	76	46	46	public debt
public deficits	75	47	68	public debt
public deficit	68	50	64	public debt
public debt sustainability	50	57	41	public debt
public debt-to-gdp	47	59	40	public debt
national debt	46	60	38	public debt
financial stability	10969	3	2636	financial stability
banking union	3588	4	1037	financial stability
banking supervision	2165	5	1017	financial stability
systemic risk	1930	6	761	financial stability
credit risk	1544	10	750	financial stability
non-performing loans	866	14	449	financial stability
npl	654	18	181	financial stability
systemic risks	631	19	381	financial stability
capital buffers	559	20	369	financial stability
capital buffer	365	23	210	financial stability
banking crisis	347	24	255	financial stability

Figure 8: Median dictionary count by year

Year	Price stability	Climate protection	Financial stability	Public debt	Sovereign bond market	Distribution
1999	11	0	0	0	0	0
2000	12	0	0	0	0	0
2001	11	0	0	0	0	0
2002	8	0	0	0	0	0
2003	5	0	0.5	0	0	0
2004	3	0	1	0	0	0
2005	3.5	0	1	0	0	0
2006	9	0	0	0	0	0
2007	5	0	1	0	0	0
2008	5	0	2	0	0	0
2009	2	0	3	0	0	0
2010	2	0	3	0	0	0
2011	4	0	2	0	0	0
2012	2.5	0	2.5	0	0	0
2013	1	0	4	0	0	0
2014	4	0	3	0	0	0
2015	6	0	2	0	0	0
2016	3	0	3	0	0	0
2017	2	0	2	0	0	0
2018	1	0	3	0	0	0
2019	2	0	2	0	0	0
2020	3	0	2	0	0	0
2021	1	1	1	0	0	0
2022	8	1	1	0	0	0

Figure 9: Individual level 2009-2014

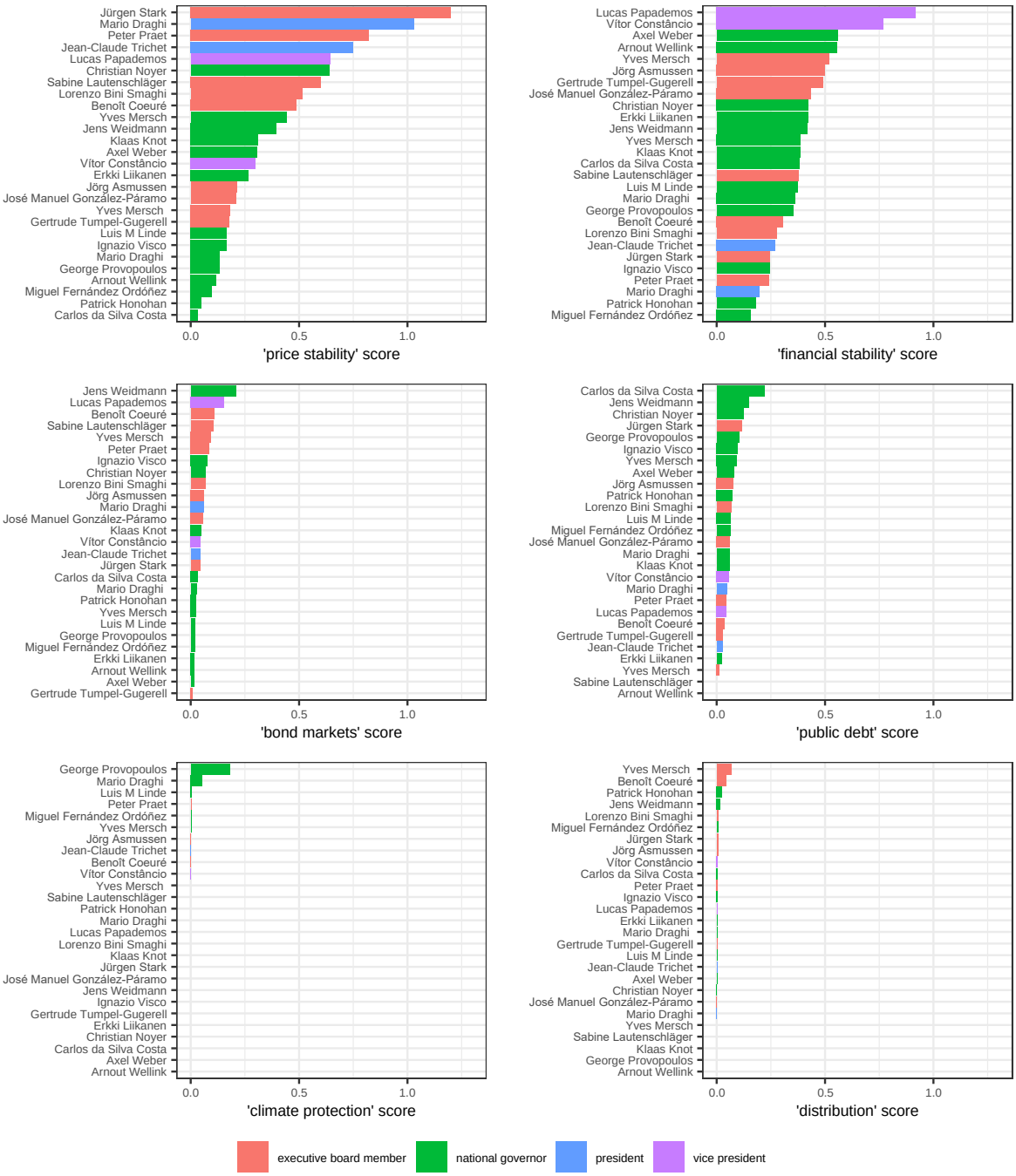
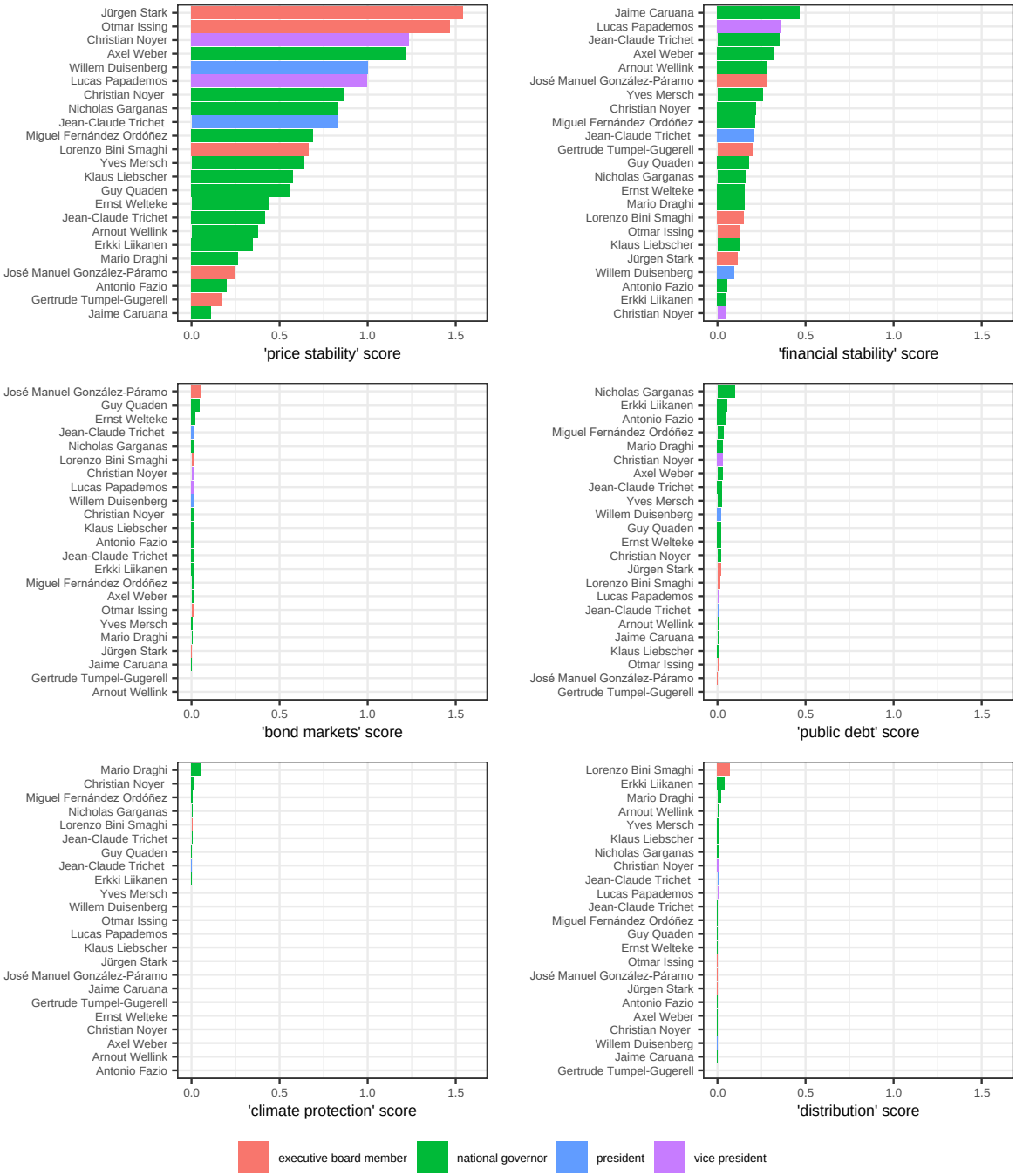


Figure 10: Individual level 1999-2008



Note: The scale of the x-axis had to be adapted because the price stability score exceeded the scale used in the previous plots for Jürgen Stark and Ottmar Issing.