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*On my honour as a student of the Diplomatic Academy of Vienna, I submit this work in good faith and
pledge that I have neither given nor received unauthorized assistance on it*

- Viktoriya Teliha

Abstract

This research provides an in-depth analysis of public communication on climate change by central banks and the political discourse of green central banking to answer the main research question: “Why and to what extent do central banks engage in climate-change-related issues?” Applying a keyword-assisted model (keyATM), the study quantifies the extent of green communication by identifying climate change topics within central banks’ speeches. The research includes various explanatory variables to explore why some central banks engage in climate change discussions more extensively than others. The analysis suggests that central banks introduce green narratives, influencing their institutional and political dynamics. Network analysis highlights the connection between climate change discourse and the financial sector, while sentiment analysis shows a balanced acknowledgment of climate change’s importance. The study concludes that monetary and fiscal interaction is crucial for addressing climate change; however, it can threaten central bank independence. Membership in the Network for Greening the Financial System (NGFS) positively correlates with increased green communication, driven by peer pressure and social reputation concerns. The proactive national government’s role in climate change, measured by national climate policies, also significantly enhances green communication, though the central bank’s mandate and long-run average temperatures play a smaller role.

Abstrakt

Diese Forschung bietet eine umfassende Analyse der öffentlichen Kommunikation von Zentralbanken über den Klimawandel und des politischen Diskurses des grünen Zentralbankwesens, um die Hauptforschungsfrage „Warum und in welchem Umfang engagieren sich Zentralbanken in klimabezogenen Themen?“ zu beantworten. Mit einem schlüsselwortgestützten Modell (keyATM) quantifiziert die Studie das Ausmaß der grünen Kommunikation, indem sie Klimawandelthemen in den Reden der Zentralbanken identifiziert. Die Forschung umfasst verschiedene erklärende Variablen, um zu untersuchen, warum einige Zentralbanken intensiver an Klimadiskussionen teilnehmen als andere. Die Analyse legt nahe, dass Zentralbanken grüne Narrative einführen, die ihre institutionellen und politischen Dynamiken beeinflussen. Netzwerkanalysen heben die Verbindung zwischen Klimadiskurs und dem Finanzsektor hervor, während Sentiment Analysen eine ausgewogene Anerkennung der Bedeutung des Klimawandels zeigen. Die Studie schließt mit den folgenden Erkenntnissen: Die Interaktion zwischen Geld- und Fiskalpolitik ist entscheidend für die Bewältigung des Klimawandels, kann jedoch die Unabhängigkeit der Zentralbanken gefährden. Die Mitgliedschaft im Network for Greening the Financial System (NGFS) korreliert positiv mit einer intensiveren grünen Kommunikation, angetrieben durch Gruppenzwang und Sorgen um den sozialen Ruf. Eine proaktive Rolle der nationalen Regierungen im Klimaschutz, gemessen an nationalen Klimapolitiken, fördert ebenfalls signifikant die grüne Kommunikation, obwohl das Mandat der Zentralbank und langfristige Durchschnittstemperaturen eine geringere Rolle spielen.

Acknowledgments

First and foremost, I want to thank my supervisor, Prof. Dr. Martin Feldkircher, for his help, support, and guidance throughout this thesis. I am especially thankful for our collaboration on the academic paper that this thesis expands on. I also want to thank Genny and all the professors who supported me throughout this work. I want to thank my family and my friends for their support.

I. Introduction

In today's financial landscape, the terms "climate change," "green finance," "green transition," and "net-zero" in the context of central banking underscore the elevated involvement of central banks in the climate change discourse. This engagement is crucial as central banks contribute to the overall understanding of climate-related risks and raise public awareness of climate change's effects on the financial landscape. While looking at the discourse of central banks around the world, at their webpages, and the conference topics, discussions, increased social media presence, and debates in recent times, climate change prevails and occurs more often.

There has been a lot of research on climate change's influence on monetary policy decisions, financial decisions, and macroprudential policies on the one side and on central bank communication in general on the other side, with an intense debate about what central banks do in reality and what they should do in accordance with their mandate. All this debate has a strong relationship with the central bank's independence, which is a very important factor to consider while assessing central bank involvement in climate change discourse. Therefore, this research aims to look at central banks' communication on climate change-related issues, their mandates, and other factors that potentially explain central banks' engagement with green topics. On this basis, the main research question addressed in this paper is as follows: *Why and to what extent do central banks engage in climate-related issues?*

We want to demonstrate the presence of green topics in central banks' discourse and the reasons behind it. Considering the main research questions, other questions follow: do central banks act within their mandates? What factors influence green communication by central banks? What is the relationship between CBI and green communication by central banks?

The importance of this topic could be emphasized by some key arguments discovered in the literature. First, climate change has a profound effect on economies, creating new challenges for central banks that are commonly the monopoly supplier of their currency, the last resort lender to the banking sector, the government's bank, and the bank of the banks, and they routinely regulate banks (Goodhart, 2011). In light of the evidence, it is clear that the relationship between climate

change and central banking needs more research contributions for future policymaking decisions. From a practical standpoint, if central banks fail to fulfill their initial duties and deviate from their legal mandate—such as shifting their focus to climate change, which may primarily be the government’s responsibility—this could undermine their role as guardians of price and financial stability.

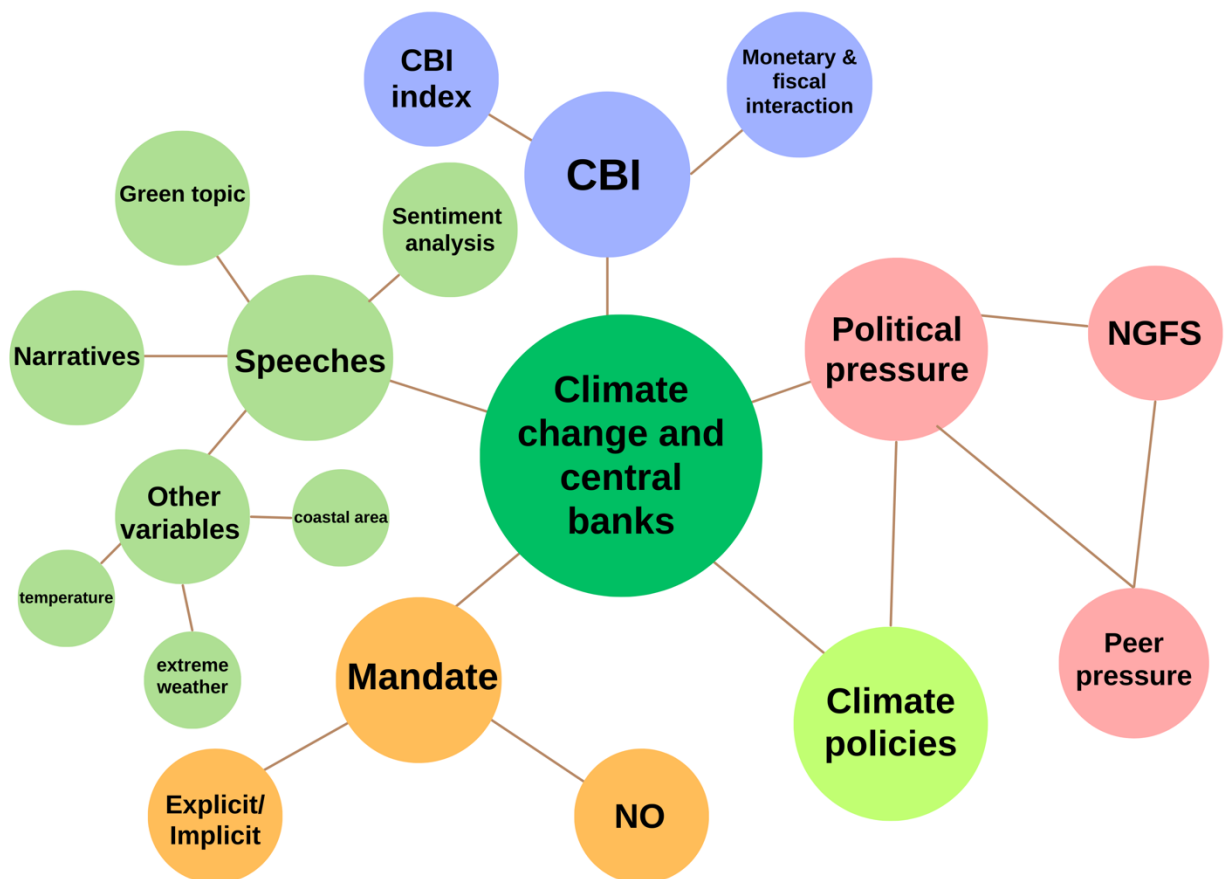
Second, in 2019, NGFS indicated that climate-related risks constitute a source of financial risks. In 2020, NGFS recommended that central banks consider the possible effects of climate change on monetary policy, stressing that climate change is already part of monetary policymaking (NGFS, 2020). The following question arises: how exactly can one measure to what extent the climate change topic is important for central banks? In this research, the main measurement of greenness is communication through central bank speeches submitted to the BIS archive, as central bank communication usually points to important issues and challenges, including the impact of climate change on the economy, financial innovation, sustainable finance, monetary policy, and the mandate of central banks.

Next, this research will delve deeper into the political discourse of central banking. As we assume, there is increasing political pressure on central banks through different channels, such as climate laws and narratives. Moreover, there always has been a particular emphasis on the importance of central bank independence. Back in 1962, Milton Friedman was the one who highlighted that central banks should be free from the government (Friedman, 1962). In this research, we will explain why this is important and the current situation with the CBI. The fact that political interference in central banking causes a lot of negative spillovers for the financial system and, following, shakes financial stability is well known in general, but there is a lot to discover in the realm of the climate change crisis.

Next, we draw the mindmap to graphically represent the main ideas for this research (see **Figure 1**). As it shows, in the middle in dark green is the main topic, and other elements that diverge from the center are explanatory factors for climate change communication by central banks. As **Figure 1** illustrates, there are many possible variables that explain central banks’ involvement in climate-related communication. To the left, we will look at speeches per se, first

measuring the greenness (the number of green speeches, among others) and the readability to potentially explain how accessible these speeches are to a broader public. Next, we will look at narratives, which could be one of the explanations of what drives central banks to engage in green topics. Other variables, such as temperature, a coastal area, or extreme weather, are assumed to be the drives of green communication from the following logic: extreme weather events might force central banks to communicate climate change threats to increase public awareness. Finally, the legal mandate is important to include while looking at central bank engagement with any issue. If central banks do not act within their mandate, they might experience external pressure to address concrete issues, such as climate change.

Figure 1. Mindmap



To the right, we will delve deeper into the political discourse of central banking. The initial assumption suggests that central banks experience political pressure from the governments to talk about climate-related issues. One way to put pressure could be through the extensive number of climate change policies adopted by national governments of respective central banks. This could threaten central bank independence. Therefore, we also include the central bank independence index to show whether it could explain central banks' communication. That said, we will look at whether the difference in CBI indices among central banks has any relation to the green context in their delivered speeches. Another form of pressure, peer pressure, is related to the NGFS membership and will be analyzed in this paper.

The paper is structured as follows: the next section (II) provides a detailed analysis of already existing literature on green communication by central banks and specifically on central banks' independence and their legal mandate. Section III describes the data and methods applied to identify green speeches from the whole corpus. Section IV presents empirical results from our model, delving deeper into the roots of central banks' green communication. Section V discusses the main findings, describing green narratives and monetary and fiscal interaction, providing an overview of why central banks talk about climate change and why some central banks address more speeches on this issue than others. Section VI concludes and includes potential for future research.

This thesis is an extension and adaptation of the paper titled "*Speeches in the green: The political discourse of green central banking*," co-authored with Prof. Dr. Martin Feldkircher and published in *Energy Economics*, 2024.¹ The original publication focused on a quantitative measure of climate change-related communication by central banks and a political discourse of green central banking. In this thesis, we build upon and expand the previous work by delving deeper into the green narratives and norms created by central banks, sentiment analysis of their speeches, on in-depth analysis of central bank independence, monetary and fiscal interaction with assessing the relationship between sovereign debt and green discourse by central banks.

¹ Feldkircher, M., & Teliha, V. (2024). *Speeches in the green: The political discourse of green central banking*. *Energy Economics*, 107646.

II. Literature Review

Explaining central banks' communication on climate change-related issues is the subject of ongoing research and, moreover, among emerging topics in the economic field. This section (II) presents the main studies that have previously contributed to the green communication of central banks, highlighting climate change and central banks' relationship, exploring general aspects of green central banking and political aspect of green finance, including the question of central bank independence, and legal analysis of central bank mandates.

The frequency and intensity of discussions by central bankers, media representation, and 121 members joining the Network of Central Banks and Supervisors for Greening the Financial System (NGFS)² showcase the elevated involvement of central banks in the climate change discourse. This engagement is crucial as central banks contribute to the overall understanding of climate-related risks. In 2019, NGFS highlighted climate-related risks as financial risks and, one year later, urged central banks to integrate climate change effects into monetary policy, asserting its current relevance (NGFS, 2020). In 2021, the ECB prioritized climate change unanimously since climate policy has an impact on monetary policy, underscoring the need to align these domains for effective action and better macroeconomic modeling frameworks (Deyris, 2023; McKibbin et al., 2020). Conti-Brown & Wishnick (2020) show that the threats climate change causes to the financial system are far greater in size and scope. Moreover, they state that climate change directly threatens the achievement of the FED's primary legal mandates. Therefore, it is a part of the Fed's crucial business to prevent some of the negative outcomes of climate change and decrease its effects.

The instruments at the disposal of central banks vary from improved disclosure of information and climate stress assessments of the financial systems to more proactive roles via the promotion of a union for the green capital market and the consideration of green bonds for their monetary policy operations (Deyris, 2023). This so-called green finance seems a crucial contribution to reaching the objectives listed in the Paris Climate Agreement (Arseneau et al., 2022; Li et al.,

² <https://www.ngfs.net/en>

2023). As the research shows, it is not only about legal obligations and responsibilities central banks have to take, but reputation plays a role here. By analyzing speeches and legislative documents, Blondeel et al. (2024) find that central banks' (BoE, ECB, and Fed) socio-political reputation affects their climate actions or inactions. Whereas central banks feel an obligation to address climate change issues to "maximize reputational gains" and "to minimize reputational damage" (Blondeel et al., 2024), they are inclined to act more.

Given the increasing involvement of central banks in climate change issues, the question arises: Should central banks actively participate in resolving climate-related risks or are they overstepping their mandate? In his research, Volz (2017) discusses central banks' role in supporting the consideration of environmental and climate risks in financial decisions. It argues for a proactive role for central banks in sustainable development but also highlights the potential risks of expanding their mandates, which could jeopardize their institutional independence. Moreover, the scholar emphasizes that green investment is a political concern. At the same time, Hansen (2022) believes that fiscal policy has a greater impact on climate change issues, which monetary policy cannot substitute. Besides, if central banks overestimate their potential to mitigate the risks posed by climate change, they might lose political and public trust.

Diluiso et al. (2021) highlight while central banks face increasing pressure to engage in sustainability efforts, the primary responsibility for addressing climate change and guiding the transition lies with governments. Central banks could play a role in the coordination of climate change efforts. Whether substituting low carbon prices with green instruments aligns with central banks' core mandates remains controversial. Campiglio et al. (2018) argue that change in central bank mandate is unlikely and unprecedented. However, if climate risk is a danger to financial stability, it requires implementing policies, some of which may engage cooperation between central banks and financial regulators.

Dikau & Volz (2021) showcase that the mandate of many central banks compels them to support the broad economic objectives of their respective fiscal authorities. Central banks navigate climate change and green finance, emphasizing the importance of clear mandates and the evolving policy context. If climate change affects their core objectives, including its effects on financial

stability, central banks consider environmental factors. The scholars made a great contribution to the research by analyzing 135 mandates of central banks, 12 % of which work with a specific directive that explicitly involves advancing sustainable growth or development as a goal, while another 40 % are assigned to assist in achieving their respective governments' national policy aims. Building on the previous study, Arseneau & Osada (2023) identified central bank speeches on climate change and examined the role of central banks' mandates in determining their communication. While speeches indicate the importance of green topics for central banks, climate change is not yet among the key topics in central bank legislation (IMF, 2023). Despite this, climate change has appeared as an important policy goal internationally, and in line with this purpose, central banks might choose to assist this attempt by looking at how climate concerns can be incorporated into their operations (Boneva et al., 2022).

Underlying the importance of implementing policies on a global level and its influence on central banks' priority setting, develop a theoretical framework based on the norm life cycle model to explain how new norms emerge and become powerful. With this, the scholars are able to explain what determines how central banks adopt policies. One of the main findings demonstrates that the EU actively supports climate policies, and this pushes the ECB to adjust to new climate change-related norms and align with them to implement new policies. In addition, the founding of NFGS influenced central banks' policy directions. Moreover, scholars conclude that varying political approaches made the ECB a climate leader and the Fed the failing actor in addressing climate change (DiLeo et al., 2023).

Why would central banks outpace addressing climate change issues? Berger et al. (2001) highlights the high degree of central bank independence, which is why central banks are more advantageous than the government in addressing climate risks related to the time inconsistency problem. Bolton et al. (2020) explained that central banks have to go beyond risk assessment, holding a coordinating role, the so-called "five C," in addressing climate change challenges, even though their expertise lies outside fiscal and environmental domains. Indeed, the severity of climate change threats to both macro-financial stability and sovereign risk is significant enough to urge for a proactive engagement of central banks in addressing climate-related risks (Volz et al., 2020).

III. Data and Methodology

In this chapter (III), we describe the data and methods for identifying climate change-related speeches. This chapter is adapted from the data and methodology section of the paper “*Speeches in the green: The political discourse of green central banking*,” co-authored with Prof. Dr. Martin Feldkircher and published in *Energy Economics*, 2024.³

i. Data and pre-processing

The main aim of this research is to analyze to what extent central banks communicate on climate-change related issues. For this purpose, we use already existing academic research on text analysis and central bank communication, and the main data, which is texts (speeches) downloaded from the BIS archive <https://www.bis.org/cbspeeches/index.htm>. The BIS collects speeches delivered by central bank governors and policy-relevant speeches by senior central bankers. Additionally, the BIS archive contains speeches from monetary authorities. All speeches are translated into English and are just to download from the webpage. There is one limitation with the data that is important to consider while analyzing findings. The database only includes speeches submitted by authorities, which likely represents only a portion of all central bank speeches. An alternative way to download speeches directly from central banks and translate them into English might create distorted results. However, the BIS database remains the primary source for making worldwide comparison analyses of central banks and their communication. In addition, among speeches, there are interviews and monetary reports included in the database, but only a small number.

The corpus includes $D = 18,902$ documents⁴ with 1996-09-10 as the earliest date and 2023-10-26 as the latest date. From these speeches, non-central banking institutions are excluded, which reduces the number of speeches to $D = 18,892$ documents. 112 central banks submitted their

³ Feldkircher, M., & Teliha, V. (2024). *Speeches in the green: The political discourse of green central banking*. *Energy Economics*, 107646.

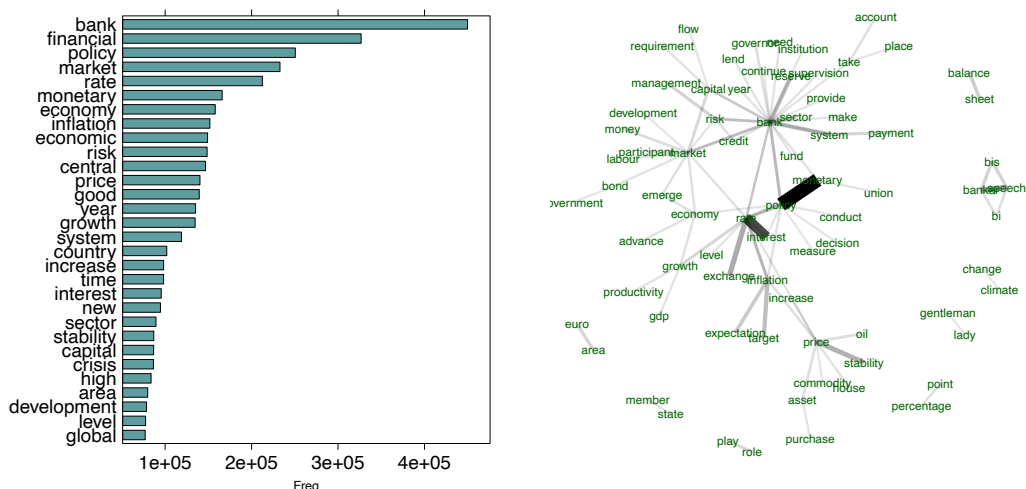
⁴ All texts were downloaded in PDF format, 140 of which were corrupted and unreadable. We converted them into plain text to extract more information from them.

speeches to BIS, which I included in the corpus analysis. **Table 1** in the Appendix lists all of them, including data on mandate (explicit/implicit), NGFS membership, and green speech availability.

First, we start preprocessing the documents, where we use a part-of-speech (POS) tagger to label each token according to its grammatical function. This process automatically removes punctuation. Second, we focus on nouns and adjectives, following the approach used by Martin & Johnson (2015), where we remove stopwords and lemmatize the tokens. POS tagging is done using the R version of the *udpipe* framework by Wiffels (2023), explained in Straka & Straková (2017), and lemmatization using the *quanteda* package from Benoit et al. (2018).

Before delving deeper into the green speeches analysis, we show some interesting results from the whole BIS corpus, including climate-change-related speeches. **Figure 2** represents the most frequent nouns and adjectives in the BIS corpus. The left panel shows the most frequent nouns and adjectives in 18, 892 documents, while the right panel illustrates the most frequent co-occurring words together in the vicinity of three words.

Figure 2. Word cloud for the BIS corpus.



The results of the analysis illustrated in **Figure 2** represent the data and the topics from the whole BIS corpus. The left panel shows that the 10 most frequent words are “*bank*,” “*financial*,”

“policy,” “market,” “rate,” “monetary,” “inflation,” “economic,” “risk,” and “central.” The right panel demonstrates how these terms are connected via network analysis. For instance, *“bank”* is in the center of the graph, creating around word combinations, such as bank(ing) sector, bank risk, bank(ing) system, and bank credit. The network analysis illustrates that the three words *“bank”* are connected and provides an overview of what are the main topics in the corpus. The next most frequent term is *“monetary,”* which is strongly connected with policy, *“monetary policy,”* followed by *“rate,”* frequently occurring with *“interest rate”* and *“exchange rate.”* From here, the next one is *“inflation”* with *“inflation expectation,” “inflation target,”* and *“inflation increase,”* pointing to the most crucial economic indicator. Both graphs, the most frequent terms, and co-occurring words, represent the main objectives of each central bank as financial guardian to secure price and financial stability within their primary mandate (Feldkircher & Teliha, 2024).

As this paper examines central banks’ communication on a green matter, the word cloud on the right side illustrates that climate change is among the most frequent words in the whole corpus. The next sections will describe to what extent central banks communicate on climate change.

ii. Methodology: A keyword-assisted topic model

This subsection describes the method used to identify climate change-related speeches from the whole BIS corpus, which contains 18,892 documents. In order to do so, I use a new variant of topic models. In essence, topic models postulate that each document comprises a combination of different topics, each identified by a distinct probability distribution of terms, and these topic probabilities provide an explicit representation of a document (Blei et al., 2003; S. Hansen & McMahon, 2016). In this research, I use a keyword-assisted topic model (*keyATM*) proposed by Eshima et al. (2023). KeyATM enables scholars to categorize topics by specifying keywords before training the model, and in this way, prevents post hoc interpretation and modifications of different topics since researchers can apply keywords to describe certain concepts further to be identified and measured. As Eshima et al. (2023) specified, keyATM is most applicable and useful when one wants to measure specific topics, such as climate change in this paper.

This base keyATM model assumes that one has a total of D documents, and each document d has N_d word. D documents have a total of V unique words, where w_{di} represent the i th word in document d where $Wd=\{wd1,wd2,...,wdNd\}$ constitutes the set of all words used in document d . Eshima et al. (2023) consider two types of topics, one of which is referred to as keyword topics. That said, we have a total of K topics, of which the first $\tilde{K} \leq K$ are keyword topics, and others are no-keyword topics. Next, we specify keywords for 7 topics, one of which is the key for this paper – “climate change-related” or “green” topic. Additionally, we use it for 3 no-keyword topics.

For each word j , then in document d , the latent topic variable $z_{dj} \in 1, 2, \dots, K$ is drawn from the *topic distribution* of the document,

$$z_{dj} \stackrel{\text{indep.}}{\sim} \text{Categorical}(\theta_d), \quad (1)$$

with θ_d being the K -dimensional vector of topic probabilities for document d with $\sum_{k=1}^K q_{dk} = 1$. A no-keyword, or residual topic, a word w_{di} is then drawn from the corresponding word distribution of the topic

$$w_{dj}|z_{dj} = k \stackrel{\text{indep.}}{\sim} \text{Categorical}(\phi_k), \quad (2)$$

with f_k denoting a V -dimensional vector of word probabilities for topic k , representing the *relative* word frequency within topic k . The set-up changes in case the topic is one of the keyword-assisted topics. The word distribution is as follows:

$$w_{dj}|z_{dj} = k \stackrel{\text{indep.}}{\sim} = \begin{cases} \text{Categorical} & (\theta_k) \text{ if } s_{dj} = 0 \\ \text{Categorical} & (\tilde{\theta}_k) \text{ if } s_{dj} = 1 \end{cases}$$

with $s_{dj}|z_{dj} = k \stackrel{\text{indep.}}{\sim} \text{Bernoulli}(f_k)$, for $k \in 1, 2, \dots, \tilde{K}$, a Bernoulli variable indicating whether the w_{di} should be drawn from the specified set of keywords based on the V -dimensional probability vector f_k , with L_k (the number of keywords for topic k) non-zero entries. Eshima et al. (2023) describe the prior distributions and the sampling algorithm. Next, we apply the dynamic set-up of the model, to allow the topic proportions θ_d to evolve over time.

As the main data are speeches downloaded from BIS, which we extract the text for further analysis from and contain a lot of uninformative words, we do some pre-processing and cleaning before applying the keyATM model to the data. First, we remove frequent uninformative words having the information from **Figure 2**. Second, we do bigrams with the remaining tokens and use trimming to discard low-frequency terms that appear less than five times or only in one document. For keywords identification, first, we analyze speech titles with the related word “*climate*”. Next, we present the word distribution of the speeches by word clouds and choose the most frequent terms. Then, we show the bigrams of the lemmatized tokens for climate change-related words. After such steps, we have the selection of climate change related bigrams (L_k) contribute to the identification of green topics that we are aiming to extract. These keywords are “*climate change*,” “*climate risk*,” “*impact climate*,” “*climate policy*,” “*green finance*,” and “*sustainable finance*.” Besides including only climate change topic in central banks’ communication, we also included keywords for other topics following the already existing literature on central banking communication. Feldkircher et al. (2021) define keywords for monetary policy and financial stability, while Hansson (2021) provides for real economy, global economy, payment systems, and banking supervision. One more topic included is “*Islamic finance*”.

Table 2. Keywords

Monetary policy	Financial stability	Banking supervision	Payment infrastructure
monetary_policy	financial_system	balance_sheet	payment_service
interest_rate	financial_market	financial_service	payment_system
price_stability	financial_stability	risk_management	settlement_system
inflation_target		capital_requirement	retail_payment
inflation_expectation		credit_risk	
		stress_test	
Real economy	Islamic finance	Global economy	Green
economic_growth	islamic_finance	exchange_rate	climate_change
economic_activity	islamic_financial	global_financial	climate_risk
real_economy		capital_flow	impact_climate
unemployment_rate		global_economy	climate_policy
productivity_growth			green_finance
			sustainable_finance

We listed all the keywords due to the topics distribution (*monetary policy*, *financial stability*, *baking supervision*, *payment infrastructure*, *real economy*, *Islamic finance*, *global*

economy, and green) in **Table 2**. In addition, we include three non-assisted topics that might pick up tonality and word usage specific to certain central banks. It is not of interest in this research to overall analyze central banks' communication, looking at other topics, but it is important to include them for better identification of green context in speeches. As a result, we have $K = 11$ topics of which $\tilde{K} = 8$ are keyword-assisted (Feldkircher & Teliha, 2024).

iii. Identification of climate change-related speeches

In this subsection, we describe the results from the keyword-assisted topic model. In order to identify climate change-related speeches among 18, 892 documents, one needs to label these speeches according to their topic proportions. This means that our speech selection will be that where green topic, $\theta_{d,gr}$, has the highest proportion in relation to other topics. The result of this identification method contains 783 speeches out of which the median topic proportion is around 0.3. Another approach to extracting climate change-related speech is by focusing on those where $\theta_{d,gr}$ value surpasses a specific threshold or where there is significant differentiation between climate change-related topics and other topics, indicated by variations in topic proportions. To showcase and validate this identification method, we present the top 20 speeches with green context in **Table 3**. The value of $\theta_{d,gr}$ varies between 0.65 at the highest and 0.57 at the lowest. Moreover, the titles of speeches show that the keyword-assisted topic model was able to classify the speeches accordingly to the extent of green context from the whole corpus. As an example, the greenest speech identified with the keyATM model has the title “*The NGFS Glasgow Declaration From a coalition of the willing to a coalition of the committed*”⁵, where the Member of the Executive Board of the European Central Bank explicitly talked about climate change, and the ECB and the EU decarbonization efforts.

⁵ <https://www.bis.org/review/r221109f.htm>

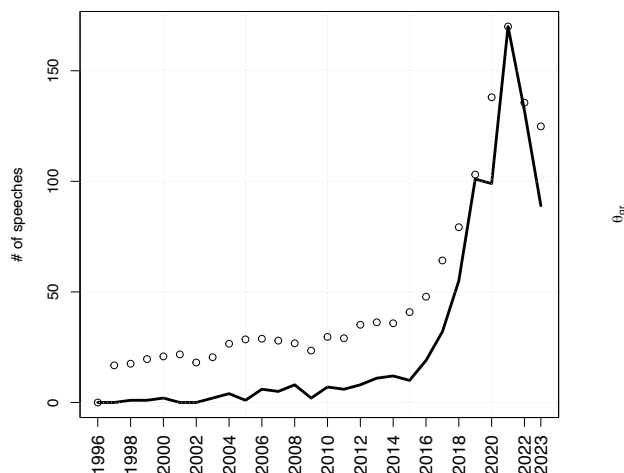
Table 3. Top 20 green speeches

	θ_{gr}	date	title	cc
1	0.65	2021-11-03	Frank Elderson: The NGFS Glasgow Declaration From a coalition of the willing to a coalition of the committed	ECB
2	0.63	2020-12-09	Yi Gang : Supporting low carbon development with green finance	CN
3	0.60	2017-06-30	Yannis Stournaras: Climate change - challenges, risks and opportunities	GR
4	0.60	2019-04-03	Yannis Stournaras: Climate change - threats, challenges, solutions for Greece	GR
5	0.60	2019-10-08	Mark Carney: TCFD - strengthening the foundations of sustainable finance	GB
6	0.60	2022-06-08	Ravi Menon: Towards net zero in Asia	SG
7	0.60	2021-05-18	Sarah Breedon: Climate change plotting our course to net zero	GB
8	0.59	2021-11-02	Frank Elderson: Forests and finance	ECB
9	0.58	2021-04-20	Ignazio Visco: Remarks on financing carbon neutrality	IT
10	0.58	2022-11-09	Sabine Mauderer: Turning ambition into action - the importance of transition plans for the green transition	DE
11	0.58	2020-10-28	Adrian Orr: Progressing climate action by driving transformational change	NZ
12	0.58	2023-02-08	Sabine Mauderer: Getting the full picture - the road ahead for climate stress testing	DE
13	0.58	2021-05-31	Yannis Stournaras: Thoughts on climate neutrality, circularity and sustainable finance	GR
14	0.57	2019-03-21	Mark Carney: A New Horizon	GB
15	0.57	2021-05-20	Ravi Menon: A vibrant carbon market for a low carbon future	SG
16	0.57	2018-11-21	Mark Carney: Remarks at the Accounting for Sustainability Summit 2018	GB
17	0.57	2019-12-10	Mark Carney: Remarks at a panel to launch the third annual Americas Pledge report	GB
18	0.57	2021-10-14	Harvesh Seegolam: Launch of the Bank of Mauritius Climate Change Centre	MU
19	0.57	2022-05-31	Ravi Menon: Gearing up for climate action - the road ahead for the Network for Greening the Financial System	SG
20	0.57	2020-10-13	Ravi Menon: Harnessing the power of finance for a sustainable future	SG

Having identified green speeches, we next analyze the word distribution of these texts. We list the 50 most frequent bigrams from 758 green speeches in **Table 4** in the Appendix. In the green set of speeches, bigrams with high frequency are related to climate change. In **Table 4**, the column “*n_target*” shows the frequency of the term in speeches identified as green. For instance, climate change word has the highest value of 4253.00 and climate risk with a value of 1159.00. In addition, the table illustrates “*n_reference*,” which is the frequency of terms used in the remaining set of speeches, not only in selected green ones. In this case, the word “*climate change*” was used 1817.00 times in the rest of the corpus. Four out of the top 11 bigrams are included in the list of defined keywords. The other terms among top terms relate to monetary policy and financial stability (value of 1515.00 and 1202.00 respectively) with the keywords “*financial_system*,” “*financial_stability*,” “*financial_institution*,” “*financial_sector*,” and “*financial_risk*.” The results show that central banks apply climate change and climate risk (the most frequent words in the green corpus) to have effects on financial stability.

The results represent the relatively high frequency of climate change topics in central banks’ communication, considering that the green topic in central banking has gained popularity since 2016. The number of speeches started to increase in 2016 and, interestingly, reached its peak in 2021, see **Figure 3** (Feldkircher & Teliha, 2024).

Figure 3. Climate change-related speeches over time.



To explain an increase in central banks’ communication on climate change matters, we delve deeper into external events that potentially might have influenced this growing attention to the issue. On December 12, 2015, the Paris Agreement was decided upon by 196 parties at the UN Climate Change Conference – COP21, in Paris, and in the following year, 2016, entered into force. The Agreement is a “*legally binding international treaty on climate change*”⁶ that, for the first time, brought all nations together with the common goal of combating climate change and mitigating its effects on a global level. This could be one of the potential explanations for why the topic started to gain momentum in 2016. As **Figure 3** illustrates, the highest number of speeches was in 2021, and there are some events that could probably explain it. The IPCC (Intergovernmental Panel on Climate Change) published the first part of its sixth assessment report in August 2021⁷ with an overview of the current state of climate change, putting a strong emphasis on humans’ negative influence on nature and thereby expressing the urgency of actions. Throughout 2021, extreme weather events happened worldwide because of the climate crisis.⁸ In addition, the media coverage of climate change reached an all-time high in 2021, pointing to the urgency of addressing the crisis.⁹ All the events demonstrated the emergence of the climate change

⁶ <https://unfccc.int/process-and-meetings/the-paris-agreement>

⁷ <https://theconversation.com/communicating-climate-change-has-never-been-so-important-and-this-ipcc-report-pulls-no-punches-165252>

⁸ <https://www.weforum.org/agenda/2023/01/climate-crisis-extreme-weather-2021/>

⁹ <https://phys.org/news/2021-12-climate-news-coverage-all-time-high.html>

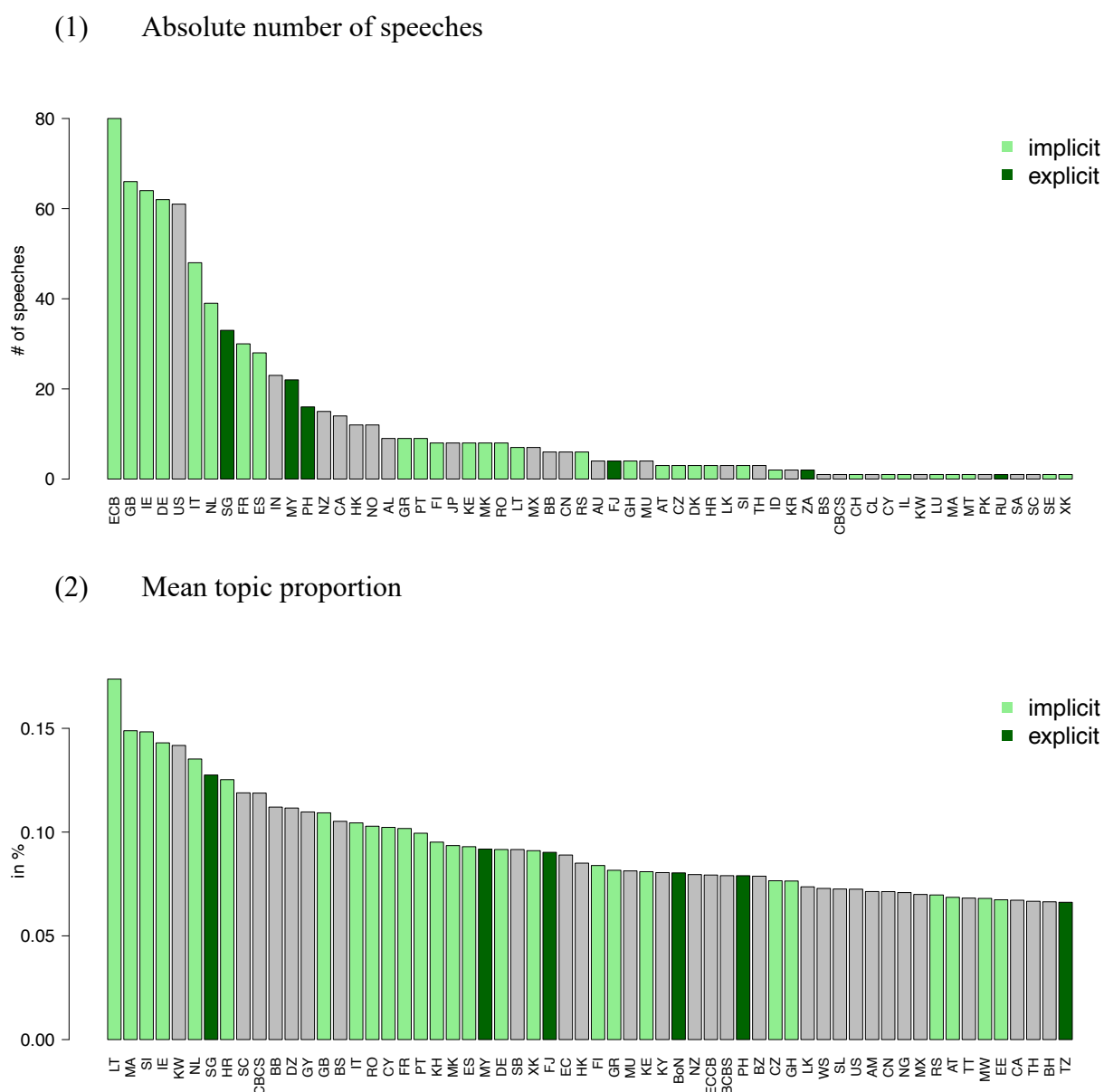
crisis and the need for proper communication, which potentially could have impacted central banks to deliver the message.

The growing number of speeches by the central bank leads us to further show how many green speeches there are per central bank. The analysis shows that 69 out of 112 institutions have delivered at least one speech on climate change. For these 69 central banks, we imply those with an implicit or an explicit mandate for conducting climate change policies, in other words, those central banks with direct or indirect sustainability mandates. Our analysis is based on Dikau & Volz (2021) contribution to the question of central banks mandates regarding climate change. The scholars used the data from the IMF Central Bank Legislation Database and central banks' webpages and listed central banks as those with an *implicit* mandate given that they have an objective to support sustainable or government climate policy goals. For instance, we take the European Central Bank (ECB) as one with the most number of green speeches. Dikau & Volz (2021) list ECB as one with an implicit mandate indirectly supporting climate change policies. One of the explanations lies in the ECB's active support of the EU climate policies, thereby underlying the importance of domestic socio-political polarization on this matter (see DiLeo et al., 2023). Moreover, a member of the executive board of the ECB pointed out that "*these provisions, although not conferring a specific mandate for ECB climate change action, do require us to take into account the EU's environmental objectives and policies when pursuing both our primary and secondary objectives*" (Dikau & Volz, 2021; Elderson, 2021).

We will further elaborate on this important finding while looking at why central banks engage in climate change. Nevertheless, the number of central banks with explicit mandates is lower. From the whole corpus, there are 43 central banks with an implicit mandate and only 12 with an explicit (direct) mandate. The results are illustrated in **Figure 4**, wherein light green are central banks with an implicit mandate, and in dark green are those with an explicit mandate. The first panel (1) illustrates the total number of climate change-related speeches by central banks. It represents the ECB, euro area central banks, the Fed, the Singapore Monetary Authority, the Indian Reserve Bank and the Central Bank of Malaysia as central banks contributing the most to climate change communication. Among the most engaging central banks, only the Fed lacks an explicit or implicit mandate for conducting climate change policies. The total number of green speeches is

likely related to the size of central banks, as larger central banks have more resources at their disposal for communication. The second panel (2) in **Figure 4**, shows the mean θ_{gr} per central bank as an average over the sample period. This representation highlights that the Singapore Monetary Authority still remains of the most active contributors. Additionally, smaller-sized central banks such as the Central Bank of the Seychelles or Barbados, also allocate some portion of their speeches to environmental topics.

Figure 4. Climate-related speeches and central banks' mandates



IV. Empirical Results

In this chapter (IV), we will explore why central banks talk about climate change, and particularly why there is a difference between central banks' communication measured by how many speeches they delivered on climate change issues. This chapter is adapted from the empirical results section of the paper "*Speeches in the green: The political discourse of green central banking*," co-authored with Prof. Dr. Martin Feldkircher and published in *Energy Economics*, 2024.

In the previous chapter (III), we conducted an empirical analysis to extract and identify green speeches by central banks from the whole BIS corpus. The main findings showed the number of speeches and which central bank is the most engaging with climate change matters. In this part, we will analyze why some central banks talk more about climate change with some explanatory variables. After previous analysis, we made some interesting observations, such as the ECB, euro area central banks, the Fed, the Singapore Monetary Authority, the Indian Reserve Bank and the Central Bank of Malaysia being the most active while talking about climate change. This has to have some explanations. Therefore, we collect additional variables that capture the economic, political, and geographic features of the countries included in this research. We include three different types of variables: Time-varying, Macroeconomic data, and Geographic data.

For macroeconomic data, we include data on year-over-year inflation (Dp_{yoy}) and real GDP growth (y_{yoy}) to capture potential trade-offs with the more traditional mandates of central banks. Next, we add nominal GDP in US dollars (y_{nom}) to capture size effects and GDP per capita in international (purchasing power parity adjusted) dollars (y_{pcap}) to account for variations in income for cross-country differences.

Based on the fact that the main topic for my analysis of central banks' communication is climate change, the important driving force for central banks to talk more about climate change and even raise higher concerns is related to geographical factors. That said, we include a set of variables related to the geographic characteristics of the countries under the study and their increased risk of climate change. For this analysis, we use the World Bank's Standardized

Precipitation-Evapotranspiration Index (SPEI)¹⁰ to measure drought based on climatic data, which helps capture extreme weather conditions. We also look at the average temperature from 1997 to 2022 using data from the World Bank’s climate change knowledge portal.¹¹ We face limitations, as the temperature data for every single year is not available for all countries. Additionally, we consider the relative size of the coastal area compared to the overall border area to see if countries exposed to rising sea levels focus more on climate-related policies. We then include variables related to central banks’ mandates. Specifically, we use constant dummy variables for implicit - *impl_m* and explicit – *expl_m* green mandates, as defined by Dikau & Volz (2021). We also add a time-varying dummy variable to indicate whether the central bank is a member of the NGFS network, reflecting that there is peer pressure from other central banks joining the network to engage more in climate change. We listed all data and sources in **Table 5** in the Appendix.

To estimate the factors influencing green communication, we use a multilevel panel data framework implemented in the R package *panelr* (Long, 2020). This model combines fixed and random effects estimation, allowing the inclusion of variables that do not change over time. It builds on Allison (2009) work with a detailed explanation provided by Schunck (2013). Throughout the analysis, this approach is useful since the explicit and implicit mandate variables are consistent over time.

We focus on θ_{ad} for all speeches, including those with a low proportion of green topics, as they still provide valuable information for my analysis. The dependent variable y_{it} represents the extent of green communication, measured by the average of $\theta_{d,gr}$ for each central bank per year. Among 112 central banks, 81 have at least two annual observations. Thus, the panel includes 81 central banks, which we call entities, with annual data from 1996 to 2023, though not all entities have complete annual observations. The total number of observations in this unbalanced panel is 1,308.

Next, we distinguish between time-varying and time-constant predictors. The time-varying variables are collected in a $k_y \times 1$ vector $x_{it} = (y_{yoy}_{\{i,t\}}, Dp_{yoy}_{\{i,t\}}, y_{pcap}_{\{i,t\}},$

¹⁰ <https://esgdata.worldbank.org/explore/stories?lang=en>

¹¹ <https://climateknowledgeportal.worldbank.org>

$y_{nom\{i,t\}}$, $spei\{i,t\}$, $NGFS\{i,t\}$), while the time-constant variables are in a $k_z \times 1$ vector $z_{it} = (expl_m\{i\}, impl_m\{i\}, temp_avg_i, coast\{i\})'$. To estimate within effects in a random effects model, we decompose the time-varying variables into a between component $\bar{x}_i = \frac{1}{n_i} \sum_{t=1}^{n_i} x_{it}$ (the average over time) and a within component $x_{it} - \bar{x}_i$. This within-between or hybrid model is expressed as:

$$y_{it} = \beta_0 + \beta_1(x_{it} - \bar{x}_i) + \beta_2\bar{x}_i + \gamma z_i + \mu_i + \epsilon_{it} \quad (3)$$

In this context, μ_i represents a random individual-specific slope. The parameter β_1 captures within-group variation while γ and β_2 helps explain cross-sectional differences.

For the estimation, we first analyze the factors influencing green communication by estimating a comprehensive model that includes all variables. Next, we perform variable selection using the BIC information criterion to identify the best-fitting model. The results of the optimal model, according to the BIC, are shown in **Table 6** in the Appendix.

The model identifies two key variables that contribute to within-group variation: the central bank independence indicator and the time-varying NGFS membership variable. An increase in either of these variables is linked to a higher proportion of green topics. Specifically, the NGFS membership dummy variable indicates that central banks becoming members are more likely to engage in green communication. Moreover, the model highlights variables that explain cross-country differences, such as the sample mean of time-varying variables and time-constant factors like dummy variables for climate-related mandates. The results show that higher average levels of central bank independence and NGFS membership correlate with more frequent climate-related discussions by central banks, which is an interesting and important finding for this research. With his contribution to the topic, Deyris (2023) argued the positive effect of the NGFS membership variable through peer pressure and the fear of bearing reputational costs. On this we will further elaborate in the next chapters on the political dimension of central banking.

Next, we want to explain how communication varies among different central banks and their respective countries. For this, the measure of long-run average temperatures is the only time-constant variable that explains differences in cross-country fixed effects. This implies that the

central banks of countries with higher average temperatures have made more investments in green communication and raised the issue of climate change in their discourse more often than those with lower average temperatures. The Intra-Class Correlation (ICC), which represents the fraction of total variance in the dependent variable owing to variation across entities, is roughly 0.2.

Subsequently, we use a dummy variable - *overall_m* - to denote the presence of an explicit or implicit mandate for the central bank. Although this dummy variable is not statistically significant, the basic findings stay the same, showing that there are not any meaningful variations in green communication across central banks that have or do not have green mandates. We divide the total mandate dummy in **Model 3**, which is shown in **Table 6** in the Appendix, far right panel, into two dummies: one for an implicit mandate and another for an explicit mandate. Like the general mandate dummy, there is no proof that central banks that have explicit or implicit mandates talk about sustainability any more or less than those that do not have any mandate at all.

In addition, we include Central Bank Independence Index (CBIE) as the explanatory variable for green communication. This indicator, which we take from Romelli (2022), includes many different characteristics that measure central banks' independence, and most importantly, includes new criteria such as financial independence, reporting, and disclosure to the framework of CBI.

We next look at possible non-linear correlations between central bank mandates and two important time-varying variables: NGFS membership and central bank independence (*Note*: before the results showed that NGFS membership and CBI affect the extent of green communication by central banks). In **Tables 7 and 8 in the Appendix**, the findings are shown along with mandate dummies and interaction terms with these factors.

The major conclusions show that including interaction terms does not change the qualitative results. Green communication is positively impacted by both central bank independence and NGFS participation, with cross-country variances explained by temperature changes. This implies that the countries that are exposed to climate change with higher temperatures, have independent central banks, and are members of the NGFS network talk more

about green. Surprisingly stronger effects of central bank independence on green communication are shown in countries without green mandates, indicating that more independent central banks have more latitude to devote resources to climate-related issues. We observe high levels of green communication by independent central banks with an explicit mandate, that act independently from governments and have the legal basis to address climate change issues in their framework. In contrast, central banks with an implicit mandate are more exposed to the political influence on their actions, which further could jeopardize their independence. The influence of peer pressure varies across different sub-groups. In **Table 8** of the Appendix, we show that the interaction between NGFS membership and the overall variable is significant and positive, especially in countries with an implicit mandate. For these countries, joining NGFS strengthens their commitment to addressing climate change-related issues in public discourse.

Overall, the analysis represented in the multilevel panel model, in which we included more explanatory variables, showed very significant results for this research. The main findings are as follows: both higher central bank independence and joining the NGFS network are positively associated with green communication by central banks. This implies that independent central banks without any external influence can address climate change risks openly, while active central banks further increase their green communication being a part of the NGFS. However, our findings do not support the hypothesis that central banks with explicit or implicit mandates communicate more frequently on green topics. Other explanatory variables, such as macroeconomic indicators or climate-related data, do not explain variations in green communication among central banks, except that those in countries with higher average temperatures tend to engage in green-related issues (Feldkircher & Teliha, 2024).

V. Discussion

This chapter (V) delves deeper into central banks' communication framework. As the main results show, central banks intensively discuss climate-change-related issues, and there are many reasons behind this phenomenon that will be discussed further. It will first delve deeper into the general framework of central banks' communication: why do central banks talk on a specific topic, and how do they choose what to prioritize? Like any other institution, central banks operate under a certain framework that helps economists not only conduct policy analysis but also predict possible future scenarios of central banks' behavior.

i. Green narratives in central banking

„I'm a weatherman, I'm a showman, and I'm an economist. I'm expected to be, and I am a storyteller. I tell stories about the future.“¹²
(Stefan Ingves, governor of the Swedish Riksbank)

This section analyses the main narratives and norms central banks use to convince the public of the credibility of their policy commitments. As storytelling and narratives are the ways of reaching the public, central banks use them to communicate on climate-change-related issues. In order to show how central banks framed climate change in their words and actions, we will first underline the importance of storytelling for central banks in general, showing the process of how it occurs through the narrative- building process. Then, we will showcase green narratives in central banking through case studies and the central bank's communication, precisely speeches used for the analysis in this paper.

According to the Cambridge dictionary¹³, the narrative is defined as “*a story or a description of a series of events*” or “*a particular way of explaining or understanding events.*” Narratives are story-creating tools and are exposed to interpretation as one creates a story or

¹² <https://www.bloomberg.com/news/articles/2019-09-16/wall-street-used-to-crunch-numbers-they-ve-moved-on-to-stories?embedded-checkout=true>

¹³ https://dictionary.cambridge.org/dictionary/english/narrative#google_vignette

describes the events from their own perspective with desirable outcomes at the end. McCloskey (1992) defined economics as “*rhetoric, human argument, all the way down*”, emphasizing that knowledge-making in economics is derived from narratives and metaphors. This leads to an assumption that for central banks to generate knowledge used to make any kind of policy decisions, they need to construct certain narratives. In his research, Smart (1999) delves deeper into the narrative-creating process, which he explains through theories of genre. Genres, at the same time, could be seen as “*a broad rhetorical strategy enacted within an [organization] in order to regularize writer/reader transactions in ways that allow for the creation of particular knowledge*” (Smart, 1999: 252). In the case of Canada, Smart (1999) showcases how the internal genres created by the Bank of Canada serve as rhetorical and analytical media to construct an intricate narrative concerning the Canadian economy. This narrative is then utilized to inform monetary policy decisions and disseminate information beyond the institution. For instance, in the Bank of Canada there are so-called institutionally created analytical frameworks that help to interpret statistical economic data. These frameworks developed over time serve as the bank’s paradigm for understanding the economy, and they are applied in daily analysis to generate narratives or stories about the state of the economy. As said by Journet, “*The need to frame reality into narrative structures is [a human] ‘predisposition’[:] We impose narrative structure on reality to endow it with meaning*” (Journet, 1991: 432). This means that in order to understand reality, its particularity, its meaning, and why certain events happen, central banks use narratives. Moreover, in order to add climate change into central banks’ framework, establishing narratives around this new concept is essential for its effective implementation within central banks’ operations.

It is generally accepted that central banks participate in the so-called “*economy of words*”, in which the words used by central bankers have a significant influence on financial markets. The stories that central banks tell in their research papers and inflation reports are meant to convince the public that their political promises deserve trust. Monetary policy, according to Douglas Holmes, is an important “*communicative experiment*” designed to establish “*collaborative relationships*” with the public. The ability to create interesting stories is crucial to creating a performance dynamic in which markets respond to central bank messages in a predictable way, confirming that the economy is an empirical reality and a field for communication (Holmes, 2009; Holmes, 2013). This underlines the importance of communication and collaboration between

central banks – monetary authorities – and the public. In recent years central banks have acknowledged the significance of transparent communication about their policy objectives and decisions. By doing this, central banks want to increase public awareness of monetary policy and build trust and credibility that foster better outcomes for the economy. Proficiency in storytelling is essential for establishing a performative relationship in which markets react predictably to central banks' communication (Blinder, 2004).

To sum up from the said above, narratives are powerful tools for creating meaning and understanding complex phenomena of economic dynamics and policymaking processes. Just as McCloskey (1992) argued that economics is essentially rhetorical, underlying the role of narratives in shaping economic knowledge, examination by Smart (1999) of narrative construction within the Bank of Canada highlights the significance of narrative frameworks in guiding monetary policy choices and effectively communicating with the public. To comprehend the economy and its complex details, it is frequently necessary to organize reality into narrative frameworks, giving significance to occurrences and facilitating understanding. According to Journet (1991), people have an inherent tendency to apply narrative frameworks to reality in order to comprehend it.

In the realm of modern central banking, communication plays an important role, while the economy is considered an “*economy of words*”, influencing verbally financial markets and public trust (Holmes, 2009). Shifting to the subject of climate change narratives, the need for communication and cooperation remains crucial. In order to effectively incorporate climate change into their operations, central banks must build narratives around this issue, similar to how they construct narratives to guide monetary policy. Green narratives which seek to increase awareness and motivate action on climate change, may gain valuable insights from the practices and communicating monetary policy.

There is an increasing number of literature sources that showcase how narratives impact political and economic outcomes, as previously discussed, and particularly how green narratives shape central banks' storytelling and are actively present in central banking discourse. As this research analyses central banks' speeches related to climate-related issues and describes the main factors that drive central banks' green communication, it includes two speeches that fit into the

climate narratives occurrence and then later delve deeper into ECB and Bank of England as case studies of pushing green narratives. The first famous speech by Mark Carney in 2015 “*Breaking the Tragedy of the Horizon – climate change and financial stability*”, where he urged to consider climate change as a big challenge. The second speech was delivered by Isabel Schnabel 2020, a Member of the Executive Board of the ECB, where she underlined the importance of crisis as an opportunity that one should not waste (Carney, 2015; Schnabel, 2020). Both speeches demonstrate the growing attention to climate change topics in the Bank of England and ECB, leading to further exploration of narratives in these two central banks. Until the end of 2019, the ECB’s primary mandate was price stability, which was used by central bankers as a fundamental justification to oppose any involvement of the ECB in climate-related matters (E. C. Massoc, 2024). Central banks, particularly the ECB, not only did not consider climate change as an important issue for them but even pushed against pro-climate engagement. However, central banks shifted very fast from staying away from climate-related issues to pursuing climate policies.

Next, Simandan et al. (2023) show the emergence of green central banking, especially highlighted by interventions during the COVID-19 crisis. Focusing on the ECB and BoE, the paper investigates their public communications to understand the narratives they implement in shaping monetary policy. In the results, the study emphasizes the use of narrative elements in central bank communications to express and rationalize policy changes towards environmental factors. It further showcases how central banks intentionally use components of conventional and innovative frameworks in their explanations to clarify and justify their main policy adjustments. One of the most exciting findings shows the growing politicization of central banking as central banks address matters such as climate change concerns, social welfare, and income inequality. The broader political debates and central banks’ communication are connected, which implies a move toward central banks being more engaged in politics. This politicization related to growing central bank engagement, leads to further analysis of its implications for central bank independence and the wider political environment (Simandan et al., 2023). That said, green narratives by central banks are closely related to the political discourse around emerging climate change topics. This will be further discussed in subsection v of this paper.

More contribution to the narrative's framework comes from Aguila & Wullweber (2024), where they analyze ECB Executive Board member speeches and identify three primary narratives regarding the climate change crisis within the monetary authority's influence. Among these, environmental phenomena are depicted as a financial concern (1), stressing the green investment gap (2), and climate change's implications on price stability (3). These narratives influence under which "umbrella" central banks intervene in climate change discourse. The study shows a shift from pointing to financial stability to prioritizing price stability in the ECB's climate policy discourse, possibly leading to major green monetary policy measures. Nevertheless, it does not indicate a divergence from market liberal central banking but rather shows a modification within the current framework, referred to as "*market liberalism in climate crisis mode*" or "*market liberalism adapted to climate change*" (Aguila & Wullweber, 2024: 23). While assessing the legitimacy of attempts to adopt green monetary policies, Aguila & Wullweber (2024) find that the shift in the ECB's discourse from originally claiming that climate change is "*not our business*" to acknowledging financial risks and eventually asserting that it is part of our mandate signifies more than simply a linguistic change. It signals a profound change that might have important policy implications.

Narratives do not emerge from the context of climate change itself but coexist with other narratives, particularly in the context of financial stability. It is important to consider that narratives emerge because of political engagement in climate change discourse, which increases central banks' politicization. Studying narratives is important as they show the political dynamics inside policymaking processes. Gaining insight into the emergence of these narratives provides a deeper understanding of the relationships, power distribution, and coalitions among different actors who play significant roles in influencing policymaking (Schmidt, 2016).

Considering institutional dynamics, the ECB is an EU institution¹⁴ and bound by EU Treaties. In 2015, the EU made its commitment to a transition to a low-carbon economy in the framework of the Paris Climate Agreement. Therefore, the following question is whether the ECB as an EU institution should align with the EU's activities. At the very beginning, the ECB had two

¹⁴ ["The European Central Bank \(ECB\) is an EU institution operating under clearly defined rules which can be found in primary and secondary EU law."](#)

main points: first, the primary mandate is price stability and not to fight climate change; second, it is a pure political responsibility to foster the green transition. Clearly the increasing engagement of the EU shifted the ECB towards green narratives.

To analyze this further, this paper looks at how central bankers and members of the European Parliament developed a common pro-climate narrative studied by Massoc (2024). By 2021, the prevailing narrative that supported the ECB in climate-related initiatives had changed to one that aligns these efforts with its primary mandate. This narrative contends that because the climate crisis unavoidably results in substantial price volatility, it is important for the ECB to address it as part of its core responsibility. The acceptance of this narrative, which once seemed unlikely, shifted to the main narrative legitimizing the pro-climate change involvement of the ECB. The following question arises: *How did the transition happen?* The accountability relationship between the ECB and the EP (European Parliament) has facilitated the formation of pro-climate coalition building within both institutions. Massoc (2024) argues against attributing this solely to internal factors within the ECB, such as organizational dynamics, or to external factors, like the EP's endorsement or ideological alignment between politicians and technocrats. The main objective of this cooperation is to create a climate-friendly narrative that may attract support, even from more conservative central bankers, by highlighting the compatibility of climate actions with the ECB's primary mandate. Central banks do prioritize climate-change-related topics, engaging in storytelling and building with these narratives certain economic knowledge. However, this phenomenon aligns together with increasing political involvement and cooperation, resulting in legitimizing central banks' actions and norm creation.

Narratives are impactful tools for shaping norms within central banks, whereas norms refer to shared expectations, behavior, and rules.¹⁵ When central banks communicate through narratives, they not only share information and create knowledge but also contribute to the establishment and reinforcement of norms. Moreover, narratives help central banks socialize norms into the institution. When it comes to climate change, new norms that emerged recently shaped central banking. For instance, joining NGFS members spreads new climate norms, which further create a new political dynamic at the global level and serve as an incentive for more central banks to join

¹⁵ <https://www.oxfordbibliographies.com/display/document/obo-9780199756384/obo-9780199756384-0091.xml>

the network and incorporate climate change into their institutional framework (DiLeo et al. 2023).

ii. Empirical analysis for green narratives

This section presents the results of the quantitative analysis from the keyword-assisted topic model, previously used to analyze green speeches from the whole corpus of 18,902 documents. It applies the model to showcase green narratives central banks create while communicating with the public. This approach identified 783 speeches related to the climate change topic.¹⁶

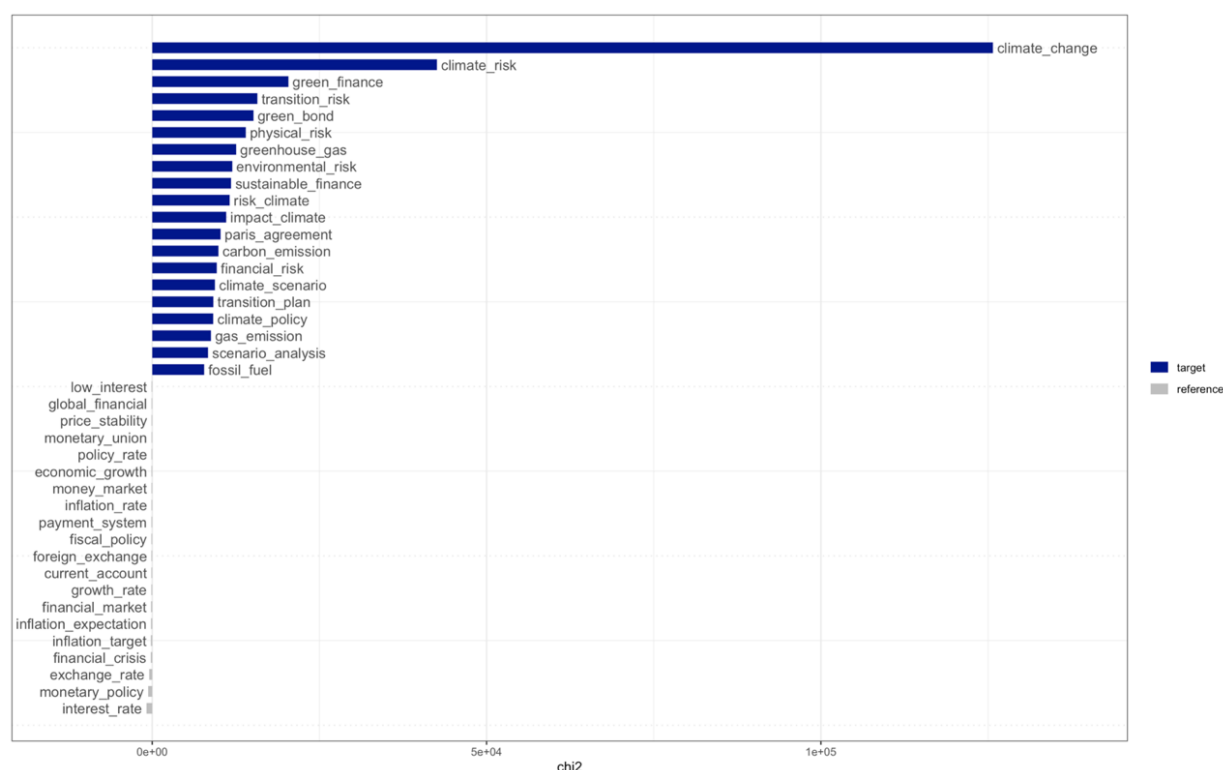
To dig deeper into the narratives, this paper first extracted out of 783 speeches identified as green 337 speeches. These 337 speeches have the highest proportion of green content and the biggest difference to the second most important topic of at least 0.15. For example, one can consider a speech by Boediono on “*Macroeconomic impact of climate change - opportunities and challenges*”, and it indeed aligns with the results of the analysis, which show the higher proportion of green in relationship to other identified topics. The difference analysis highlights the narrative depth related to pro-climate matters in central banks’ communication. Considering that the topic of climate change in central banks has gained popularity and started growing recently, the number of speeches from the entire dataset is quite high. This indicates that central banks are constructing green narratives to inform the public.

To analyze this further, this research presents the results of a keyness analysis in **Table 4** in the Appendix. This analysis compares the frequency of specific expressions within the set of green speeches, which is referred to as “*n target*” with the expected frequency based on the remaining texts, respectively referred to as “*n reference*.” For this purpose, a χ^2 test was employed. For context, similar analyses have been conducted by researchers such as Scott & Tribble (2006) and Dunning (1994). The goal is to determine whether certain terms appear more or less frequently in the green corpus compared to the set of non-green speeches.

¹⁶ Detailed analysis of identifying green speeches see Section IV.

Figure 5 visually represents the outcomes of the keyness analysis. Terms that occur more frequently in the green corpus are highlighted in blue, while those that deviate significantly from the expected value appear in grey. This approach allows us to gain insights into the distinctive language patterns associated with green content in the speeches. Moreover, this analysis breaks the assumption that green narratives align with other topics in most green speeches.

Figure 5. Over- and underrepresented terms in green speeches

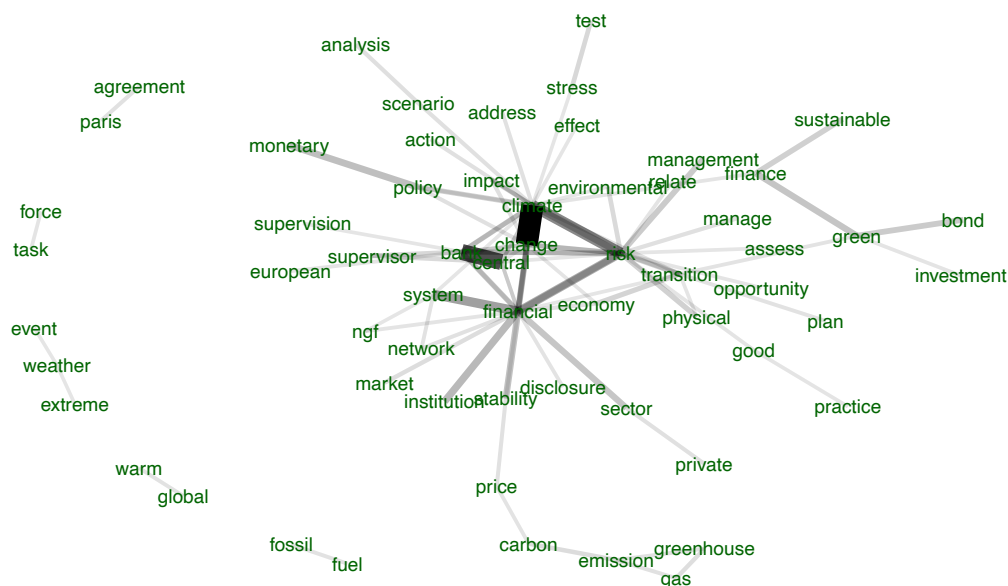


In the context of green speeches, all relevant terms are closely related to climate change. Conversely, the terms that receive less attention relate to monetary policy, its instruments, and price stability. Notably, central banks' perspective on climate change diverges from the lens of price stability, which one finds appealing, especially considering the recent developments, such as an increase in global energy prices and the fact that climate change affects inflation through rising food and energy prices (Dafermos et al., 2021; E. Massoc, 2022). Next, the research delves deeper into analyzing narratives by conducting part-of-speech tagging analysis and co-occurrences of

various words in the corpus of green speeches. **Figure 6** illustrates the network consisting of the 100 most frequent co-occurrences.

Related to this analysis is the paper by Ash et al. (2023), who conduct semantic role labeling answering basic questions about the meaning of written sentences: *who* is doing *what* to *whom*, where *who* is the actor, *what* – action, and lastly to *whom* – patient, the entity affected by action. The scholars use dimensionality reduction methods to aggregate similar narratives or expressions. This analysis applies a similar approach, where it uses parts of speech (POS) tagging and then analyzes co-occurrences of nouns and verbs. Then, to be able to identify a narrative, one looks at the subset of nouns, verbs and adjectives.

Figure 6. Word co-occurrences



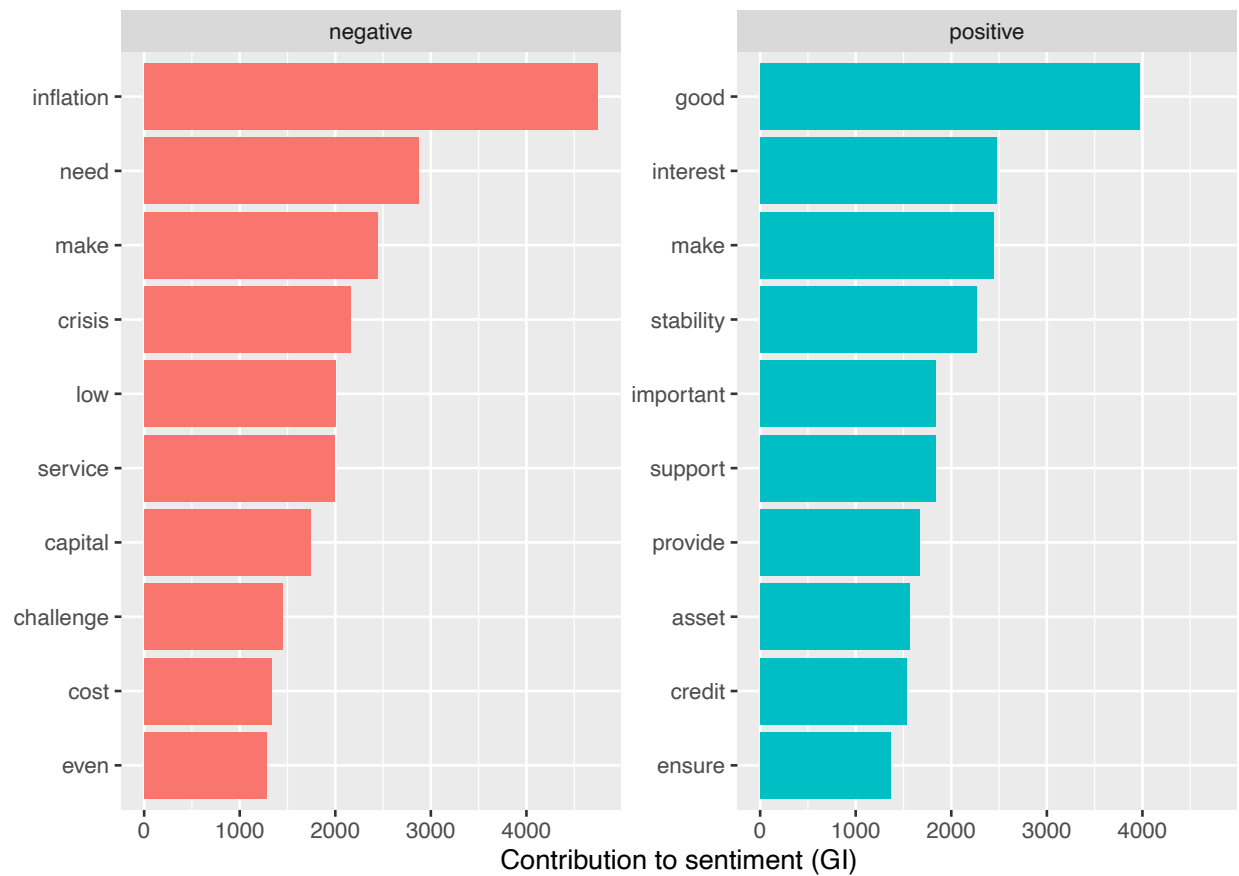
The co-occurrences figure shows some interesting results. The central network consists of three main links. First, climate change (who), which is addressed (what - action) by central bank (whom). This shows that the main actor here is climate change, which poses a threat to central banks. The links direct on the right from climate change to the risk, as the second word next to climate change, further followed by verbs “*manage*” and “*assess*”, underlying the urge to consider this threat. The explanation is evident if one looks at the left intersection adjacent to climate

change, which not only represents risk but has an impact on the financial intersection, which in turn has an impact on issues connected to stability that are more general. Additionally, one observes that risk implications for the financial sector bring both the public and private sectors into the picture—a story that is consistent with Simandan et al. (2023).

To the left, task force, extreme weather events, global warm(ing) and fossil fuel are also among the most 100 co-occurrences, contributing to the narrative building. Thus, it underlines the causes and consequences of climate change. The other intersections next to climate change, such as action and policy, further connected to monetary, the Paris Agreement, bank supervision, and the NGF system illustrate the policy action needed to assess and combat climate change effects on central banking. The word network also includes carbon price, which captures the external costs of greenhouse gas emissions. This shows that in their speeches, central banks create a narrative to deliver a signal and raise awareness for emitters. To add, the right side of the figure represents what actions can be taken with the words transition plan, sustainable finance, green bonds, and investments to intersect with climate change. By contrast, there are no intersections among the most frequently occurring words that are strongly negative, indicating the urgency of action against climate change threats to central banks.

To delve deeper into the analysis of expressions and their positive or negative implications for climate discourse, this paper conducted sentiment analysis for green corpus based on Loughran & McDonald (2011). The aim is to find whether the sentiment analysis in climate change-related speeches by central banks differs from the whole speech corpus (18,902 speeches). The results in **Figure 7** show a relatively equal number of negative/positive expressions in the speeches. Therefore, central banks address climate change issues with a balance of negative and positive words, not using any particularly negative expressions. This either shows central banks' specific approach to the climate change question or assumes that there is no urgency for central banks to address it with more negative sentiment, for example, to raise awareness.

Figure 7. Sentiment analysis of green speeches



To conclude, the analysis of green speeches by central banks introduces a complex narrative around climate change. By digging deeper into the language patterns and content of these speeches, one observes a common effort by central banks to inform and engage the public on climate-related risks and policy responses, thereby creating narratives and new norms. The network analysis shows the connection of climate change discourse with financial sector implications and policy actions, where central banks play an important role in assessing climate change. In addition to this, sentiment analysis demonstrates a balanced approach in central bank discourse, avoiding negative expressions while acknowledging the importance of addressing climate change. That said, the analysis underlines the role of central banks in shaping the narrative and response to climate change through transparent and proactive communication, raising awareness, and contributing to the joint effort of bringing climate change into the institutional framework.

iii. Central Bank Independence: monetary and fiscal interaction

In order to delve deeper into the climate change framework of central banks and further assess the political influence on central banks' communication, it is important to overall understand how central banks and governments relate to each other in the discourse of central bank's independence. The pressure is a relatively negative expression, whereas the cooperation fosters monetary and fiscal policies aligned with the purpose of improving economic performance. This section (iii) analyzes the interaction of fiscal and monetary policies, focusing on the political dimension of central bank independence with the focus on monetary and fiscal interaction in the Eurozone countries as an example. For this, this analysis refers to one of my unpublished papers on "*The ECB's Interaction with Fiscal Policy: the Relationship between the ECB's Monetary Policy and Fiscal Policy in the Eurozone*" that I wrote for the central banking seminar (Teliha, 2023).

Central banks are considered unique public institutions with the exclusive power to issue money and conduct independent monetary policy, placing them between government and financial markets. Over time, their goals and independence have changed based on the dominant economic ideas of the era. Today, central banks operate under the central bank independence framework, which became popular in the early 1990s. This approach grants them independence from political influence, focusing mainly on keeping prices stable within their legal mandate. For nearly two decades, central banks were seen as neutral, technical bodies. However, following the 2007 financial crisis, they considered taking on more political roles (see Goodhart, 2011; Marcussen, 2009; Mudge & Vauchez, 2016; Singleton, 2010). Before moving to an analysis of fiscal and monetary interaction, first, this research delves deeper into the theoretical framework of central bank independence.

To start with, there are two main perspectives available for understanding central bank independence (CBI): **instrumental independence** and **goal independence**. Instrumental independence describes the central bank's freedom in determining how to carry out its policy objectives, which usually include inflation controls, whereas the ability to choose these policy objectives is implied by goal independence, on the other hand. According to the initial idea, central banks may commit to low inflation targets with more credibility when they are not subject to

political pressure, which further helps to stabilize inflation expectations and foster economic stability (Central Bank of Sri Lanka, 2024; Eijffinger & de Haan, 1996). Current research demonstrates how central bank independence is changing. For instance, the average degree of central bank independence has significantly increased worldwide. Given the previous economic crises that have put the robustness of economic institutions to the test, this tendency reflects a renewed commitment to shielding monetary policy from political cycles. This worldwide tendency extends to countries with different institutional frameworks and wealth levels, which leads to the point that central bank independence plays an important role in maintaining economic stability (Romelli, 2023; Romelli, 2024). Empirically, some studies found a strong correlation between CBI and lower inflation volatility in developing countries, proving that the more the central bank is independent, the stronger is price stability (see Garriga & Rodriguez, 2023). Important to preserving independence are ways of communication by central banks, well presented in the Bank of England strategy, which shows how effective communication may improve the legitimacy and transparency of monetary policy even beyond formal independence (Baker et al., 2023). In this study, communication plays a crucial role in assessing how independent central banks are in their decision to include climate change in their discourse and their agenda.

Despite the ideal realms of the theory, central bank independence experiences several obstacles. For instance, political pressures can undermine central bank independence can jeopardize the autonomy of monetary policy during events such as financial crises, economic downturns, or geopolitical challenges. Political cycles and short-term economic concerns often collide with the long-term objectives of central banks. In addition, global economic developments and the expansion of unorthodox monetary policies pose new difficulties for central banks, and they have to operate in this complex environment with their policies creating international spillovers (The White House, 2024).

A central bank has to be trustworthy, independent of the government, and open in its goals in order to manage monetary policy objectively, as Goodhart (2011) underlined in his research. More existing literature shows an interplay between monetary and fiscal policies and their influence on the economic environment, with different views on central bank independence, external pressures, and government interdependencies. Beukers (2013) highlights the evolving

relationship between the ECB and Eurozone countries post 2008 crisis, with the ECB now influencing national policies and pushing for reforms. Von Hagen & Mundschenk (2003) argue that monetary policy can maintain price stability independently but may face short-term tensions with fiscal policy due to their combined effect on demand. Eggertsson & Borgne (2003) examine why policy tasks are delegated to independent central banks while Ahrend et al. (2006) discuss how monetary policy adjustments can mitigate the negative effects of fiscal tightening.

To demonstrate whether governments influence central banks, it is important to assess how these two separate policies interact. The interplay between monetary and fiscal policy is critical for fostering macroeconomic stability. Their coordination helps to identify potential cooperation or conflicts that may affect economic growth, inflation, employment, and overall stability. Understanding how these policies interact enables us to develop more effective and coordinated measures for economic goals, such as boosting growth and controlling inflation. For example, knowledge of how fiscal policy complements or counteracts monetary policy contributes to the creation of integrated strategies to solve macroeconomic problems and improves policymaking processes. In addition, the study of the interaction between monetary and fiscal policy contributes to improved coordination and communication between central banks and national governments (Ahrend et al., 2006). As the main focus of this research is to measure central banks' stance on climate change through communication, in the case of the ECB this paper aims to show what role fiscal policies play in Banks' public discourse, implying the results from Teliha (2023).

The ECB's monetary policy rhetoric is well-known and extensively researched, but its fiscal policy discourse has not gotten the same level of attention. An interesting finding suggests that just 12% of the ECB's opening remarks—the majority of which are normative—address fiscal issues. The level of fiscal debate in the Euro Area is mostly influenced by government deficits. When the Euro Area's government deficits rise, so does the ECB's public discussion of fiscal policy. This conclusion is supported by my empirical study of interest rates and government debt, which shows that the ECB pays more attention to fiscal issues when deficits are larger. In addition, by means of discretionary measures like tax rate adjustments and automatic stabilizers, fiscal policy influences the short-term monetary policy environment. Long-term fiscal strategies are essential to prospective economic development and the sustainability of state finances (Allard et

al., 2013). That said, the ECB's broad public discussion of fiscal policy demonstrates a degree of collaboration between the fiscal authorities and the central bank, thereby showing how fiscal and monetary policy are interrelated and how crucial it is to coordinate them. These results have useful implications for the central bank's discourse on climate change. The ECB has actively included climate change in its public discourse (as previous findings listed the ECB among the top contributors for green speeches), acknowledging the growing impact of climate change on economic stability. On this issue, monetary and fiscal policy interaction is crucial to mitigate risks and promote green investment, as fiscal policy decisions affect central banks. Therefore, next, this research will assess the impact of climate change on sovereign debt, assuming that, based on evidence from the ECB, an increase in sovereign debt will lead to increased communication from central banks on this issue.

Already existing research emphasizes that climate risk should be incorporated into public sector funding and public debt strategies (Centre for Sustainable Finance, 2021). According to the policy brief by United Nations (2022), if the governments do not have any public policies and measures to mitigate climate risks, climate change affects public debt vulnerabilities, especially for the countries with high government debt. Therefore, it is crucial to conduct new policies and reforms, change the debt architecture, and facilitate financing for climate investments. Based on previous results that showed the impact of governments on the ECB's communication, this research includes a recent analysis by the European Commission. It demonstrated the fiscal impacts of natural disasters across 13 EU countries projects and that debt-to-GDP ratios will be, on average, 2.3 and 2.7 percentage points higher by 2032 under 1.5°C and 2°C global warming scenarios, respectively (Emambakhsh et al., 2023). This illustrates the necessity for fiscal authorities to incorporate potential climate risks in their debt sustainability analyses. That said, these fiscal concerns linked to climate change may incentivize central banks to increase their focus on climate-related topics. To empirically prove this, the next section (v), assessing the political dimension of central banking, will link climate policies and central banks' speeches. Before, this chapter included scatterplot and correlation analysis to showcase the possible relationship between the green index in central bank speeches and government debt-fiscal policy.

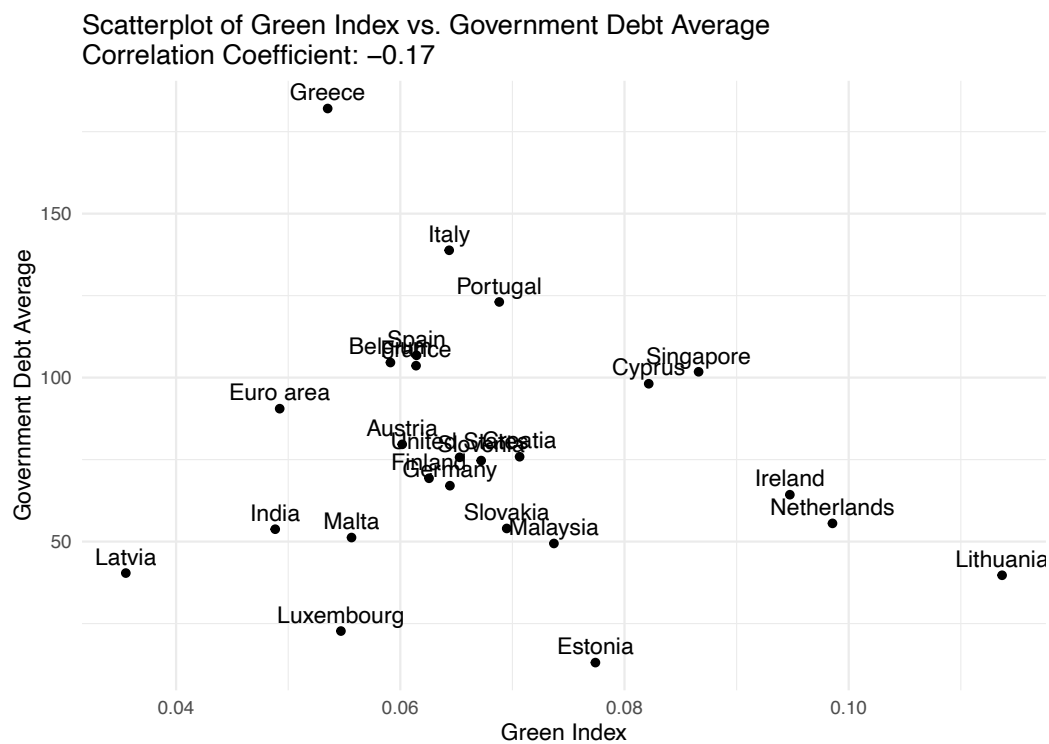
iv. Scatterplot and correlation analysis

In addition, given the assumption that higher government debt concerns central banks, leading them to include more fiscal issues in their communications, and particularly add climate change into their discourse if it affects government debt, resulting in a higher green index (green topic among central banks speeches), this research includes analysis performed with scatterplot (see **Figure 8**). A scatterplot is a type of data visualization used to analyze the relationship (the correlation) between two variables (Strain et al., 2023). For this, first, it is necessary to collect an average of the government debt of countries where central banks contribute the most to the green topic: the ECB (eurozone countries), US Fed, Singapore Monetary Authority, Indian Reserve Bank, and Central Banks of Malaysia. Second, the analysis includes an average of the green index for central banks' speeches over a time period of 1996-2023 (same as speeches in the main corpus). The data is represented in **Table 9** in the Appendix.

Next, with the two variables represented in the data – Green index and government debt average – the analysis includes a scatterplot to assess the relationship between them. In this case, the independent variable is government debt, and the dependent variable is a green index, as one assumes that the change in government debt causes the change in the green index, as central banks communicate more on fiscal matters. This potentially happens when the government debt changes as a consequence of climate change, which causes the change in government debt, based on Allard et al. (2013) and Emambakhsh et al. (2023) findings. The negative correlation coefficient of **-0.17** indicates an inverse relationship between the two variables, which implies that generally, as the government debt increases, the green index tends to decrease, and vice versa. However, this relationship is weak within this dataset, suggesting that changes in government debt levels are not strongly related to changes in the green index. This applies that if government debt increases and central banks increase their communication on fiscal matters, it does not directly apply that they also include climate change to their framework. That said, there is no evidence that changes in government debt affect green communication by central banks. To elaborate further on this, it is necessary to add extra variables to the analysis, such as climate change's influence on government debt, government spending on green investments, or any other explanatory factors.

It looks as if the correlation could vary for different country groups. For instance, countries with different economic statuses or regions might experience varying relationships between government debt and the green index. It could be possible that as government debt increases, central banks and policymakers may focus more on fiscal and economic issues, leading to less emphasis on green policies and environmental issues. This shift in focus could indirectly impact the green index, as environmental concerns might receive less attention. To sum up, the analysis shows a very weak negative correlation between the green index and government debt averages, which is not statistically significant. This only suggests that in this dataset there is no strong linear relationship between these two. However, a more robust analysis, including different variables, could provide better results and an overview of this relationship.

Figure 8: Scatterplot of green index vs. government debt average

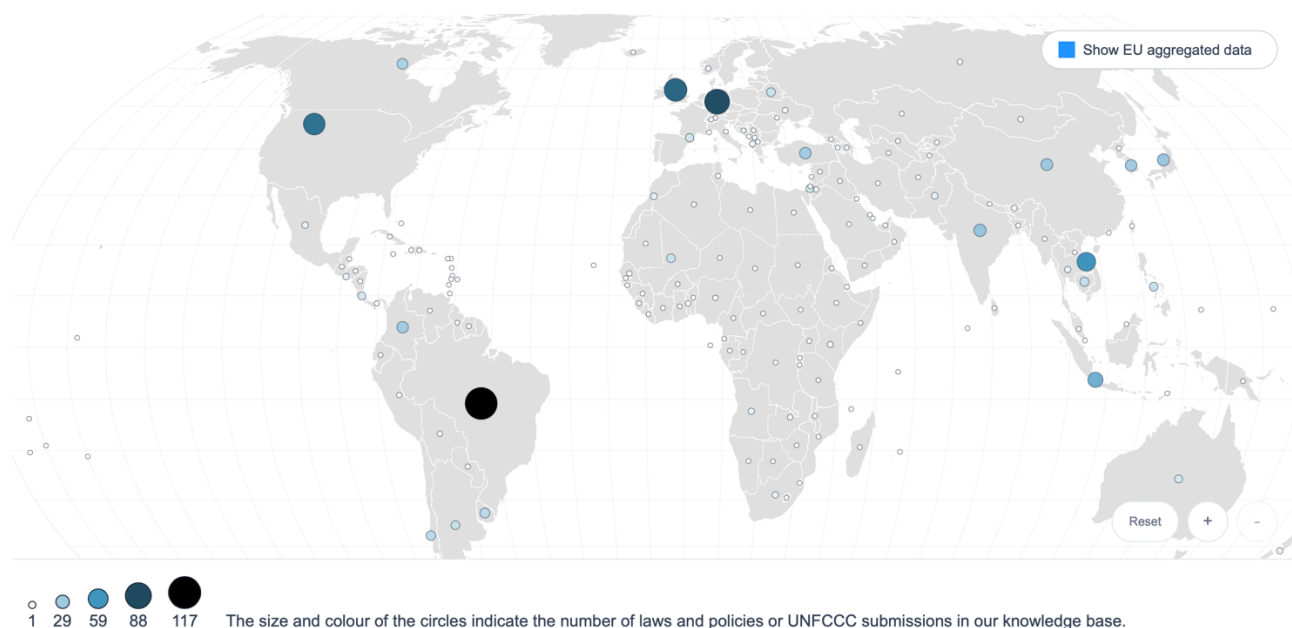


v. The political discourse of central banks' green communication

This concluding subsection (v) analyzes the political framework of central banking, particularly how national governments and their policymaking affect central banks' communication on climate change. The hypothesis suggests that those central banks that have higher levels of green communication are exposed to national government pressure. The reason is that national governments intensively include climate change in their policy framework, raising the awareness of central banks. For this purpose, this part assesses the link between governments and central banks in incorporating climate change into their policy framework with the second corpus of text data for the climate change policies. This chapter is adapted from the political discourse section of the paper “*Speeches in the green: The political discourse of green central banking*,” co-authored with Prof. Dr. Martin Feldkircher and published in *Energy Economics*, 2024.

This analysis includes data from the Climate Change Laws of the World database (<https://climate-laws.org>). In addition to climate laws, the database includes policy documents from all over the world, more than 5,000 documents in total. **Figure 9** visually represents the data from the Climate Laws webpage, showing the number of laws and policies around the world.

Figure 9. Climate laws and policies worldwide



Climate Change Laws of the World is a database of national climate change laws and policies from across the globe. It comprises both laws and policies encouraging low-carbon transitions, and those immediately linked to climate change. The database emphasizes the need for climate policy in areas like land use, transportation, energy, and climate resilience.¹⁷ This research examines specific documents that are submitted under the United Nations Framework Convention on Climate Change (UNFCCC) framework (<https://unfccc.int>) and takes into consideration only documents in English. Having analyzed the documents, one observes that the database mostly contains Nationally Determined Contributions (NDC), which are defined as climate action plans to reduce emissions and adapt to the impacts of climate change. Each party to the Paris Agreement is obliged to submit the NDC every five years. For now, all 193 parties to the Paris Agreement have released at least one initial NDC in comparison to 2021, when only 151 parties contributed. The level of quality and ambition among parties depends on different factors such as lack of finance, limited capacity, and also political commitment.¹⁸ The data also contains National Communication submissions (<https://unfccc.int/non-annex-I-NCs>), which are more detailed reports of the countries on how to meet climate goals and cut greenhouse gas emissions. Whereas NCs are long and cover a country's efforts to reduce greenhouse gas emissions, vulnerability, and impact from climate change, NDCs that form the basis of the Paris Agreement are shorter and less detailed. That said, both documents showcase the actions by national governments to mitigate climate change. The intensity and the numbers of these documents submitted by national governments determines how committed governments are to the Paris Agreement, and how they fulfill their obligations as Parties to the Agreement. Therefore, the more documents national governments submit, the higher their political commitment. The relationship between climate policies and central banks is based on the argument that the more intensely the governments implement climate policies, the more concerns they raise for central banks. As a consequence, central banks feel the political pressure and include climate change in their public discourse.

The relationship between the political commitment of national governments to addressing climate change and concern by central banks for climate policy could be explained by looking at the possible impact of climate policies on financial markets. In 2022, the European Central Bank

¹⁷ <https://climate-laws.org>

¹⁸ <https://www.un.org/en/climatechange/all-about-ndcs>

has acknowledged some significant points, the underlying relationship between climate change objectives and financial stability, and showing the ECB's strategic approach to incorporating climate change within its mandate. First, the ECB's presence at COP27 shows global unity on climate change issues. The European Climate Law includes that the EU aims to reduce greenhouse gas emissions by 55% by 2030 and achieve climate neutrality by 2050, as it has implications for financial stability. Next, even though the ECB is not a policymaker in environmental matters, it must include environmental objectives in its policy framework and climate change should be considered for monetary policy and banking supervision. The ECB emphasized that its corporate sector purchase program (CSPP) now prioritizes bonds from companies with better climate performance. With its banking supervision obligations, the ECB encouraged banks to manage climate-related risks, reflecting the transition to a sustainable economy and to be compliant by the end of 2024. The ECB shows a strong commitment to mitigating climate change and its influence on monetary policy, participating in the NGFS.¹⁹

Countries with high climate targets often have comprehensive national action plans. The reason these countries' central banks should pay greater attention to climate concerns is not so much because of outside pressure as it is because they need to keep an eye on how these national climate programs impact financial markets. It is the mandate of central banks to maintain financial stability. Therefore, they have to know and be able to predict how national climate policies will affect financial and economic circumstances, including shifts in investment patterns, threats to specific sectors, and the stability of the market as a whole. The amount of central bank communication on climate-related topics is predicted to positively correlate with the frequency of climate policy documents in a respective country. This implies that central banks are likely to talk more about their own climate-related activities and concerns in countries where climate policies are often discussed and implemented. Due to the growing national legislation, central banks are expected to communicate more about how they are tackling climate challenges within their mandates as they become more aware of and involved in these issues.

The analysis includes the number of climate policy documents that represent the annual number of climate policy texts in each country and links it to the central banks of that country.

¹⁹ https://www.ecb.europa.eu/press/key/date/2022/html/ecb.sp221201_1~435e6ea81a.en.html

mandates; others do not have any mandates. In the multilevel panel model, the climate policy variable is included to assess its effects on green communication by central banks (see **Table 11**).

Table 11. Climate policy

	<i>Model 1</i>					<i>Model 2</i>					<i>Model 3</i>				
<i>Variable</i>	<i>Est.</i>	<i>S.E.</i>	<i>t val.</i>	<i>d.f.</i>	<i>p</i>	<i>Est.</i>	<i>S.E.</i>	<i>t val.</i>	<i>d.f.</i>	<i>p</i>	<i>Est.</i>	<i>S.E.</i>	<i>t val.</i>	<i>d.f.</i>	<i>p</i>
CBIE	0.05	0.02	2.52	1242.10	0.01	0.05	0.02	2.52	1242.40	0.01	0.05	0.02	2.52	1242.76	0.01
NGFS	0.07	0.00	17.73	1242.10	0.00	0.07	0.00	17.73	1242.40	0.00	0.07	0.00	17.74	1242.76	0.00
climate	0.01	0.00	3.08	1242.10	0.00	0.01	0.00	3.08	1242.40	0.00	0.01	0.00	3.08	1242.76	0.00
Between Effects															
(Intercept)	0.01	0.02	0.88	65.03	0.38	0.01	0.02	0.87	64.33	0.39	0.02	0.02	0.96	61.72	0.34
imean(CBIE)	0.04	0.02	2.68	60.45	0.01	0.04	0.02	2.20	61.43	0.03	0.04	0.02	1.80	60.86	0.08
imean(NGFS)	0.05	0.03	1.88	72.75	0.06	0.04	0.03	1.65	71.17	0.10	0.05	0.03	1.70	70.61	0.09
imean(climate)	0.02	0.02	1.05	65.90	0.30	0.02	0.02	1.16	65.21	0.25	0.02	0.02	1.07	63.82	0.29
temp.avg	0.00	0.00	3.44	66.15	0.00	0.00	0.00	3.47	64.37	0.00	0.00	0.00	3.47	64.28	0.00
overall_m						0.00	0.01	0.64	62.51	0.52					
impl_m											0.01	0.01	0.79	63.67	0.43
expl_m											0.00	0.01	0.06	63.82	0.95
Model information															
Entities: 81 (39 impl_m, 8 expl_m)															
AIC / BIC	-4618.17 / -4566.2					-4608.31 / -4551.15					-4608.31 / -4551.15				
Pseudo-R ² (fixed Eff.)	0.25					0.26					0.25				
Pseudo-R ² (total)	0.40					0.40					0.40				
Entity ICC	0.19					0.19					0.20				

Notes: Authors' calculations. P-values calculated using Satterthwaite d.f. Estimates with p-value ≤ 0.10 in bold

The models show that CBIE, NGFS, and climate [policy] variables significantly influence the dependent variable, with consistent effects across all three models. In addition, the average temperature variable is significant across all models, indicating a robust relationship with the dependent variable, whereas the overall mandate variable is not significant. Overall, the climate policy documents have a positive within-effect on central banks' green communication. This means the more active national governments are in their climate change policymaking, the more central banks address the issue of climate change in their speeches, raising awareness and underlying its importance. That said, across all three models, the climate policy variable consistently shows a positive and significant effect on climate-related central bank communication. This indicates that in countries with more extensive climate policy texts, central banks are more likely to communicate about climate change-related topics. This suggests that when a national government increases the number of climate policies, it results in a higher frequency and intensity of communication regarding climate issues by central banks. This can be seen as a form of political pressure on central banks. Similarly, the NGFS variable also shows a positive and highly significant effect in all models. Central banks that are members of NGFS tend

to discuss climate change-related topics more frequently. Membership in the NGFS represents a form of peer pressure among central banks. Being part of this network likely encourages central banks to align with the group’s initiatives and norms, thereby increasing their green communication.

Furthermore, peer and domestic political pressures may be explained by the frameworks used to develop climate standards. The instance of the Fed and the ECB illustrates how there is now a definite disparity on the matter of climate change, as shown by DiLeo et al. (2023). As we discovered before, peer pressure is fostered by NGFS participation, which incentivizes additional central banks to join. It also demonstrates how NGFS members propagate new climatic standards, which in turn create a new political dynamic globally and a common logic of “rightness” that puts pressure on other central banks. Central banks are under pressure from various political limitations as well as internal political pressure resulting from decision procedures. For example, the ECB was pressured to adopt new climate-related standards by the EU’s broad support for climate policies and powerful policy entrepreneurs. In contrast, the Fed abstained from discussing climate policy due to severe socio-political polarization at home. Consequently, the degree to which central banks include climate change in their communication framework is influenced by political influence and peer pressure, as discovered via norms (DiLeo et al., 2023).

Table 12. Climate policy interaction

	<i>Model 1</i>					<i>Model 2</i>					<i>Model 3</i>				
<i>Variable</i>	<i>Est.</i>	<i>S.E.</i>	<i>t val.</i>	<i>d.f.</i>	<i>p</i>	<i>Est.</i>	<i>S.E.</i>	<i>t val.</i>	<i>d.f.</i>	<i>p</i>	<i>Est.</i>	<i>S.E.</i>	<i>t val.</i>	<i>d.f.</i>	<i>p</i>
CBIE	0.05	0.02	2.27	1241.10	0.02	0.05	0.02	2.36	1241.08	0.02	0.05	0.02	2.49	1241.40	0.01
NGFS	0.07	0.00	17.72	1241.10	0.00	0.07	0.00	18.31	1241.08	0.00	0.07	0.00	17.66	1241.40	0.00
climate	0.01	0.00	3.04	1241.10	0.00	0.01	0.00	4.97	1241.08	0.00	0.00	0.00	0.86	1241.40	0.39
climate:CBIE	-0.02	0.05	-0.30	1241.10	0.76										
climate:NGFS						-0.02	0.00	-4.12	1241.08	0.00					
Between Effects															
(Intercept)	0.01	0.02	0.88	65.02	0.38	0.01	0.02	0.87	65.09	0.38	0.01	0.02	0.87	64.34	0.39
imean(CBIE)	0.04	0.02	2.68	60.45	0.01	0.04	0.02	2.68	60.55	0.01	0.04	0.02	2.20	61.45	0.03
imean(NGFS)	0.05	0.03	1.88	72.75	0.06	0.05	0.03	1.88	72.76	0.06	0.04	0.03	1.65	71.17	0.10
imean(climate)	0.02	0.02	1.05	65.90	0.30	0.02	0.02	1.06	65.96	0.29	0.02	0.02	1.16	65.23	0.25
temp.avg	0.00	0.00	3.44	66.15	0.00	0.00	0.00	3.43	66.22	0.00	0.00	0.00	3.47	64.39	0.00
overall_m											0.00	0.01	0.64	62.53	0.52
Cross-Level Interactions															
climate:overall_m											0.01	0	2.09	1241.4	0.04
Model information															
Entities: 81 (39 impl.m, 8 expl.m)															
AIC / BIC	-4612.22 / -4555.06					-4623.92 / -4566.76					-4601.19 / -4538.83				
Pseudo-R ² (fixed Eff.)	0.26					0.26					0.26				
Pseudo-R ² (total)	0.40					0.41					0.40				
Entity ICC	0.19					0.20					0.20				

Notes: Authors’ calculations. P-values calculated using Satterthwaite d.f. Estimates with p-value≤ 0.10 in bold

Next, this analysis shows non-linear effects by interacting the climate policy variable with CBIE, the NGFS variable, and the overall mandate dummy variable (see **Table 12**). The first specification analyses whether varying degrees of central bank independence have an effect on how green communication is affected by climate policy texts. There is no significant effect in the interaction coefficient, showing that the level of central bank independence does not influence the effect of climate policy documents on green communication. In other words, whether a central bank is more or less independent from the government does not change how strongly climate policy texts influence its green communication.

To summarize, how often national climate policy materials are released positively impacts green communication by central banks, in addition to peer pressure from NGFS membership. This indicates that central banks communicate on climate change more often as a result of proactive government actions. Interestingly, the two types of pressure—government pressure and NGFS peer pressure—improve each other. In particular, high political pressure may cause central banks to decrease green communication if they are also members of NGFS, as shown by the negative interaction between NGFS and climate policy in one model. This shows that there is a balancing effect between both kinds of pressure. Lastly, the interaction of the overall mandate with climate policy text shows a positive effect, implying that central banks with a mandate are more responsive to government pressure than central banks without a mandate. This shows that having a mandate makes it easier for national governments' climate policies to affect green communication by central banks.

VI. Conclusion

This research offers an extensive analysis of central banks' public communication on climate change-related issues and the political discourse of green central banking. The keyword-assisted topic model (keyATM) helps to quantify the extent of green communication by measuring climate change topics, among other topics, in central bank speeches. For the time period between 1996 and 2023, 18,892 documents were submitted to BIS by 112 financial institutions, out of which 783 speeches by 69 central banks were identified as green. Taking into consideration different types of explanatory variables, such as macroeconomic data and geographic data, this research explores why some central banks talk more about climate change than others. In order to deeper understand public discourse by central banks on the issue, this paper includes green narratives analysis and the sentiment analysis of climate change related speeches. Next, for the political discourse analysis of green central banking, CBI, monetary and fiscal interaction, NGFS, and climate change policies by national governments were to consider assessing what the relationship between governments and central banks is.

The main findings reveal several key points. Firstly, through proactive communication, central banks introduce green narratives and norms to central banking, creating new political dynamics and incorporating climate change into their institutional framework. In addition, the network analysis shows the connection of climate change discourse with the financial sector, while sentiment analysis illustrates a balanced approach in central banks' discourse, acknowledging the importance of addressing climate change. For the underlying importance of climate change, monetary and fiscal interaction is crucial; however, it could jeopardize central bank independence. Second, the NGFS network is positively related to variations in green communication, applying that central banks that are part of the network talk more about climate change. The explanation for it lies in the presence of peer pressure, which creates motivation for central banks to join the network, as they fear losing their social reputation. With the second dataset, namely climate policy documents, this analysis shows that the more climate change policies national governments adopt, the higher the extent of central banks' communication on a green matter. Interestingly, the explicit or implicit mandate does not play a role. However, long-run average temperatures have a small but positive effect on green communication. Next, regarding CBI, the more independent central

banks become, the more they talk about climate change. Central banks with explicit mandate are often with lower CBI levels. Lastly, when peer pressure is linked to an active engagement by governments with climate change, central banks communicate less on this issue. For central banks that become part of NGFS, political pressure from the governments decreases their green communication.

To conclude, this research has explored central banks' communication on climate change and the political discourse of it. However, there are several directions for future research. Firstly, incorporating political spectrum and ideology could provide a deeper understanding of how left-wing or right-wing governments influence central banks' discourse. Secondly, considering government debt as a factor could show why central banks include fiscal issues in their communications and whether it has a potential link to climate change, affecting sovereign debt. Future research should include more variables and expand the data to understand this relationship.

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Appendix

Table 1. Mandates and central banks included in the BIS database

Entity	explicit mandate	implicit mandate	NGFS	Panel estimation	Green speech	Entity	explicit mandate	implicit mandate	NGFS	Panel estimation	Green speech
AE	0	0	✓	✓	0	JO	0	0	✓	0	0
AL	0	0	✓	✓	✓	JP	0	0	✓	✓	✓
AM	0	0	✓	0	0	KE	0	✓	✓	✓	✓
AN	–	–	0	0	0	KH	0	✓	✓	✓	0
AR	0	0	✓	✓	0	KR	0	0	✓	✓	✓
AT	0	✓	0	✓	✓	KW	0	0	0	✓	✓
AU	0	0	✓	✓	✓	KY	–	–	✓	0	0
AW	–	–	0	0	0	LK	0	0	0	✓	✓
BA	0	0	0	✓	0	LT	0	✓	✓	✓	✓
BB	0	0	✓	0	✓	LU	0	✓	✓	✓	✓
BCBS	–	–	0	0	0	LV	0	✓	✓	✓	0
BE	0	✓	✓	✓	0	MA	0	✓	0	✓	✓
BG	0	✓	0	✓	0	MK	0	✓	✓	✓	0
BH	0	0	✓	✓	0	MO	–	–	0	0	0
BIS	–	–	0	0	0	MT	0	✓	✓	✓	✓
BO	0	0	0	0	0	MU	0	0	0	✓	✓
BoN	✓	0	0	0	0	MV	0	0	0	✓	0
BR	0	✓	✓	✓	0	MW	0	✓	0	✓	0
BS	0	0	0	✓	✓	MX	0	0	✓	✓	✓
BW	0	✓	0	✓	0	MY	✓	0	✓	✓	✓
BZ	0	0	0	0	0	MZ	0	0	0	0	0
CA	0	0	✓	✓	✓	NG	0	0	✓	✓	0
CBCS	–	–	0	0	✓	NL	0	✓	✓	✓	✓
CH	0	✓	✓	✓	✓	NO	0	0	✓	✓	✓
CL	0	0	✓	✓	✓	NP	✓	0	0	✓	0
CN	0	0	✓	✓	✓	NZ	0	0	✓	✓	✓
CO	0	0	✓	✓	0	PG	0	0	0	0	✓
CY	0	✓	✓	✓	✓	PH	✓	0	✓	✓	✓
CZ	0	✓	0	✓	✓	PK	0	0	✓	✓	✓
DE	0	✓	✓	✓	✓	PL	0	✓	0	✓	0
DK	0	✓	✓	✓	✓	PT	0	✓	✓	✓	✓
DZ	0	0	0	✓	0	RO	0	✓	✓	✓	✓
EC	0	0	0	0	0	RS	0	✓	✓	0	✓
ECB	0	✓	✓	✓	✓	RU	✓	0	✓	✓	✓
ECCB	–	–	0	0	0	SA	0	0	✓	✓	✓
EE	0	✓	✓	✓	0	SB	0	0	0	0	0
ES	0	✓	✓	✓	✓	SC	0	0	✓	✓	✓
FI	0	✓	0	✓	✓	SE	0	✓	✓	✓	✓
FJ	✓	0	0	0	✓	SG	✓	0	✓	✓	✓
FR	0	✓	✓	✓	✓	SI	0	✓	✓	✓	✓
GB	0	✓	✓	✓	✓	SK	0	✓	0	✓	0
GH	0	✓	✓	✓	✓	SL	0	0	0	✓	0
GM	✓	0	0	0	0	TH	0	0	✓	✓	✓
GR	0	✓	✓	✓	✓	TR	0	✓	✓	✓	0
GT	0	0	0	0	0	TT	0	0	✓	✓	0
GY	0	0	0	0	0	TZ	✓	0	0	0	0
HK	0	0	✓	0	✓	UA	✓	0	✓	✓	0
HR	0	✓	✓	✓	✓	UG	0	0	✓	✓	0
HU	✓	0	✓	✓	0	US	0	0	✓	✓	✓
ID	0	✓	✓	✓	✓	UY	0	0	✓	0	0
IE	0	✓	✓	✓	✓	VU	0	0	0	0	0
IL	0	✓	✓	0	✓	WS	0	0	0	0	0
IN	0	0	✓	✓	✓	XK	0	✓	0	0	✓
IS	0	✓	✓	✓	0	ZA	✓	0	✓	✓	✓
IT	0	✓	✓	✓	✓	ZM	0	0	0	✓	0
JM	0	0	0	✓	0						

Notes: Entity codes refer to ISO 2 codes, except for the following abbreviations: BIS (Bank for International Settlements), BoN (Central bank of Namibia), CBCS (Central Bank of Curaçao and Sint Maarten), ECB (European Central Bank), ECCB (Eastern Caribbean Central Bank).

Table 4. Keyness analysis of green speeches

#	feature	chi2	p-value	n_target	n_reference
1	climate_change	87978.29	0.00	4253.00	1817.00
2	financial_system	197.05	0.00	1834.00	39901.00
3	monetary_policy	-1307.23	0.00	1515.00	113325.00
4	financial_stability	4.84	0.03	1202.00	34217.00
5	climate_risk	28236.06	0.00	1159.00	264.00
6	financial_institution	65.28	0.00	1122.00	26653.00
7	financial_sector	203.53	0.00	944.00	17882.00
8	risk_management	332.92	0.00	767.00	11953.00
9	financial_risk	6201.47	0.00	731.00	1536.00
10	sustainable_finance	14183.69	0.00	721.00	356.00
11	green_finance	14070.71	0.00	652.00	243.00
12	green_bond	12435.76	0.00	577.00	216.00
13	financial_market	-397.90	0.00	491.00	35841.00
14	stress_test	424.89	0.00	439.00	4974.00
15	financial_service	-0.38	0.54	427.00	13364.00
16	transition_risk	10136.95	0.00	417.00	96.00
17	private_sector	0.30	0.58	366.00	10795.00
18	price_stability	-256.67	0.00	362.00	25058.00
19	physical_risk	9284.96	0.00	359.00	58.00
20	financial_crisis	-238.37	0.00	359.00	24234.00
21	impact_climate	8054.77	0.00	346.00	97.00
22	interest_rate	-1604.96	0.00	344.00	68102.00
23	greenhouse_gas	7642.81	0.00	331.00	96.00
24	risk_financial	241.77	0.00	330.00	4233.00
25	environmental_risk	7729.14	0.00	325.00	83.00
26	balance_sheet	-76.31	0.00	324.00	15982.00
27	economic_activity	-73.09	0.00	314.00	15446.00
28	risk_climate	6782.96	0.00	308.00	107.00
29	scenario_analysis	4775.93	0.00	285.00	207.00
30	carbon_emission	5941.60	0.00	281.00	112.00
31	economy_financial	243.99	0.00	273.00	3210.00
32	paris_agreement	6944.28	0.00	269.00	44.00
33	capital_market	-10.50	0.00	267.00	9908.00
34	climate_policy	5552.42	0.00	261.00	102.00
35	network_financial	3957.60	0.00	260.00	229.00
36	fossil_fuel	4888.86	0.00	254.00	133.00
37	gas_emission	5603.37	0.00	251.00	83.00
38	transition_economy	2921.06	0.00	249.00	339.00
39	global_financial	-99.87	0.00	249.00	14171.00
40	task_force	1185.39	0.00	243.00	917.00
41	good_practice	183.58	0.00	238.00	2987.00
42	business_model	76.39	0.00	238.00	4067.00
43	green_transition	3551.19	0.00	237.00	215.00
44	global_warm	4696.79	0.00	235.00	111.00
45	economic_growth	-198.78	0.00	233.00	17381.00
46	economic_financial	7.01	0.01	232.00	5902.00
47	change_financial	539.53	0.00	211.00	1350.00
48	manage_risk	339.98	0.00	207.00	1769.00
49	transition_plan	4589.06	0.00	201.00	61.00
50	datum_gap	3188.41	0.00	200.00	161.00

Notes: Authors' calculations. "n_target" refers to the frequency of a term in speeches identified as green, "n_reference" to the frequency of that term in the remaining set of speeches. In bold, seeded keywords.

Table 5. Variable Definitions and Sources

Variable	Definition	Source
y_yoy	Real GDP growth rate, in year-over-year terms	IMF, WEO 2023-10
Dp_yoy	CPI inflation rate, in year-over-year terms	IMF, WEO 2023-10
y_pcap	GDP per capita, in international Dollars and logarithmic transform	IMF, WEO 2023-10
y_nom	GDP in current prices and US dollar, logarithmic transform	IMF, WEO 2023-10
temp_avg	Average temperature in 1996-2022	World Bank's climate change knowledge portal
coast_area	Coast/area ratio (m/km ²)	https://en.wikipedia.org/wiki/List_of_countries_by_length_of_coastline

spei	Standardised Precipitation- Evapotranspiration Index (SPEI), 1996 to 2021	World Bank
impl_m	Implicit green mandate	Dikau (2021)
expl_m	Explicit green mandate	Dikau (2021)
NGFS	NGFS membership	https://www.ngfs.net/en/about-us/membership
climate_policy	Number of national climate policy texts, retrieved from https://climate-laws.org	Climate Laws

Table 6. Multilevel panel model: Baseline specification

Table 2: Multilevel panel model: Baseline specification

Variable	Model 1					Model 2					Model 3				
	Est.	S.E.	t val.	d.f.	p	Est.	S.E.	t val.	d.f.	p	Est.	S.E.	t val.	d.f.	p
Within Effects															
CBIE	0.05	0.02	2.73	1241.43	0.01	0.05	0.02	2.73	1241.54	0.01	0.05	0.02	2.73	1242.19	0.01
NGFS	0.07	0.00	21.02	1241.43	0.00	0.07	0.00	21.02	1241.54	0.00	0.07	0.00	21.02	1242.19	0.00
Between Effects															
(Intercept)	0.02	0.01	1.64	59.18	0.11	0.02	0.01	1.67	59.29	0.10	0.03	0.01	1.76	57.79	0.08
imean(CBIE)	0.04	0.01	2.48	58.07	0.02	0.03	0.02	1.98	60.10	0.05	0.03	0.02	1.57	60.28	0.12
imean(NGFS)	0.06	0.02	2.68	79.68	0.01	0.06	0.02	2.55	78.11	0.01	0.06	0.02	2.61	78.55	0.01
temp.avg	0.00	0.00	3.30	62.89	0.00	0.00	0.00	3.31	61.27	0.00	0.00	0.00	3.33	61.93	0.00
overall m						0.00	0.01	0.42	61.92	0.68					
impl_m											0.00	0.01	0.66	63.14	0.51
expl_m											-0.00	0.01	-0.21	64.51	0.84
Model information															
Entities: 81 (40 impl_m, 8 expl_m)															
AIC / BIC	-4628.33 / -4586.75					-4618.18 / -4571.41					-4609.21 / -4557.24				
Pseudo-R ² (fixed Eff.)	0.25					0.25					0.25				
Pseudo-R ² (total)	0.39					0.40					0.40				
Entity ICC	0.19					0.19					0.19				

Notes: Authors' calculations. P-values calculated using Satterthwaite d.f. Estimates with p-value <= 0.10 in bold

Table 7. Multilevel panel model: Interaction with CBIE

Variable	Model 1					Model 2					Model 3				
	Est.	S.E.	t val.	d.f.	p	Est.	S.E.	t val.	d.f.	p	Est.	S.E.	t val.	d.f.	p
Within Effects															
CBIE	0.12	0.04	3.05	1240.54	0.00	0.14	0.04	3.67	1240.91	0.00	0.05	0.02	2.40	1240.87	0.02
NGFS	0.07	0.00	21.08	1240.54	0.00	0.07	0.00	21.07	1240.91	0.00	0.07	0.00	20.82	1240.87	0.00
Between Effects															
(Intercept)	0.02	0.01	1.67	59.31	0.10	0.02	0.01	1.76	58.98	0.08	0.02	0.01	1.67	57.62	0.10
imean(CBIE)	0.03	0.02	1.98	60.12	0.05	0.03	0.02	1.58	60.92	0.12	0.04	0.02	2.34	57.31	0.02
imean(NGFS)	0.06	0.02	2.55	78.11	0.01	0.06	0.02	2.66	78.83	0.01	0.06	0.02	2.69	80.00	0.01
temp.avg	0.00	0.00	3.31	61.28	0.00	0.00	0.00	3.35	62.61	0.00	0.00	0.00	3.29	62.98	0.00
overall_m	0.00	0.01	0.42	61.93	0.68										
impl_m						0.00	0.01	0.76	65.78	0.45					
expl_m											-0.00	0.01	-0.42	67.24	0.67
Cross-Level Interactions															
CBIE:overall_m	-0.09	0.05	-1.90	1240.54	0.06	-0.12	0.04	-2.61	1240.91	0.01	0.48	0.17	2.82	1240.87	0.00
CBIE:impl_m															
CBIE:expl_m															
Model information															
Entities: 80 (39 impl_m, 8 expl_m)															
AIC/BIC	-4615.43 / -4563.46					-4619.1 / -4567.14					-4623.1 / -4571.14				
Pseudo-R ² (fixed Eff.)	0.39					0.40					0.40				
Pseudo-R ² (total)	0.25					0.25					0.25				
Entity ICC	0.19					0.19					0.19				
Notes: Authors' calculations. P-values calculated using Satterthwaite d.f. Estimates with p-value<= 0.10 in bold															

Table 8. Multilevel panel model: Interaction with NGFS

Variable	Model 1					Model 2					Model 3				
	Est.	S.E.	t val.	d.f.	p	Est.	S.E.	t val.	d.f.	p	Est.	S.E.	t val.	d.f.	p
Within Effects															
CBIE	0.05	0.02	2.63	1240.52	0.01	0.05	0.02	2.63	1240.90	0.01	0.05	0.02	2.73	1240.88	0.01
NGFS	0.05	0.01	8.72	1240.52	0.00	0.06	0.01	11.49	1240.90	0.00	0.07	0.00	19.58	1240.88	0.00
Between Effects															
(Intercept)	0.02	0.01	1.67	59.39	0.10	0.02	0.01	1.76	59.02	0.08	0.02	0.01	1.67	57.56	0.10
imean(cbi)	0.03	0.02	1.98	60.19	0.05	0.03	0.02	1.58	60.95	0.12	0.04	0.02	2.34	57.25	0.02
imean(NGFS)	0.06	0.02	2.55	78.08	0.01	0.06	0.02	2.66	78.81	0.01	0.06	0.02	2.69	80.02	0.01
temp.avg	0.00	0.00	3.30	61.35	0.00	0.00	0.00	3.35	62.64	0.00	0.00	0.00	3.29	62.95	0.00
overall_m	0.00	0.01	0.42	61.98	0.68	0.00	0.01	0.76	65.79	0.45	-0.00	0.01	-0.42	67.24	0.68
impl_m															
expl_m															
Cross-Level Interactions															
NGFS:overall_m	0.03	0.01	3.92	1240.52	0.00	0.02	0.01	3.58	1240.90	0.00	0.00	0.01	0.14	1240.88	0.89
NGFS:impl_m															
NGFS:expl_m															
Model information															
Entities: 81 (39 impl_m, 8 expl_m)															
AIC / BIC	-4623.49 / -4571.53					-4621.28 / -4569.3					-4609.57 / -4557.6				
Pseudo-R ² (fixed Eff.)	0.26					0.26					0.25				
Pseudo-R ² (total)	0.40					0.40					0.39				
Entity ICC	0.19					0.19					0.19				
Notes: Authors' calculations. P-values calculated using Satterthwaite d.f. Estimates with p-value<= 0.10 in bold															

Table 9. CB Green Index and Government debt average by country

Country Name	Green index	Government debt average, % of GDP
Euro area	0.049240	90.53000
United States	0.065291	75.69545
Singapore	0.086610	101.77610
India	0.048841	53.77401
Malaysia	0.073703	49.42488
Austria	0.060171	79.65000
Belgium	0.059121	104.60000
Croatia	0.070643	75.87000
Cyprus	0.082162	98.13000
Estonia	0.077405	13.10000
Finland	0.062561	69.31000
France	0.061404	103.64000
Germany	0.064427	67.04000
Greece	0.053521	182.06000
Ireland	0.094750	64.29000
Italy	0.064360	138.83000
Latvia	0.035515	40.40000
Lithuania	0.113682	39.73000
Luxembourg	0.054704	22.72000
Malta	0.055649	51.23000
Netherlands	0.098551	55.55000
Portugal	0.068828	123.07000
Slovakia	0.069493	54.00000
Slovenia	0.067213	74.70000
Spain	0.061446	106.79000