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Central Bank Mandates and Communication about Climate Change: Evidence from A Large Dataset of Central Bank Speeches

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Abstract

We compare alternative methodologies to identify central banks speeches that focus on climate change and argue a supervised word scoring method produces the most comprehensive set. Using these climate-related speeches, we empirically examine the role of the mandate in shaping central bank communication about climate change. Central banks differ considerably in the extent to which their mandates support a sustainability objective—it can be explicit, indirect whereby the central bank is mandated to support broader government policies, or it may not be supported at all. Our results show that these differences are important in determining the frequency of climate-related communication as well as context in which central banks address climate-related issues. All told, these findings suggest that mandate considerations play an important role in shaping central bank communication about climate change.

Keywords: Central bank speeches; Mandates; Climate change; Natural language processing
JEL Classifications: E58; E61; Q54

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1 Introduction

Climate change is an increasingly important issue for central banks around the world. At the same time, it is a complex topic outside the traditional areas of expertise. Little is known about the interaction between climate and economic activity or the propagation of climate-related risks through the financial system. Moreover, this interaction occurs over a longer time horizon than central banks typically consider. In light of these complexities, central banks face a unique challenge with regard to how to effectively communicate about climate change and what role, if any, they play in responding to it.

We analyze a large dataset of central bank speeches to better understand the role of the mandate in shaping climate-related communication. The paper is divided into two parts. We begin with a large corpus of central bank speeches and compare four methodologies for identifying those related to climate change. One methodology uses hand-selection by the Bank of International Settlements (BIS). The other three use natural language processing (NLP) tools: a simple dictionary method; a supervised word scoring method; and an unsupervised word embedding method.

Each approach strikes a different balance between the number of speeches identified and the extent to which they relate to climate change. For example, amongst the NLP tools, the simple dictionary identifies the largest set, but many are misidentified in the sense that they are not really about climate change. In contrast, unsupervised word embedding produces a smaller set more narrowly focused on climate change, but the strict identification criteria fails to identify some relevant speeches. Hand selection also misses a number of important contributions.

We argue the supervised word scoring method of Arseneau and Osada (2023) does the best job of identifying 734 climate-related speeches given by 55 central banks from 1997 to 2022. This method works well because it complements the computational power of NLP topic identification tools with manual review of speeches on the margin of inclusion. Manual review allows for supervision of the NLP algorithm and improves accuracy. Our focus is on climate change, but this methodology could be used more generally.

Regardless of the identification methodology, climate-related communication has expanded rapidly in recent years. The second half of the paper sheds light on this by investigating the role of the mandate in shaping climate-related communication. We build on Dikau and Volz (2021) who used the IMF's Central Bank Legislation Database to document the extent to which climate-related objectives fit into the mandates of 135 central banks. They showed that over half operate under a mandate that includes a sustainable growth or development objective, either explicitly or indirectly in the form of being mandated to support broader government policy priorities. They link these mandate differences to implementation of green financial policies. Our view is that they are also important for shaping communication about climate change.

We examine this question empirically using our climate-related speeches. Our results show that the sustainability objective is important for determining the frequency of climate-related communication as well as the context in which climate-related issues are presented to the public. Central banks with either an explicit or indirect sustainability objective engage in climate-related communication with greater frequency. When the objective is explicit, climate-related speech content tends to address issues through the narrow lens of the sustainable development objective, mainly touching on sustainable development goals and sustainable

finance. In contrast, when the objective is indirect, climate-related issues are discussed in the context of the traditional mandated objectives of price stability and financial stability. These central banks, in particular, face a unique communication challenge of needing to be responsive to a widening set of policy responsibilities while, at the same time, staying focused on their primary policy objectives. Finally, for central banks that do not have a sustainability objective, membership in the Network for Greening the Financial System (NGFS) is the most important driver of the frequency of climate-related communication. All told, our results suggest mandate considerations play an important role in shaping climate-related communication.

This paper is related to a small body of literature that applies topic analysis to central bank communication through monetary policy statements and speeches. Examples include: Hansen, McMahon, and Prat (2018); Armelius, et al. (2020); Hansson (2021); and Ahrens and McMahon (2021). Our contribution is twofold. First, along with Arseneau and Osada (2023), it is among the first to study central bank communication about climate change. This paper builds on our earlier work by comparing the topic identification methodology developed in that paper to some alternative methods, including those using NLP tools. Second, we establish a novel empirical link between the mandate and climate-related communication. This aspect of the paper is most closely linked to Dikau and Volz (2021), but Campiglio, et al. (2018) also touch on the role of the mandate. More generally, McKibbin, et al. (2021) and Bolton, et al. (2020) both discuss ways in which climate-related developments fit into the existing monetary policy and financial stability frameworks. Hansen (2022) offers the view that in order to maintain credibility, central banks need to adhere narrowly to their mandated roles.

The remainder of this paper is organized as follows. The next section compares different methodologies to identify climate-related speeches. Section 3 analyzes our set of climate-related speeches, focusing on the role of the mandate in shaping climate-related communication. Section 4 concludes.

2 Methodology and Identified Speeches

We apply alternative methodologies for identifying climate-related speeches to a large corpus of central bank speeches. The results are compared, and we discuss trends over time.

2.1 Central Bank Speech Dataset

We start with all central bank speeches available from the BIS from 1997 to 2022. Table 1 shows the dataset consists of 18,264 speeches by representatives from 108 central banks. The majority are by advanced economy central banks, which average 17 speeches annually a little over one thousand words in length.[1][2] Emerging market central banks give fewer speeches less frequently and they tend to be shorter.

[1]Our split between advanced and emerging market economies is informed by IMF classification for their World Economic Outlook (see https://www.imf.org/external/pubs/ft/weo/2021/01/weodata/groups.htm).

[2]The number of words are counted after the raw text is pre-processed. We follow standard practice in the text analysis literature by dropping extremely common words (so-called stopwords) and creating noun-phrases by Part-of-Speech (POS) tagging techniques. Therefore, a "word" in this paper is defined as a meaningful word token.

Table 1: Summary statistics, all speeches

	# of Central Banks	# of Speeches	Avg. # of Speeches Annually per Bank	Avg. # of Words per Speech
Advanced Economy	37	12,647	17.0	1,031
Emerging Market Economy	71	5,617	7.7	809
Total	**108**	**18,264**	**12.4**	**963**

2.2 Alternative Methods for Identifying Climate-related Speeches

Using this comprehensive set of speeches, our goal is to identify those that are "climate-related", meaning a speech that discusses the impact of climate change on the economy and/or the financial system in a meaningful way. We consider four alternatives: (1.) hand-identification by the BIS; (2.) a simple dictionary approach; (3.) a word scoring method; and (4.) a word embedding method.

BIS Identification. The BIS maintains a dataset of speeches related to climate change, green finance, and sustainability.[3] As of early-2023, it contained 401 speeches identified by BIS staff as climate-related. Given the availability, this is a natural starting point for analyzing climate-related speeches. However, identifying a speech as climate-related seems to be based on the subjective expert judgment of the BIS staff and therefore the criteria for identification is not transparent. Moreover, as we discuss below, the BIS dataset misses some important speeches, suggesting this methodology is not comprehensive.

The following three alternatives use different natural language processing (NLP) tools for topic identification. The three tools differ in ease of implementation and each strikes a different balance between comprehensiveness (maximizing the identification of relevant speeches) and accuracy/precision (minimizing the number of misidentified speeches).

M1: Simple Dictionary Method. The first NLP tool considered is a *simple dictionary method*. Our simple dictionary consists of the word pair "climate change" and it identifies 989 speeches (over twice the number identified by the BIS). The simple dictionary method is easy to implement, but it is imprecise. For example, there may be climate-related speeches that do not contain the word pair "climate change", but instead contain other relevant words, such as "green transition" and/or "climate risk". Alternatively, we may not want to include speeches that mention "climate change" only once in a sentence. Finally, nothing guarantees that the words "climate change" are used in the appropriate context (for example, a change in the investment climate).

M2: Word Scoring Method. Arseneau and Osada (2023) argue that a *word scoring method* allows us to build a more refined dictionary that better distinguishes whether or not a speech is climate-related. Following Laver, et al. (2003) and Watanabe (2018), the word score is constructed for every word in the corpus by comparing the frequency with which each individual word shows up in speeches *include* the word pair "climate change" relative to the frequency that it shows up in speeches that *do not include* the

[3] Available at: https://www.bis.org/topic/green_finance/speeches.htm.

word pair. Once we have a score for every word in the corpus, the word scores are used to construct a measure of the propensity of a speech to be "climate-related" by taking a weighted average of the word frequency using the word scores as weights. Using this *climate speech score*, we identify an initial set of unrefined climate-related speeches and then go through a second stage refinement. The refinement allows us to construct a dictionary consisting of: "Climate Change", "Green Finance", "Greening Financial System", "Paris Agreement", "Carbon Emission", "Climate Risk", "Green Transition", "Climate-related Risk", and "Green Bond", which enables us to detect all climate-related speeches in the top 2.5% of the highest-scoring speeches. A climate-related speech is one that has a positive speech score and contains any keyword from the dictionary in at least two separate sentences.[4] This methodology identifies 734 climate-related speeches. Arseneau and Osada (2023) do extensive quality checks, including manually examining boundary speeches (i.e., speeches that are not identified but have a high speech score and speeches that are identified but have a low speech score), and conclude that it is effective in identifying climate-related speeches.

M3: Word Embedding Method. Finally, we use a *word embedding method*, which has become popular in large language models such as BERT and GPT. The word embedding method maps a large corpus into low-dimensional word vectors so that words with similar meanings/usages are represented by similar vectors.[5] We apply the Glove algorithm proposed by Pennington, et al. (2014) to find these speech-level vectors by simply averaging the embeddings of each word in a speech. We then measure a *similarity metric* relating each speech to the word pair "climate change" by computing the inner product of the speech vector and the word vector of "climate change". A climate-related speech is then identified as a one with a similarity metric greater than 0.5. This fully-automated approach identifies 482 speeches.[6]

2.3 Comparing Alternative Identification Methods

Table 2 compares the four methodologies. The BIS identifies a narrow set of speeches (401) with an average speech score of 1.15 and an average similarity metric of 0.60. Turning to the NLP tools, the simple dictionary method (M1) finds the largest number of speeches (989), but scores the lowest on both the average speech score (0.70) and similarity metric (0.52). In contrast, the speeches identified by the word embedding method (M3) score the highest on both the average speech score (1.23) and similarity metric (0.63), but this approach identifies less than half (482) the number identified by M1. Comparing M1 and M2 highlights a trade-off between the number of speeches identified and the extent to which they relate to climate change. The word scoring method (M2) strikes a balance between the two in the number of speeches identified (734) and the average speech score (0.92) and similarity metric (0.56).

[4] A word that has a positive word score is supposed to appear more frequently in climate-related speeches. When we assume a simple data generating process in which each word is generated independently of all other words, a speech that has a positive speech score is likely to be a climate-related speech.

[5] Grimmer, et al. (2022) introduce practical applications of the word embedding method.

[6] To automatically identify topics in documents, the Latent Dirichlet Allocation (LDA) has been often used in the economics literature, such as Hansen and McMahon (2016), Hansen, McMahon, and Prat (2018), Armelius, et al (2020), and Hansson (2021). However, it is not effective to apply to our task for identifying whether a speech is "climate-related" which is a very specific and pre-defined topic. On the other hand, Cieslak, et al. (2022) has a motivation close to our task and uses the word embedding technique to construct topic dictionaries for "risk" and "uncertainty."

Table 2: Summary statistics, climate-related speeches

	# of Speeches	Relevance to Climate Change: Average Speech Score	Relevance to Climate Change: Average Similarity Metric
All speeches	18,264	-0.27	0.35
Climate-related speeches identified by:			
BIS	401	1.15	0.60
$M1$: Simple dictionary method	989	0.70	0.52
$M2$: Word scoring method	734	0.92	0.56
$M3$: Word embedding method	482	1.23	0.63
Speeches identified by multiple methods			
$M2 \cap M3$	428	1.33	0.65
$M2 \cap M3^C$	306	0.36	0.43
$M2^C \cap M3$	54	0.49	0.52
$M2^C \cap M3^C \cap BIS$	57	0.14	0.39

The bottom half of the table shows M2 identifies 428 of the 482 speeches also identified by M3 and this intersection has both the highest average speech score and the highest similarity metric. As shown by the top left panel of Figure 1, a word cloud created by these speeches, represented by $M2 \cap M3$, features prominently a wide variety of topics that are clearly climate-related.

There are 306 speeches identified by M2, but not M3 ($M2 \cap M3^C$) with a relatively low average speech score and similarity metric. However, by construction these speeches mention at least one keyword from our dictionary in at least two different sentences, suggesting they are meaningfully climate-related. Indeed, the upper right panel shows that climate-related concepts (transition, climate risk, and green transition) are addressed, though not necessarily the most prominent topics. In contrast, the 54 speeches in $M2^C \cap M3$ have an average speech score and similarity metric roughly in line with $M2 \cap M3^C$, but upon examination these speeches are not related to climate change in a meaningful way. As shown in the lower left panel, they discuss cyber- or technology-related issues as opposed to climate change largely due to the mechanics of the word embeddings. A cyber-related word such as "cyber risk" is similar to "climate change" in terms of the embedding because they share similar characteristics with respect to risk to financial institutions and are often used together in similar contexts. In general, unsupervised machine learning methods offer no guarantee that identified speeches are really climate-related. As discussed in Grimmer, et al. (2022), some form of supervision seems necessary to accurately identify climate-related speeches and this speaks to the strength of M2. It leverages computational techniques to help reduce the set of speeches that need to be hand verified to only those on the margin of inclusion.

Figure 1: Word clouds for climate-related speeches, by method

Finally, 57 speeches are identified by the BIS, but not M2 or M3. This set has the lowest average speech score and similarity metric. The lower right panel of Figure 1 shows the word cloud associated with these speeches.[7] Although "sustainability" and "sustainable finance" feature prominently, based on our review these words are used in very general ways that are not clearly associated with the topic of climate change. Moreover, this dataset omits some obviously important climate-related speeches, casting some doubt on its comprehensiveness.[8]

In summary, we view M2 as the preferred methodology for identifying climate-related speeches because it strikes a better balance between comprehensiveness (more relevant speeches) and accuracy/precision (fewer misidentified speeches). Our supervised word scoring approach can identify some important speeches that are missed using either purely computational (M1 or M3) or purely manual (BIS speeches) approaches. That said, our methodology is sufficiently general that it is not limited to identifying climate-related speeches and could be applicable to a wider set of topics.

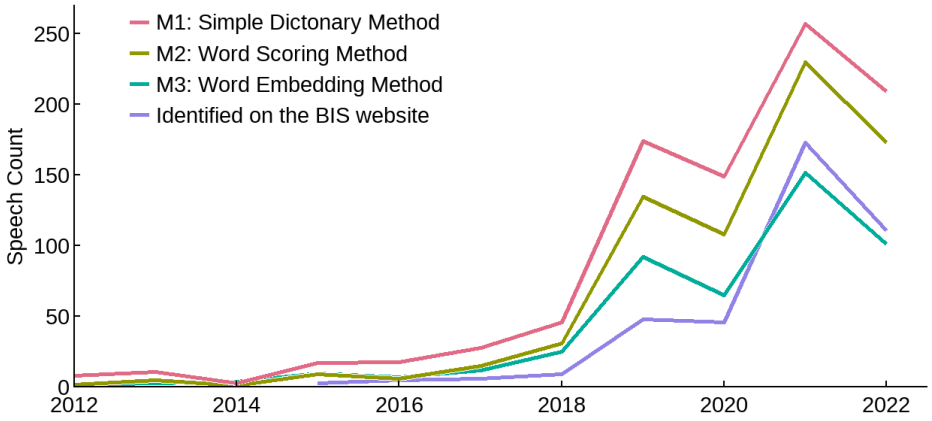
2.4 Evolution of climate-related speeches over time

Regardless of the method of identification, the number of climate-related speeches has grown significantly in recent years, as shown in Figure 2. The explosion of climate-related speeches began following Mark Carney's 2015 speech on the tragedy of the horizon and accelerated further following the establishment of the NGFS in 2017. Since that time, the number of climate-related speeches averaged across all four identification methodologies increased from 15.2 in 2017 to 148.5 in 2022, a roughly 10-fold increase. The share of climate-related speeches in total speeches peaked at 24.5% in 2021 before falling back to 17.4% in the most recent data.

[7] In the word clouds, size represents TF-IDF (term frequency-inverse document frequency), which is widely used in practice. TD-IDF adjusts a simple frequency by putting less weights on words that commonly appear across the entire set of speeches.

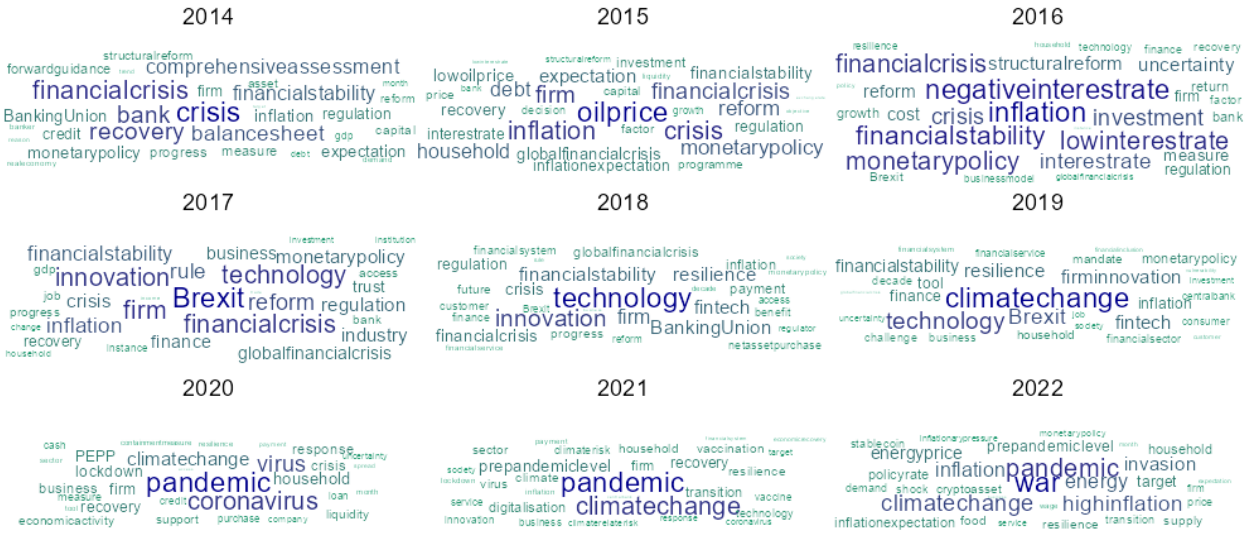
[8] For example, the BIS does not identify two speeches we found closely related to the issue of climate change and how it pertains to central banks: Mark Carney: A transition in thinking and action (April 2018); and Yannis Stournaras: Climate change - threats, challenges, solutions for Greece (April 2019). Figure 2 shows that the coverage of BIS-identified speeches expands significantly after 2020. In contrast, other methodologies—and in particular M2—do a better job of detecting climate-related speeches given prior to 2020, and especially those given even earlier, such as a HKMA's speech delivered in November 2000 (David Carse: Environmental issues and their implications for financial institutions in Hong Kong).

Figure 2: Evolution of climate-related speeches, by identification method, 2012-2022



An alternative way to look at the emergence of climate change as a topic in central bank speeches is shown in Figure 3. The focus of speech content varies from year to year. Early attention concentrated on the financial crisis and the plunge in oil prices in 2015, and then shifted to low and negative interest rates to support the post-financial crisis recovery even amid notable international developments such as the UK leaving the European Union in the so-called Brexit and its implications for financial stability. Over the last four years of the sample, however, climate change emerged as an important focus even as the global pandemic evolved.

Figure 3: Word clouds for central bank speeches, by year (2014-2022)



3 Climate-related Speeches and the Central Bank Mandate

Focusing on our set of climate-related speeches, we build on Dikau and Volz (2021) to investigate how the central bank mandate shapes communication about climate change.

3.1 Summary Statistics

Table 3 shows roughly half of the central banks in the dataset are responsible for the 734 climate-related speeches identified. Thirty advanced economy central banks gave 616 climate-related speeches, while emerging market central banks account for the remainder. The share of climate-related speeches in total speeches given within the year has grown, reaching nearly 20% over the 2019-2022 period.

Table 3: Summary statistics for climate-related speeches, by region and by time period

		Region:		Time Period:		
	All Central Banks	Advanced Economy	Emerging Market	2000-2014	2015-2018	2019-2022
		Panel A: All Speeches				
# of Central Banks	108	37	71	101	79	77
# of Speeches	18,264	12,647	5,617	10,448	3,710	3,411
		Panel B: Climate-related Speeches				
# of Central Banks	55	30	25	15	18	53
# of Climate-related speeches	734	616	118	27	61	646
Share of Climate-related speeches	4.0%	4.9%	2.1%	0.3%	1.6%	18.9%

To put these speeches in the context of central bank mandates, we focus on three main central bank objectives: (1.) price stability; (2.) financial stability; and (3.) sustainable development. Central banks have a number of other objectives and functions (including supervision and regulation, operation of the payment system, management of public pensions, among others that differ greatly across our large and diverse set of central banks), but we focus on price stability and financial stability because they are closely associated with traditional aspects of central bank mandates. Our focus on sustainable development—despite the non-traditional nature of the objective—is motivated by Dikau and Volz (2021). These authors argue sustainability objective is important because it frames how climate change relates to the operational framework of different central banks. Using the IMF's Central Bank Legislation Database they attribute differences in the willingness of central banks to pursue green financial policies (or, those with climate objectives) to the nature of the sustainability objective. We think the nature of the sustainability objective may also be important for explaining central bank communication about climate change.

Following Table 1 of Dikau and Volz (2021), each of the 55 central banks that have given climate-related speeches are classified according to how the sustainability objective fits into its mandate.[9] The 35 central banks that have sustainable development objectives are assigned to one of two categories, central banks that have: (1) an explicit objective to directly enhance, promote, or support "sustainability" or "sustainable

[9]See Appendix A for details of how each central bank is classified.

development/growth".[10] Or, (2) central banks that have an implicit objective to indirectly support the broader government's economic objectives or policy goals, which may comprise sustainability objectives.[11] The remaining central banks are classified as not having any sustainable development objective.

Additionally, for each of our climate-related speeches we calculate three *mandate similarity metrics* that quantify the extent to which the content in a given climate-related speech is related to each of the three objectives.[12] A climate-related speech with a high mandate similarity score for price stability is likely focus on the impact of climate change on inflation, for example, or, alternatively, on its impact on the long run equilibrium interest rate.[13] Similarly, a speech with a high similarity score for financial stability likely focuses on the impact of climate change on, for example, asset prices.[14] Finally, a climate-related speech with a high mandate similarity score for sustainable development might be one that focuses on sustainable growth and finance.[15]

Table 4 shows summary statistics for speeches broken out by central bank characteristics. There are four main insights. First, nothing prevents a central bank without a sustainable development objective from addressing climate-related issues in its communication with the public. Indeed, twenty central banks without a sustainable development mandate are responsible for nearly 20% of our climate-related speeches. Second, the content of climate-related speeches by advanced economy central banks hues more closely to the price stability aspect of the mandate, while it is more closely associated with sustainable development for emerging market central banks. This is consistent with Dikau and Volz (2021), who document that a large proportion of central banks with a sustainable development objective are in emerging market economies. Third, the link between climate-related speeches and the sustainable development mandate is strongest when this objective is explicitly in the mandate. In contrast, when it is indirect climate-related issues tend to be addressed more through the lens of the traditional objectives of price stability and financial stability. Finally, climate-related speeches given by NGFS members are also more closely associated with traditional aspects of the mandate.

[10]The case of the Monetary Authority of Singapore offers an example. According to Table 1 in Dikau and Volz (2021), its primary objective is price stability implemented through an exchange rate anchor. That said, sustainable development does factor into the mandate explicitly: "The principal objective of the Authority shall be—(a.) to maintain price stability conducive to sustainable growth of the economy..."

[11]The Bank of England is an example of a central bank with an implicit sustainable development objective. Its primary objectives are prices stability and financial stability, both implemented through an inflation targeting framework. Nonetheless, the bank's objective is to "(a) maintain price stability, and (b) subject to that, to support the economic policy of Her Majesty's Government, including its objectives for growth and employment." The government's economic policy objectives focus on"sustainable and balanced growth", implying that the Bank of England is implicitly mandated to support a sustainable development objective.

[12]The mandate similarity metric is calculated as follows. Every speech in the dataset can be represented by a vector calculated as an average of word vectors produced for the identification using M3 in Section 2. In addition, we have separate word vectors for each of our three mandates: price stability, financial stability, and sustainable development. The mandate similarity metric is calculated as the cosine similarity (a popular measure in the machine leaning literature) between the speech vector and the word vector that represents the central bank mandate.

[13]Concretely, three examples of climate-related speeches with high price stability mandate similarity scores are: Isabel Schnabel: A new strategy for a changing world; François Villeroy de Galhau: The role of central banks in the heart of the ecosystem; and Tiff Macklem: Renewal of the Monetary Policy Framework.

[14]Examples include: Sarah Breeden: Macropru – fit for the future?; Claudia Buch: Central bank independence - mandates, mechanisms, and modifications; and Mark Carney: The grand unifying theory (and practice) of macroprudential policy.

[15]Examples include: R Gandhi: Green finance - early initiatives; Anna Maria Tarantola: Women nurturing sustainable development; and Yannis Stournaras: Challenges and prospects for sustainable growth.

Table 4: Summary Statistics: Climate-related speeches, by central bank characteristics

	# of Speeches	Climate Score Mean	Climate Score St. Dev.	Mandate Similarity: *Price Stability* Mean	*Price Stability* St. Dev.	*Financial Stability* Mean	*Financial Stability* St. Dev.	*Sustain. Devel.* Mean	*Sustain. Devel.* St. Dev.
All Speeches	18,264	-0.27	0.39	0.56	0.12	0.64	0.10	0.19	0.07
Climate-related Speeches	734	0.92	0.69	0.55	0.12	0.68	0.08	0.27	0.08
By country group:									
Advanced Economy, (n = 30)	616	0.93	0.70	0.56	0.12	0.68	0.08	0.26	0.07
Emerging Market, (n = 25)	118	0.86	0.63	0.50	0.09	0.68	0.07	0.33	0.07
By nature of sustainable development mandate:									
Explicit, (n = 7)	86	0.91	0.61	0.45	0.09	0.63	0.07	0.34	0.06
Indirect, (n = 28)	503	0.96	0.70	0.57	0.11	0.70	0.07	0.26	0.07
None, (n = 20)	145	0.82	0.68	0.51	0.10	0.66	0.09	0.27	0.08
By NGFS Membership:									
Member, (n = 46 in 2022)	647	0.93	0.68	0.55	0.12	0.69	0.08	0.27	0.07
Non-member, (n = 9 in 2022)	87	0.84	0.74	0.51	0.10	0.67	0.08	0.31	0.09

3.2 Regression Analysis

These summary statistics motivate two empirical questions regarding the nature of the mandate: (Q1.) To what extent does it determine the likelihood of a central bank to engage in climate-related communication? And, (Q2.) To what extent does it shape the way central banks talk about climate-related issues?

We examine Q1 using the following empirical model, estimated in a probit regression:

$$CRS_{i,j,t} = \boldsymbol{\beta}\ \mathbf{CBChar}_{j,t} + \boldsymbol{\gamma}\ \overline{\mathbf{CBMS}}_{j,t} + \delta_t + \epsilon_{i,j,t}$$

where: $CRS_{i,j,t}$ is equal to one if speech i given by central bank j in month t is climate-related; δ_t is a year fixed-effect; and $\epsilon_{i,j,t}$ is a normally distributed error term.

To explain the frequency of climate-related communication we introduce a set of central bank-specific characteristics, $\mathbf{CBChar}_{j,t}$, which includes: a time-varying indicator for NGFS membership; an indicator if the central bank is in an advanced economy; and a set of indicators that capture the nature of the sustainable development mandate (two dummy variables indicating whether the objective is explicit or indirect, interpreted relative to the alternative of no sustainability mandate). We also include a set of central bank-level mandate similarity metrics, $\overline{\mathbf{CBMS}}_{j,t} = [\overline{PS}_{j,t}\ \overline{FS}_{j,t}\ \overline{SD}_{j,t}]$, which capture the extent to which the contents of non-climate-related speeches given by central bank j over the year relate to each of the three different aspects of the mandate, on average. Intuitively, these should capture the average propensity to communicate about various issues outside of climate change through the lens of different aspects of the mandate.

Results in Table 5 show the frequency of climate related communication is positively and significantly related to NGFS membership and being in an advanced economy.[16] Similarly, a central bank with either an explicit or indirect sustainability objective is more likely to give a climate-related speech. These results are consistent with earlier findings in Arseneau and Osada (2023), who show that the European Central

[16]The sample size for the first four specifications drops to 14,713 because the inclusion of the year fixed-effects forces us to drop 3,551 speeches over nine separate years during which no climate-related speeches were given. For the fifth specification, we need to drop an additional 18 speeches due to lack of data on the corresponding average mandate similarity scores for non-climate-related speeches.

Table 5: Likelihood of a central bank engaging in climate-related communication

	Dependent variable: Climate-related speech (yes=1, no=0)				
	(1)	(2)	(3)	(4)	(5)
NGFS Membership$_{j,t}$	0.64***			0.43***	0.49***
	(0.12)			(0.14)	(0.09)
Advanced Economy$_j$		0.40***		0.25***	0.60***
		(0.06)		(0.09)	(0.10)
Nature of sustainability mandate:					
Explicit$_j$			0.25***	0.36***	0.21**
			(0.04)	(0.09)	(0.09)
Indirect$_j$			0.48***	0.39***	0.25***
			(0.04)	(0.06)	(0.07)
Average annual mandate similarity in Non-CRS:					
Price Stability, ($\overline{PS}_{j,t}$)					-0.89*
					(0.53)
Financial Stability, ($\overline{FS}_{j,t}$)					1.25*
					(0.65)
Sustainable Development, ($\overline{SD}_{j,t}$)					3.56***
					(0.96)
Observations	14,713	14,713	14,713	14,713	14,695
R^2	0.30	0.29	0.30	0.31	0.33
Within R^2	0.02	0.02	0.02	0.04	0.06
Year fixed-effect	✓	✓	✓	✓	✓

* p < 0.1, ** p < 0.05, *** p < 0.01

Bank, the Bundesbank, and the Bank of England give the most climate-related speeches. All three are in advanced economies and are NGFS members with indirect sustainability objectives. These results are robust to controlling for the average propensity to engage in communication touching on the three different aspects of the mandate in non-climate-related speeches. The more the content in the average non-climate-related speech hues toward the price stability objective, the less likely that central bank is to give a climate-related speech.[17] The opposite is true for financial stability. The coefficients for $\overline{PS}_{j,t}$ and $\overline{FS}_{j,t}$ are both marginally significant. In contrast, the coefficient on $\overline{SD}_{j,t}$ is both large and highly significant, indicating that central banks that frequently touch on topics related to sustainable development in their non-climate-related speeches (for example, Malaysia, Philippines, and Singapore) are more likely to engage in climate-related communication.

Turning to Q2, we investigate how the mandate shapes climate-related communication using the following framework:

$$MS_{i,j,t} = \lambda\, \mathbf{CBChar}_{j,t} + \mu\, \overline{\mathbf{CBMS}}_{j,t} + \delta_t + \epsilon_{i,j,t}$$

In this case, the dependent variable, $MS_{i,j,t}$, is one of the three mandate similarity metrics (price stability, financial stability, and sustainable development) measured at the level of an individual climate-related speech. The model is estimated using year fixed-effects on our set of 734 identified climate-related speeches

[17] This tendency may stem from a potential conflict between monetary policy tightening and supporting climate-related investments. This needs to be further analyzed.

(i.e., any i for which $CRS_{i,j,t} = 1$) in a linear regression framework. We examine the same set of central bank-specific characteristics, $\mathbf{CBChar}_{j,t}$, and bank-level mandate similarity metrics, $\overline{\mathbf{CBMS}}_{j,t}$, as above to understand the extent to which content in climate-related speeches can be related back to traditional and non-traditional aspects of the mandate.

Table 6: Relating content in climate-related speeches to different aspects of the mandate

	Dependent variable: Mandate similarity for climate-related speech (CRS)					
	Price Stability,$(PS_{i,j,t})$		Financial Stability, $(FS_{i,j,t})$		Sustain. Devel., $(SD_{i,j,t})$	
	(1)	(2)	(3)	(4)	(5)	(6)
NGFS Membership$_{j,t}$	0.01	0.04**	0.02	0.03**	-0.00	-0.02*
	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Advanced Economy$_j$	-0.00	-0.02	-0.03***	-0.03***	-0.04***	-0.01
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Nature of sustainability mandate:						
Explicit$_j$	-0.07***	-0.04**	-0.04***	-0.03**	0.06***	0.03**
	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)
Indirect$_j$	0.06***	0.04***	0.04***	0.01	0.00	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Average annual mandate similarity in Non-CRS:						
Price Stability, $(\overline{PS}_{j,t})$		0.73***		0.06		-0.14
		(0.10)		(0.06)		(0.08)
Financial Stability, $(\overline{FS}_{j,t})$		-0.17		0.55***		0.07
		(0.12)		(0.18)		(0.10)
Sustainable Development, $(\overline{SD}_{j,t})$		0.24		-0.05		0.42**
		(0.34)		(0.19)		(0.19)
Observations	734	716	734	716	734	716
R^2	0.17	0.27	0.12	0.23	0.20	0.28
Within R^2	0.14	0.24	0.09	0.20	0.14	0.22
Year fixed-effects	✓	✓	✓	✓	✓	✓

* p < 0.1, ** p < 0.05, *** p < 0.01

Table 6 shows that, when controlling for content in non-climate-related speeches, NGFS members tend to address climate-related issues more through the lens of the traditional price stability and financial stability objectives. The nature of the sustainability objective is also important. When explicit, climate-related issues tends to be presented narrowly through the lens of the sustainability objective. In this sense, the explicit nature of the mandate helps focus communication. In contrast, when the sustainability objective is indirect, central banks tend to address climate-related issues through the traditional price stability and, to a lesser extent, financial stability objectives. This likely reflects the challenge of responding to a widening set of policy responsibilities through the indirect nature of the objective while, at the same time, staying focused on their primary policy objectives. The positive coefficients on the bank-level mandate similarity metrics suggest that typical communication in non-climate-related speeches shapes how a given central bank approaches communication about climate-related issues (for example, central banks that talk about non-climate related issues mainly through the lens of one particular aspect of the mandate are more likely to also talk about climate through this lens). Finally, after accounting for these other factors, whether the central bank is in an advanced or emerging market economy is less important.[18]

[18]Regressing the dependent variables on the advanced economy dummy alone yields coefficients estimates of 0.06*** (p-value of 4.40), 0.01 (p-value of 0.81) and -0.06*** (p-value of -9.50) for price stability, financial stability and sustainable development,

4 Conclusion

We compare four alternative methodologies to identify central bank speeches that focus on climate change and argue the supervised word scoring method developed in Arseneau and Osada (2023) produces the most comprehensive set of climate-related speeches. Using this set of identified climate-related speeches, we investigate how the central bank mandate shapes the nature of communication about climate change. The extent to which central bank mandates do or do not support a sustainability objective differs notably throughout the world. Our results suggest these differences play an important role in determining not only the frequency of climate-related communication, but also the context in which different central banks discuss climate-related issues with the public.

respectively. This is in line what was shown in Table 4, but this relationship disappears when we control other factors. That said, columns 3 and 4 show advanced economies relate climate related-issues to the financial stability objective to a lesser extent than emerging market central banks, but this effect is negated by NGFS membership. A Wald test of $H0 : \lambda_{NGFS} + \lambda_{AE} = 0$ for each specification results in chi-squared statistics of 0.324 (p-value of 0.569) and 0.014 (p-value of 0.903), respectively, so the null hypothesis cannot be rejected for either at 10 percent level.

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A Appendix

Table A1: List of central banks in our central bank speech database, by NGFS membership and the nature of sustainability mandate

	The nature of sustainability mandate based on Dikau and Volz (2021)		
NGFS	Explicit sustainability mandate	Implicit sustainability mandate	Non sustainability mandate
Joined in 2017	Singapore*	Germany*, United Kingdom*, France*, Netherlands*	China*, Mexico*
Joined in 2018	Malaysia*	Euro area*, Sweden*, Spain*, Finland*, Portugal*, Belgium*	Australia*, Norway*, New Zealand*, Luxembourg
Joined in 2019	South Africa*, Russia*, Hungary	Swiss*, Italy*, Ireland*, Greece*, Denmark*, Indonesia*, Malta*	Japan*, Canada*, Hong Kong*, Thailand*, Korea*, Colombia
Joined in 2020	Philippines*	Mauritius*, Israel, Iceland, Romania*, Lithuania*, Estonia*, Brazil, Latvia, Slovenia*, Cambodia, Cyprus	United States*, Seychelles, Armenia, Uruguay
Joined in 2021	Ukraine	Serbia*, Turkey, Ghana*, Croatian*	India*, Albania, Chile*, Trinidad Tobago*, North Macedonia*, Argentina, Jordan
Joined in 2022	–	Kenya*	Bahrain, Nigeria, Saudi Arabia, UAE, Cayman Islands
Joined in 2023	–	–	Uganda, Pakistan*, Barbados*
Non-member	Zambia, Fiji*, Czech*, Nepal, Gambia, Tanzania	Austria*, Botswana, Bulgarian, Namibia, Kosovo*, Malawi, Poland, Morocco, Slovakia	Sri Lanka, Papua New Guinea, Curacao Sint Maarten, Macao, Jamaica, Solomon Islands, Bahamas*, Eastern Caribbean, Bosnia Herzegovina, Sierra Leone, Algeria*, Kuwait*, Samoa, Maldives, Mozambique, Guyana, Vanuatu, Aruba, Belize, Bolivia, Ecuador, Guatemala

Note: Based on press releases on the NGFS website as of September 2023 and Dikau and Volz (2021). Asterisk (*) denotes the central bank is responsible for at least one climate-related speech (by M2) in our dataset.