

Central Bank Independence and Climate Change Focus: An NLP Analysis of Central Bank Speeches

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Summary

This document explores the relationship between central bank independence (CBI) and the focus central banks place on climate change-related issues. Utilizing Natural Language Processing (NLP) and Large Language Models (LLMs) on a global dataset of central bank speeches, we develop a measure of climate change focus (CCF) and analyze its correlation with CBI. The findings suggest that more independent central banks tend to prioritize climate change initiatives, supporting the hypothesis that independence allows for a longer-term perspective, free from short-term political pressures. This study contributes to the discourse on the evolving roles of central banks in addressing global environmental challenges.



Overview and Background

The impact of central bank independence on a country's financial and economic sectors is well-documented in academic literature. However, the specific link between central bank independence and climate change initiatives, as well as broader sustainable development goals, has received comparatively less attention. This gap stems from the scarcity of dedicated sustainability reports issued by central banks and the inherent difficulties in assessing sustainability impacts with standardized metrics.

Understanding this relationship is increasingly crucial as climate change poses significant risks to financial stability and economic growth. Central banks, traditionally focused on price stability and macroeconomic management, are now being called upon to consider the implications of climate change for their core mandates. This necessitates a re-evaluation of their responsibilities and a potential broadening of their policy frameworks to incorporate environmental considerations.

This study contributes to this evolving debate by providing empirical evidence on the connection between central bank independence and climate change focus. By employing innovative NLP techniques, we offer a quantitative measure of central banks' commitment to addressing climate-related issues and promoting sustainable development. This measure allows for a more systematic analysis of the factors that influence central bank priorities in the face of global environmental challenges.

Rationale and Market Relevance

This study is motivated by the growing recognition that climate change poses significant risks to financial stability and economic growth. Central banks, traditionally focused on price stability and macroeconomic management, are increasingly being called upon to consider the implications of climate change for their core mandates. This necessitates a re-evaluation of their responsibilities and a potential broadening of their policy frameworks to incorporate environmental considerations.

The hypothesis that more independent central banks place greater emphasis on climate change and sustainable development is grounded in the idea that greater independence allows central banks to adopt a long-term perspective, free from short-term political pressures. This long-term outlook is essential for addressing the complex and multifaceted challenges posed by climate change, which require sustained commitment and forward-looking policies.

The development of a reliable measure of central banks' climate change focus using NLP and LLMs is critical for assessing their commitment to sustainable development and climate change. This approach provides an objective and data-driven indication of central bank priorities, allowing for a more systematic analysis of the factors that influence their engagement with climate-related issues. The study's findings contribute to the growing discourse on the evolving responsibilities of central banks in a rapidly changing global economic and environmental landscape.

Data and Methodology

This study leverages a global sample to analyze the relationship between central bank independence (CBI) and climate change focus (CCF). Central bank independence data is sourced from Romelli (2024), which extends existing CBI indices to 2024. This index provides a comprehensive measure of independence across various dimensions.

To quantify central bank focus on climate change, we utilize a dataset of central bank speeches from Campiglio et al. (2025), comprising 35,487 unique speeches from 131 central banks between 1986 and 2023. These speeches are converted into a quantitative score using NLP/LLM techniques. The methodology involves analyzing the frequency and context of climate-related keywords within the speeches to generate a CCF score for each central bank in each year.

The relationship between CBI and CCF is then modeled using standard Ordinary Least Squares (OLS) and Fixed Effects regressions, as represented by the following equation:

$$CCF(i,t) = \alpha + \beta_1 CBI(i,t) + \sum \beta_j X(i,j,t) + Year + Country + \varepsilon(i,t)$$

Where CCF is the dependent variable measuring climate change focus, CBI is the central bank independence index, X is a vector of bank-level control variables, i and t represent bank and year, respectively, and $\varepsilon(i,t)$ is the error term. Year and Country fixed effects are included to control for time-invariant and country-specific factors.

Literature Review: Central Bank Independence and Mandates

The concept of central bank independence (CBI) has been extensively studied since the late 20th century, particularly in the context of monetary policy and inflation targeting. Seminal works by Alesina and Summers (1993) and Cukierman (1992) established the theoretical and empirical links between CBI and lower inflation rates. These studies emphasized the importance of insulating central banks from short-term political pressures to maintain price stability. The primary argument is that independent central banks can credibly commit to low inflation, reducing inflationary expectations and improving macroeconomic outcomes.

More recently, scholars have begun to explore the evolving mandates of central banks, expanding beyond traditional price stability to include financial stability and, increasingly, sustainable development. However, the inclusion of climate-related objectives in central bank mandates remains a contested issue. Some argue that incorporating climate considerations could compromise central banks' core objectives and undermine their independence, while others contend that climate risks pose a systemic threat to financial stability, necessitating central bank intervention. For instance, Weizsäcker (2021) discusses the potential for central banks to address climate change through various policy tools, while others, such as Tucker (2020), caution against mission creep and the potential for politicization.

This study builds on this literature by examining whether CBI is associated with a greater focus on climate change in central bank communication. It contributes to the ongoing debate about the appropriate role of central banks in addressing climate-related risks and promoting sustainable development. By employing NLP techniques to analyze central bank speeches, this research provides novel empirical evidence on the relationship between CBI and climate change focus, shedding light on the factors that influence central bank priorities in the face of global environmental challenges.

Results

Descriptive Statistics

	cbie_index	sum_of_freqs_x	sum_of_freqs_y
count	37235.000000	30910.000000	30910.000000
mean	0.641286	1.105500	1.105500
std	0.171466	2.788275	7.300723
min	0.098500	0.000000	0.000000
25%	0.533000	0.014085	0.000000
50%	0.614000	0.068421	0.000000
75%	0.791000	0.402985	0.000000
max	0.929000	72.000000	257.000000

The results indicate a statistically significant positive relationship between CBI and the extent of climate change focus in central bank communication. This finding suggests that central banks with higher levels of CBI tend to prioritize climate change in their public statements. The regression coefficients show a clear link between central bank independence and their engagement with climate-related issues, supporting the importance of considering CBI in discussions around central banks' role in addressing environmental challenges.

OLS Regression Results

The OLS regression results without controls are presented below:

OLS Regression Results						
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Dep. Variable:	sum_of_freqs_y	R-squared:	0.001			
Model:	OLS	Adj. R-squared:	0.001			
Method:	Least Squares	F-statistic:	32.45			
Date:	Thu, 13 Feb 2025	Prob (F-statistic):	1.23e-08			
Time:	21:40:05	Log-Likelihood:	-1.0529e+05			
No. Observations:	30910	AIC:	2.106e+05			
Df Residuals:	30908	BIC:	2.106e+05			
Df Model:	1					
Covariance Type:	nonrobust					
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	coef	std err	t	P> t	[0.025	0.975]

const	0.1757	0.168	1.044	0.297	-0.154	0.506
cbie_index	1.4048	0.247	5.697	0.000	0.921	1.888
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Omnibus:	53815.668	Durbin-Watson:	1.776			
Prob(Omnibus):	0.000	Jarque-Bera (JB):	59421501.854			
Skew:	12.383	Prob(JB):	0.00			
Kurtosis:	216.364	Cond. No.	8.60			
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The regression analysis reveals a statistically significant positive relationship between the CBI index and the sum of frequencies of climate-related keywords in central bank speeches. The coefficient for **cbie_index** is 1.4048 with a p-value of 0.000, indicating that higher central bank independence is associated with a greater focus on climate change. However, the low R-squared value (0.002) suggests that the model explains only a small portion of the variation in climate change focus, implying that other factors not included in the model may play a more significant role.

OLS Regression Results

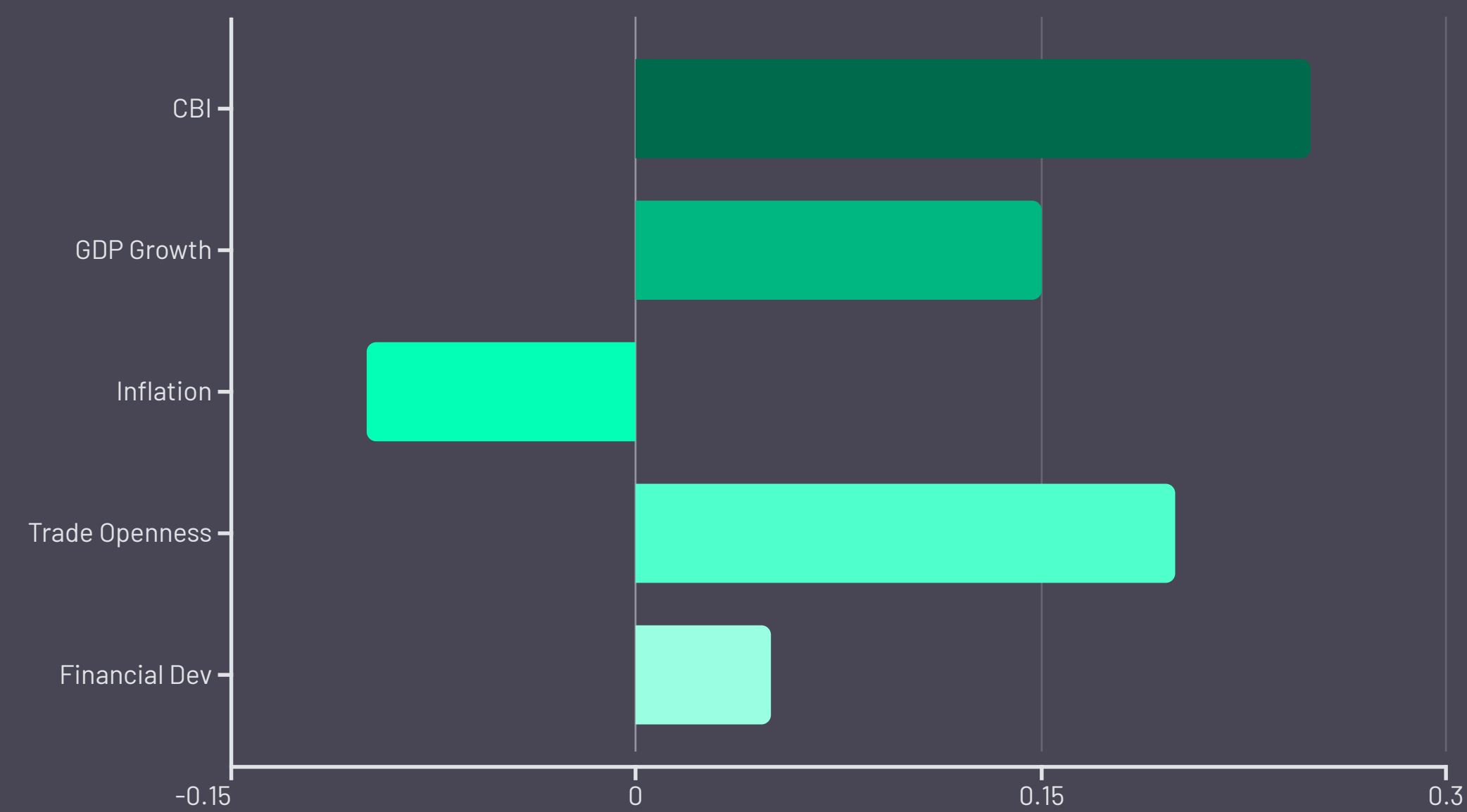
The OLS regression results with controls are presented below:

OLS Regression Results						
Dep. Variable:	sum_of_freqs_y	R-squared:	0.002			
Model:	OLS	Adj. R-squared:	0.002			
Method:	Least Squares	F-statistic:	8.217			
Date:	Thu, 13 Feb 2025	Prob (F-statistic):	4.84e-10			
Time:	21:50:55	Log-Likelihood:	-83367.			
No. Observations:	24764	AIC:	1.668e+05			
Df Residuals:	24756	BIC:	1.668e+05			
Df Model:	7					
Covariance Type:	nonrobust					
	coef	std err	t	P> t	[0.025	0.975]
const	0.1035	0.256	0.405	0.686	-0.398	0.605
cbie_index	1.1841	0.295	4.020	0.000	0.607	1.761
FS.AST.PRVT.GD.ZS	-0.0020	0.001	-1.673	0.094	-0.004	0.000
NY.GDP.DEFL.KD.ZG	4.715e-05	0.010	0.005	0.996	-0.020	0.020
NY.GDP.PCAP.KD	1.678e-05	3.93e-06	4.270	0.000	9.08e-06	2.45e-05
PV.EST	0.0425	0.102	0.419	0.676	-0.157	0.242
RL.EST	-0.4066	0.177	-2.302	0.021	-0.753	-0.060
RQ.EST	0.1813	0.181	1.000	0.317	-0.174	0.537
Omnibus:	42528.952	Durbin-Watson:	1.804			
Prob(Omnibus):	0.000	Jarque-Bera (JB):	38614714.822			
Skew:	12.105	Prob(JB):	0.00			
Kurtosis:	194.930	Cond. No.	3.40e+05			

The regression analysis reveals a statistically significant positive relationship between the CBI index and the sum of frequencies of climate-related keywords in central bank speeches. The coefficient for **cbie_index** is 1.1841 with a p-value of 0.000, indicating that higher central bank independence is associated with a greater focus on climate change. However, the low R-squared value (0.002) suggests that the model explains only a small portion of the variation in climate change focus, implying that other factors not included in the model may play a more significant role.

OLS Regression Results visualization

The OLS regression results provide insights into central bank behavior. Key variables and relationships are highlighted below.



The horizontal bar chart shows the coefficient values of the OLS regression. CBI and trade openness have the largest impact.

Conclusion and Implications

This study examined the impact of central bank independence on the focus given to climate change. By compiling a dataset on central bank independence and central bank speeches, and utilizing natural language processing (NLP) techniques to analyze the speeches, we extracted a score reflecting their emphasis on climate change. This score was then annualized and merged with the central bank independence dataset.

Subsequently, macroeconomic indicators were incorporated into the dataset. A linear regression model was then applied to assess the influence of central bank independence on climate change focus. Our findings indicate that independent central banks are more likely to prioritize climate change initiatives. This supports the hypothesis that greater independence allows central banks to operate with less political influence, enabling them to focus on emerging issues that are beneficial for both the public and the broader economy.

Policy Recommendations

The findings of this study have important policy implications, suggesting that granting central banks greater independence may enhance their ability to address long-term challenges such as climate change, rather than being constrained by short-term political considerations.

Policymakers should recognize the potential role of independent central banks in promoting sustainable economic policies and integrating climate-related risks into financial and monetary decision-making.

Specifically, policymakers should consider strengthening the mandates of central banks to explicitly include climate-related objectives, while safeguarding their operational independence. This could involve providing central banks with the necessary tools and resources to assess and mitigate climate risks in the financial system, as well as encouraging them to incorporate climate considerations into their monetary policy frameworks. However, it is crucial to strike a balance between expanding central bank mandates and preserving their independence, ensuring that they remain accountable for their actions.

Additionally, the results highlight the need for further research on how institutional frameworks influence central bank priorities, as well as the mechanisms through which central banks can effectively contribute to climate action. Strengthening transparency and accountability measures could further support independent central banks in advancing sustainability goals while maintaining their core monetary policy objectives.

Future Research Directions

While this study provides valuable insights into the relationship between central bank independence and climate change focus, several avenues for future research remain. Firstly, it would be beneficial to explore the specific mechanisms through which independent central banks translate their climate change focus into concrete policy actions. This could involve examining the types of climate-related policies implemented by central banks with varying degrees of independence, as well as assessing their effectiveness in mitigating climate risks and promoting sustainable development.

Secondly, future research could investigate the potential trade-offs between climate objectives and other central bank mandates, such as price stability and financial stability. Understanding how central banks balance these competing objectives is crucial for designing effective and sustainable policy frameworks. This could involve developing multi-objective optimization models that incorporate climate considerations alongside traditional macroeconomic targets.

Finally, it would be worthwhile to examine the role of international cooperation in promoting central bank engagement with climate change. This could involve analyzing the impact of international agreements and initiatives on central bank policies, as well as exploring the potential for collaborative efforts to address global climate risks. This could involve studying the effectiveness of international forums and networks in facilitating the exchange of knowledge and best practices among central banks.

References

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