CPU and EPU: The Influence of Climate and Economic Policy Uncertainty on Global Financial Performance

Trabajo de Grado: Asistente de Investigación

Juliana Dussán Téllez,

Paula Valentina Pérez González

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Juliana Dussán Téllez (Marketing y Negocios Digitales)
Paula Valentina Pérez González (Marketing y Negocios Digitales)

Tutor: Jesús Enrique Molina

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Declaración de originalidad y autonomía

Declaro bajo la gravedad del juramento, que he escrito el documento de título "CPU and EPU: The Influence of Climate and Economic Policy Uncertainty on Global Financial Performance", en la opción de grado de Asistente de Investigación III y que por lo tanto, su contenido es original. Declaro que he indicado clara y precisamente todas las fuentes directas e indirectas de información y que este trabajo no ha sido entregado a ninguna otra institución con fines de calificación o publicación.

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Declaración de exoneración de responsabilidad

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Juliana Dussán Téllez

Paula Valentina Pérez González

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Glosario

Carbon-intensive sectors: These are economic sectors where a large amount of greenhouse gases is produced in their activities, as well as carbon dioxide (CO2). This is mainly due to the excessive use of fossil fuels such as natural gas, coal and oil in their operating trades. Examples of these sectors are manufacturing, energy and transportation (Henríquez, Gálvez, 2022).

Climate Policy Uncertainty (CPU): The CPU refers to the lack of clarity regarding climate policy issues that may arise in the future, making it difficult for industries and investors to make decisions and strategies, particularly in the behavior of clean technology markets or environmental regulation (Arouri et al., 2010).

Developed countries: Developed countries are nations with a high level of economic, industrial and technological development, advanced infrastructure, high per capita income and accessible quality services (health, education and security), so that citizens generally have a satisfactory quality of life. For example: Germany, Austria, the United States and Japan (Huang et al., 2023).

Economic Policy Uncertainty (EPU): The EPU refers to the lack of certainty about the economic policies that industries may face in the future, as well as changes in government policies and regulations, taxes or government decisions that may impact the economy. This lack of clarity creates high volatility in the financial markets, causing investors to be cautious and delay economic operations (Aizenman, Jinjarak, 2019).

Emerging countries: Emerging countries are those nations that have a process of rapid economic growth and industrial development; however, although they have made significant progress in economic stability and modernization of the country, they do not have as advanced a level of infrastructure or wealth as developed countries. These nations have a high level of foreign investment, and their financial markets are constantly evolving. For example: South Africa, China, Brazil and India (Dahlhaus et al., 2022).

Environmental policies: These are rules and regulations established by international organizations or the governments of nations to protect the environment, promoting the sustainable use of natural resources and thus minimizing pollution and mitigating its consequences (Ren et al., 2022).

Financial markets: Financial markets are physical or virtual places where financial assets can be exchanged by buying and selling them, for example, currencies, bonds, stocks, among others. Their purpose is to facilitate the flow of capital between governments, companies and investors interested in financing projects (Ghirelli et al., 2021).

Fiscal policies: These are strategies on public spending or tax collection, developed by governments, with the purpose of influencing the country's economy and thus regulating market demand, which allows them to control indicators such as inflation or unemployment and thus promote the nation's economic growth (Barnes, Nae, 2024).

Foreign capital: Foreign capital is wealth in the form of money or other assets that come from the investment of other countries, with the objective of promoting collaboration between different nations and their economic growth. It can be direct, such as investments in infrastructure, or indirect, such as investment in bonds or stocks (Caceres, Hopenhayn, 2019).

Fossil fuels: Fossil fuels are those natural resources composed of organic remains that have been decomposed over millions of years, such as coal, oil or gas (He, Zhang, 2022).

GARCH-MIDAS Model: The GARCH-MIDAS model combines short-term and long-term volatility components. It uses the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model for capturing time-varying volatility and the Mixed Data Sampling (MIDAS) model to incorporate macroeconomic variables. This model is especially useful for examining financial volatility with both high-frequency data (daily) and low-frequency data (monthly or quarterly) such as macroeconomic factors (Engle et al., 2013).

Macroeconomic Factors: Macroeconomic factors refer to broader economic variables such as GDP, inflation, and unemployment that have substantial effects on financial markets. They often impact asset prices and market volatility. For instance, studies show that incorporating these macroeconomic variables into volatility models enhances the predictive accuracy of GARCH-MIDAS models (Engle et al., 2013). These variables help explain shifts in market dynamics and are crucial for long-term forecasting in financial analysis (Diebold & Yilmaz, 2009).

Market Volatility: Market volatility is a critical measure of uncertainty or risk in the market, typically defined by the fluctuations in asset prices over time. The volatility of financial markets is influenced by both short-term events and long-term economic factors such as interest rates, inflation, and macroeconomic shocks. Volatility can be modeled using GARCH-type models that account for time-varying volatility (Bollerslev, 1986; Engle et al., 2013). The incorporation of macroeconomic variables into these models allows for a more accurate representation of market uncertainty (Fleming et al., 2001).

Monetary policies: Central bank decisions, such as interest rate adjustments and changes in the money supply, significantly influence market volatility. A shift in monetary policy can cause substantial fluctuations in asset prices, particularly in interest-sensitive sectors like energy or real estate (Bernanke & Kuttner, 2005). Studies have shown that volatility can be predicted using monetary policy indicators, where GARCH-MIDAS models play a key role in incorporating both high-frequency data and economic policies (Bauer & Neely, 2014).

Public policies: Public policies, including environmental regulations or fiscal reforms, can have profound effects on market volatility. For instance, energy price regulations and climate policies often introduce new risks or reduce uncertainty in the market. Research has highlighted how government policies impact financial markets, particularly in energy sectors, where regulatory changes can affect supply, demand, and ultimately price stability (Bredin et al., 2016). Understanding the implications of public policies is essential for forecasting market volatility accurately.

Risky sectors: Risky Sectors: Risky sectors are industries that are highly vulnerable to unforeseen economic shocks, such as financial crises, market fluctuations, or regulatory changes. These sectors, such as financial services, energy, and technology, tend to exhibit higher levels of uncertainty and volatility. The exposure to unforeseen risks makes these sectors prone to substantial price fluctuations and greater financial instability (Brunnermeier, 2009; Campbell et al., 2008). The ability to predict volatility in these sectors often involves models that account for macroeconomic variables, monetary policies, and other external shocks

Social movements: Social movements are collective efforts by groups of people aiming to promote or resist social, political, or environmental changes. These movements seek to influence public opinion, government policies, and societal norms through collective action. They can arise in response to perceived social injustices or to advance specific goals, such as civil rights, gender equality, or environmental sustainability (Tilly & Tarrow, 2015).

Sustainable development goals (SDGs): The Sustainable Development Goals (SDGs) are a set of 17 global objectives established by the United Nations to address the world's most pressing challenges, including poverty, inequality, environmental degradation, and climate change. These goals promote sustainable development through action on critical issues such as education, clean energy, and economic inequality. Achieving the SDGs requires coordinated efforts from governments, businesses, and civil society (United Nations, 2015; Sachs, 2015).

Volatility: Volatility refers to the degree of variation in the price or value of an asset or market over time. It is often used as a measure of risk and uncertainty in financial markets, reflecting how much the value of an asset deviates from its mean over a specific period. High volatility indicates greater uncertainty and risk, while low volatility suggests a more stable market (Black, 1976; Mandelbrot, 1963).

Resumen

La Incertidumbre de las políticas climáticas (CPU) y económicas (EPU), impactan en gran medida a los mercados financieros considerando su gran utilidad en la toma de decisiones de los inversionistas y la relevancia que tiene para los entes reguladores. La CPU hace referencia a la falta de claridad de las políticas gubernamentales del cambio climático de un futuro, y la EPU, es la incertidumbre de las políticas fiscales y monetarias que afectan la fiabilidad de los mercados financieros. Ambas incertidumbres provocan un nivel de volatilidad alto, generando que las personas sean más cautelosas al invertir.

Tanto en los países desarrollados como emergentes, la CPU y EPU afectan incuestionablemente el rendimiento de sus economías. Por un lado, en los países desarrollados donde se encuentran mercados financieros más fuertes con políticas medioambientales superiores, cuentan con la dificultad de adaptarse a modelos más sostenibles. Por otra parte, la EPU y CPU en los países emergentes, tiene un nivel de afectación más alto dada la sensibilidad de los mercados financieros, incrementando la volatilidad del mercado, y generando que el acceso a capital extranjero se vea limitado.

La relación entre el EPU, CPU y la volatilidad de los mercados financieros se puede analizar a partir de GARCH-MIDAS. Este es un modelo de regresión que permite capturar la variabilidad de la volatilidad en diferentes periodos de tiempo, proporcionando un análisis completo de las fluctuaciones que tienen los índices de la incertidumbre en las diferentes regiones.

Palabras Clave

Incertidumbre Política Climática (CPU), Incertidumbre Política Económica (EPU), mercados financieros, volatilidad, cambio climático, regulaciones ambientales, países emergentes y desarrollados

Abstract

Climate Policy Uncertainty (CPU) and Economic Policy Uncertainty (EPU) have a major impact on financial markets considering their usefulness in investor decision-making and their relevance for regulators. CPU refers to the lack of clarity of future governmental climate change policies, and EPU is the uncertainty of fiscal and monetary policies that affect the reliability of financial markets. Both uncertainties cause a high level of volatility, making people more cautious when investing.

In both developed and emerging countries, CPU and EPU unquestionably affect the performance of their economies. On the one hand, in developed countries, where there are stronger financial markets with superior environmental policies, it is difficult to adapt to more sustainable models. On the other hand, EPU and CPU in emerging countries have a higher level of impact given the sensitivity of the financial markets, increasing market volatility and limiting access to foreign capital.

The relationship between EPU, CPU and volatility of financial markets can be analyzed using GARCH-MIDAS. This is a regression model that allows capturing the variability of volatility in different time periods, providing a complete analysis of the fluctuations of the uncertainty indexes in different regions.

Keywords

Climate Policy Uncertainty (CPU), Economic Policy Uncertainty (EPU), financial markets, volatility, climate change, environmental regulations, emerging and developed countries.

1.Introduction

In a globalized and constantly changing world, financial markets face increasing uncertainty due to both climate policies (CPU) and economic policies (EPU), which directly impact financial stability. These uncertainties not only generate volatility, but also affect investment and consumption decisions, making it essential to understand their interaction for informed decision making and risk management in a changing economic and climate environment (Arouri et al., 2020). Climate policy uncertainty (CPU) refers to the lack of clarity about future environmental regulations, such as carbon taxes or incentives for renewable energy, which especially affect sectors such as energy and transportation, both of which are carbon intensive (Li & Sun, 2023). This uncertainty can arise from factors such as changes in government administration, technological advances, social pressures and extreme weather events, making it difficult for investors to forecast and plan strategically.

On the other hand, economic policy uncertainty (EPU) encompasses the lack of clarity regarding fiscal and monetary policies, which generates concern in financial markets. This lack of certainty leads investors and economic agents to face greater difficulties in forecasting the future development of financial and economic conditions, complicating the formulation of investment strategies (Barnes & Nae, 2024). Recent studies suggest that EPU can have direct effects on market volatility and investment decisions of firms in developed and emerging economies, inducing changes in risk management strategies to adapt to an uncertain environment (Dahlhaus et al., 2022). Both CPU and EPU influence investors' perception of economic risk, affecting their willingness to support sustainable projects or projects with a positive impact on the environment (Fried et al., 2021).

In this context, climate uncertainty often leads to increased caution among investors, who reconsider their strategies due to the lack of clarity about future policies. For example, the possibility of stricter environmental regulations may prompt investors to avoid carbon-intensive sectors, such as fossil fuels, and opt instead for companies that promote clean energy (Bordo & Levin, 2022). This uncertainty also increases market volatility, as sudden changes in regulation can generate unpredictable reactions, making it difficult to forecast future trends (Li & Sun, 2023). Although the transition to a more sustainable environment poses risks, the CPU can also be a catalyst for innovative policies that contribute to economic growth and sustainable development goals globally (Aydin et al., 2021).

To address these interactions, the analysis is performed using the GARCH-MIDAS model, a statistical technique that allows modeling the long-term volatility of financial markets as a function of low-frequency macroeconomic factors, such as CPU and EPU. This model, developed by Engle, Ghysels and Sohn (2013), combines the GARCH methodology to capture short-term volatility with a MIDAS (Mixed Data Sampling) approach, which incorporates information from different time frequencies, thus providing a comprehensive perspective of the factors driving volatility in the markets.

Given the above, CPU and EPU play crucial roles in financial markets, affecting both specific sectors, such as carbon-intensive ones, and the stock market in general. Understanding how these uncertainties interact is essential for designing investment strategies and public policies that mitigate risk and promote long-term economic stability (He & Zhang, 2022). This article analyzes in detail the interplay between these uncertainties to provide valuable information to investors, policy makers, and other stakeholders interested in promoting economic stability in a changing world.

On the other hand, it is important to take into account that the research development of this document is supported by articles from recognized databases such as Web of Science and Google Scholar, in order to provide relevant and quality information. Likewise, the tool DeepL, a machine translation tool based on Artificial Intelligence (AI) was implemented to support the production process, with the purpose of guaranteeing accuracy and coherence of the information appropriate to the required language, which in this case is English, allowing the language of the document to be clear and professional as requested.

2. Methodology

The development of the document was carried out in two stages. The first consisted of a systematic literature review and the second of a bibliometric analysis. To produce the first stage, a collection of documents was made and stored in an organized and structured manner, the data were downloaded from the Web of Science database, based on the following search equations.

Tabla 1 Search Equations

Search questions
“GARCH MIDAS” + “VOLATILITY”
“GARCH MIDAS” + “CPU”
“GARCH MIDAS” + “EPU”
“Climate Policy Uncertainty” + “Economic Policy Uncertainty”

Source: own elaboration

For an effective investigation, the documents had to have the property of being articles, exclusively from the Web of Science database, written in English, and qualified in quartiles 1 or 2 of the SSCI collection.

After an exhaustive search, 105 documents were obtained, each of which was inspected by hand to discard those that were not relevant to this research. Considering the above, about 50 articles were rejected. The remaining papers were thoroughly reviewed and sorted by title, authors, main topic and abstract. This was done in order to classify them and facilitate the search for specific patterns, as well as the results obtained by the authors. Furthermore, in the second stage, a bibliometric analysis was elaborated from the applied database, thus evaluating the number of publications per country, the contribution between nations and authors, the relationship between the different variables, the production of the authors over time and the comparison of the authors who have written more articles on the subject, the annual production of scientific articles, among others. The objective of these analyses is to understand the similarities and differences that have been found over time, and the importance of the topic over the years.

3. Results

Following the methodology employed, the results of the literature review are presented to provide an overview of the topic studied. This analysis is divided into two sections focusing on (i) the application and advances of the GARCH-MIDAS model, and (ii) bibliometric analyses highlighting trends, prominent authors, collaborative networks in this field, among others.

Together, these sections provide a comprehensive overview of the methodologies and scholarly contributions related to this area of research.

3.1. Literature Review

Financial markets face growing climate policy uncertainty (CPU) and economic policy uncertainty (EPU), two interconnected forces that impact financial stability, both of which generate volatility, investment caution and consumption shifts (Baker, et al., 2016; Choi, 2020). Understanding how these uncertainties interact is essential for making informed financial decisions and managing risk in a changing economic and climate environment. This article will analyze in detail the interaction between CPU and EPU, assessing their impact on financial markets to provide valuable information to investors, policymakers, and other market actors.

Climate policy uncertainty (CPU) is defined as the lack of clarity regarding future government regulations and actions associated with environmental changes. It is considered as a "net receiver of uncertainty shocks" (Mokni et al., 2024, Pg. 1.), in other words, it is able to capture variables that are affected by sudden and unexpected changes in laws involving climate policies, as well as environmental regulations, carbon emission taxes, renewable energy incentives, and other policies with direct impact on the economy and financial markets (Garrett & Liu, 2023). This uncertainty can arise due to a variety of factors, such as changes in government administration, social pressures, technological advances, and extreme weather events (Tian et al., 2022). The CPU is carried out from major U.S. newspapers, such as Tampa Bay Times, Chicago Tribune, Boston Goble and Miami Herald; categorizing it by the most relevant words, e.g., climate risk, global warming, uncertainty, climate change, regulations, among others. Subsequently, it is categorized according to the most important texts and the total number of productions per month, averaging the data and normalizing it to compose the global Climate Policy Uncertainty (CPU) (Li et al., 2023).

On the other hand, "EPU" or "Economic Policy Uncertainty" is a concept that encompasses the lack of clarity about future fiscal and monetary policies that will be implemented by government authorities, this uncertainty can generate doubts and anxiety in financial markets, as investors and economic agents may have difficulties in predicting how economic and financial conditions will develop in the future (Bordo, M. D. et al., 2022). This uncertainty can arise for a variety of reasons, including changes in government administration as a result of elections, unforeseen events such as economic crises or natural disasters that require rapid economic responses, and inadequate communication by economic authorities.

Climate policy uncertainty (CPU) and economic policy uncertainty (EPU) have a direct influence on financial markets, affecting investment decision-making and the perception of economic risk (Arouri, M. H. et al., 2010). In the case of CPU, this climate uncertainty can generate caution among investors and market participants, who tend to reconsider their investment strategies in the absence of clarity about future climate policies. For example, uncertainty about stricter environmental regulations could lead investors to avoid carbon-intensive industrial sectors, such as fossil energy, and move towards companies that promote renewable energy or clean technologies (Ren et al., 2022). This change in asset demand may affect the prices of stocks and bonds in those specific sectors. In addition, uncertainty about climate policies can increase market volatility, as sudden changes in government regulations or approaches can generate unpredictable reactions in financial markets, making it difficult to predict future trends, affecting the investment strategies of market participants (Littlewood, 2019), and intervening in the assessment to foresee Black Swans or Climate Green Swans (Mokni et al., 2024). However, despite the growing threat that the uncertainty of the climate transition may be an impediment to the development of a more sustainable world, the CPU can guide innovative policies, which contribute to the development of technologies that stimulate economic growth in the future, forcing decision makers to meet global sustainable development goals (Mokni et al., 2024; Chen et al., 2023;Yao et al., 2023). EPU also plays a crucial role in financial markets by influencing business investment decisions and consumption, lack of clarity about future fiscal and monetary policies can generate doubts and anxiety in financial markets, leading investors and economic agents to have difficulty predicting how economic and financial conditions will develop in the future (Aizenman, J., & Jinjarak, Y. 2019). This uncertainty can result in higher volatility in asset prices, more cautious investment decisions, and changes in risk management strategies. In addition, uncertainty about future fiscal and monetary policies can influence firms' investment decisions, affecting their revenues and earnings, which in turn can ultimately impact stock and bond prices in the market (Ghirelli et al., 2021).

Now, with respect to the research that has been developed on CPU, a negative impact on stock returns has been observed, especially in carbon-intensive sectors such as fossil energy, transportation, and industrial companies. For example, studies conducted in the United States by (Baker et al., 2016), and in Europe by (Arouri et al., 2010), highlight this negative relationship between CPU and economic growth. Likewise, (Howarth, 2003) proposes the theory of investor behavior under uncertainty, revealing that when the market is faced with the ambiguity of long-term political decisions, investors are cautious and reluctant to contribute their capital to projects related to climate change (Mokni et al., 2024). In addition, CPU has been associated with increased volatility, as evidenced in the Wavelet coherence analysis by (Choi, 2020), who found that CPU increases volatility in carbon-intensive sectors. This phenomenon also affects consumption, as rising energy prices and a shift in consumer preferences towards sustainable products are direct consequences of climate uncertainty. On the other hand, some academics consider the CPU as an advantage when exposed with meteorological indicators, such as (Garvriilidis, 2021), who presents his proposal explaining that the CPU is of great utility as it is an indicator with the quality of evaluating different dynamic variables of climate change and weather, such as temperature variation or the significance of atmospheric pollution (Chen et al., 2023).

Additionally, EPU also has a significant impact on financial markets in developed countries. A negative impact on GDP growth has been observed, as pointed out by the findings of (Ghirelli et al., 2021) in the United States, who found an inverse relationship between EPU and economic growth. Also, EPU has been associated with a decrease in liquidity and an increase in the cost of capital, which makes it more difficult for firms to obtain financing. In addition, fluctuations in exchange rates affect companies with international operations, demonstrating the global impact of economic uncertainty. These findings have been corroborated in specific studies carried out in different developed countries, such as the United States, Europe, and Japan, where a negative impact of EPU on the stock market and investment has been found.

To conclude, both CPU and EPU have a significant impact on financial markets in developed countries. While CPU mainly affects specific sectors, such as those intensive in carbon and greenhouse gas emissions, EPU has a more generalized impact on the stock market. Likewise, the CPU and EPU comprise a close relationship, therefore, when periods of uncertainty occur, CPU shocks intervene in the EPU of countries, therefore, strategies to appease and control the concern of climate change can be developed through economic policies and vice versa. It is essential that governments fulfill their role as regulators and implement clear and predictable policies related to fiscal policies and economic planning to mitigate the effects of these climate uncertainties, which will contribute to long-term stability and sustainable economic growth (Mokni et al., 2024).

Similarly, there has been sufficient research on emerging countries, where factors such as Climate Policy Uncertainty (CPU) and Economic Policy Uncertainty (EPU) have become determinants of the performance of these countries, therefore, understanding the interrelationships and impact of these indices is fundamental for the creation of effective solutions for investment decisions and government policies. In this sense, the increase of the EPU in emerging countries has been analyzed, which triggers concern by virtue of the high variability of currencies, the affectation that is generated in trade and the questionable policy regulation given the political and international relations scenario, as well as the trade dispute between China and the United States (Huang, H., Ali, S., & Solangi, Y. A., 2023). As a consequence, the EPU greatly impacts the cost of capital of these countries, affecting entrepreneurs and their organizations, reflected in the low interest from their investors, the reduction of their profits and investment capital. Although small and medium-sized companies are affected, the ones who are hit the hardest are large companies, mainly in the private sector (Liu, J., & Wang, H., 2022), who have a more complex capital structure, being more sensitive to currency variations or interest rate changes, as well as experiencing a higher dependence on foreign investment and greater vulnerability to fluctuations in commodity prices. In addition, some studies reveal that the average return is positive among emerging countries such as BRIC (Brazil, Russia, India and China) and Economic Policy Uncertainty (EPU), and volatility can be highly variable, while return spillover results in negative values (Hung, 2021; Dakhlaoui y Aloui 2016). Research developed on the Climate Policy

Uncertainty (CPU) index in emerging countries shows that the CPU directly harms the returns of clean energy stocks, mainly in countries such as China (Ye et al., 2021), negatively impacting the evolution of environmental sustainability care and even climate change mitigation alternatives (Huang, H., Ali, S., & Solangi, Y. A., 2023), therefore, emerging countries have greater vulnerability to climate change, as well as to increased resource scarcity and reduced environmental resilience. On the other hand, the CPU in this market also has a significant impact on the country's financial risks. Other authors state that the CPU affects the financing processes of banks, for example, passive and active risks, which decrease because, as banks take a precautionary position in their investments, consumers also reduce their deposits. In addition, it increases the insolvency risk of the country, i.e., thanks to an increase in the CPU, the inability to pay is higher, generating a prolonged growth in the debts of both consumers, companies, and the nation (Dai, Z., & Zhang, X., 2023).

The intersection between economic and climate uncertainty in Latin America exerts a crucial impact on investment decisions and economic analysis, creating an atmosphere of doubt among investors due to the lack of solid information. This situation poses a dilemma for investors, who are faced with the need to adjust their positions or maintain their investments in the face of environmental and political volatility. In this scenario, it is essential to deepen the understanding of these phenomena to promote stability and economic growth in the region, adopting strategies that mitigate uncertainty and foster confidence in financial markets. In this context, the scant research available has witnessed a consistency in the variables affecting these investment decisions and the economic development of the region, highlighting the reduction of Economic Policy Uncertainty (EPU) and the promotion of investment as key measures to boost economic growth in Latin America (Caceres & Hopenhayn, 2019). The impact of global EPU on exchange rate expectations in the region suggests that global EPU shocks can lead to significant upward revisions in exchange rate depreciation expectations over a 12-month time horizon (Ojeda-Joya & Romero, 2023). Furthermore, the relationship between US EPU and Latin American financial markets has shown a negative correlation, especially in countries like Mexico and Colombia, where increases in US EPU are associated with reductions in stock market returns (Henríquez & Gálvez-Gamboa, 2022). Likewise, the analysis has examined how both national and international EPU can influence exchange rate volatility in the region, finding that increases in international EPU are associated with increases in real exchange rate volatility (Bush & López Noria, 2021). Additionally, the importance of understanding how uncertainty in economic policy affects Latin American financial markets is emphasized, highlighting the need to continue exploring these links for a better understanding of economic processes in the region. It is also crucial to highlight that increasingly serious governmental efforts to reduce the environmental footprint in response to the increase in abnormal climate phenomena have compelled companies to modify their strategies to address climate-induced political uncertainty (Tan & O. F, 2024). These considerations underscore the need for a comprehensive approach that takes into account both economic and climate uncertainty as well as sustainability measures to ensure stability and sustainable development in Latin America.

3.2 Methodology: GARCH-MIDAS MODEL

The research is based on the model developed by Engle, Ghysels and Shohn in 2013, the GARCH MIDAS model. This is in order to understand the long-term changes that are reflected in the volatility of the stock market, with respect to the uncertainty exposed in the United States.

In this research, long-term volatility is modeled based on lagged NVIX, applying a MIDAS polynomial on the monthly NVIX. Now, the number of days in a month is expressed in the form $N(j)$, the element that varies with the month j of long term is represented by l_t. And $S_{i,j}$ represents the short-term element of variance that refers to day-to-day fluctuations which must be of short duration. Taking the above into account, the GARCH MIDAS model is presented with the following equation.

$$r_{i,j} = \varepsilon + \sqrt{l_j * S_{i,j}}\xi_{i,j} \tag{1}$$

In which $S_{i,j}$ obeys the GARCH (1,1) model, presented as follows.

$$S_{i,j} = (1 - \alpha_1 - \alpha_2) + \alpha_1 \frac{(r_{i-1,j} - \varepsilon)^2}{l_j} + \alpha_2 s_{i-1,j} \tag{2}$$

Where $\alpha_1 > 0$ and $\alpha_2 > 0, \alpha_1 + \alpha_2 < 1$.

Now, following the RV model of MIDAS regression and filtering, the l_j element is represented as:

$$Log\left(l_j\right) = m + L$$

$$L = \theta \sum_{k=1}^{K} \varphi_k\,(\omega_1, \omega_2) RV_{j-k} \tag{3}$$

$$RV_j = \sum_{i=1}^{N_j} r^2{}_{i,j}$$

And *K* shows the number of periods in which volatility is smoothed.

On the other hand, RV and NVIX were introduced in the previous equation (3), with the objective of understanding the effect that NVIX has on the performance variance. Expressing it in the following way:

$$l_j = m + L_1 + L_2$$

$$L_1 = \theta_{RV} \sum_{k=1}^{K} \varphi_k \left(\omega_1^{RV}, \omega_2^{RV}\right) RV_{j-k} \quad (4)$$

$$L_2 = \theta_X \sum_{k=1}^{K} \varphi_k \left(\omega_1^{NVIX}, \omega_2^{NVIX}\right) X_{j-k}^{NVIX}$$

Where the change in NVIX is X_{j-k}^{NVIX}, this means that X_{j-k}^{NVIX} determines the difference between the logarithms of NVIX. Furthermore, in equation 4 you can see the weighting scheme in which the beta weights are deciphered, expressed as:

$$\varphi_k(w_i) = \frac{\left(1-\frac{k}{K}\right)^{w_i-1}}{\sum_{s=1}^{K}\left(1-\frac{s}{K}\right)^{w_i-1}}, \forall k = 1, \ldots, K \quad (5)$$

Considering the above, the GARCH-MIDAS model of time-varying conditional variance with RV of fixed temporality and the parameter space expressed as $\Theta = \{\varepsilon, \alpha_1, \alpha_2, m, \theta, \omega_1, \omega_2\}$, are formed from the five equations set out above.

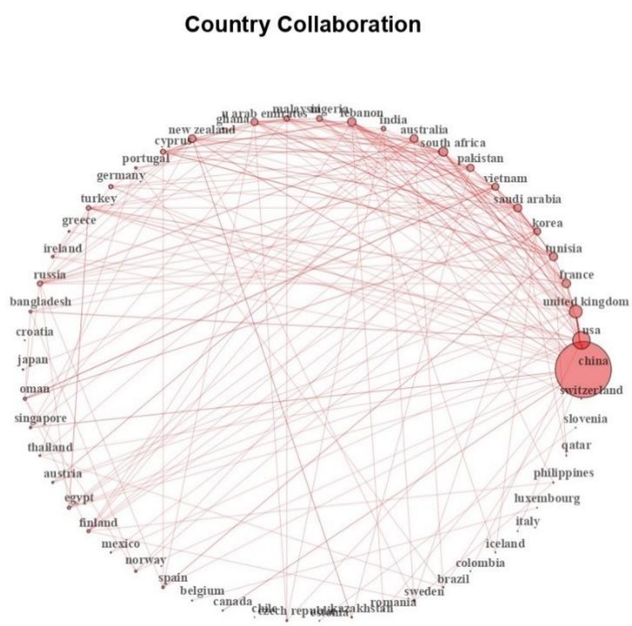
Finally, the total conditional variance is defined as follows:

$$\sigma_{i,j}^2 = l_j * s_{i,j} \quad (6)$$

3.3 Bibliometric Analysis

The bibliometric analysis was carried out to obtain information on trends, concentration of academic production, authors, collaborations and countries related to the reviewed documents. This approach allows the identification of the main topics, the most prominent authors and the connections between them and their institutions at the international level.

Figure 1 Country Collaboration

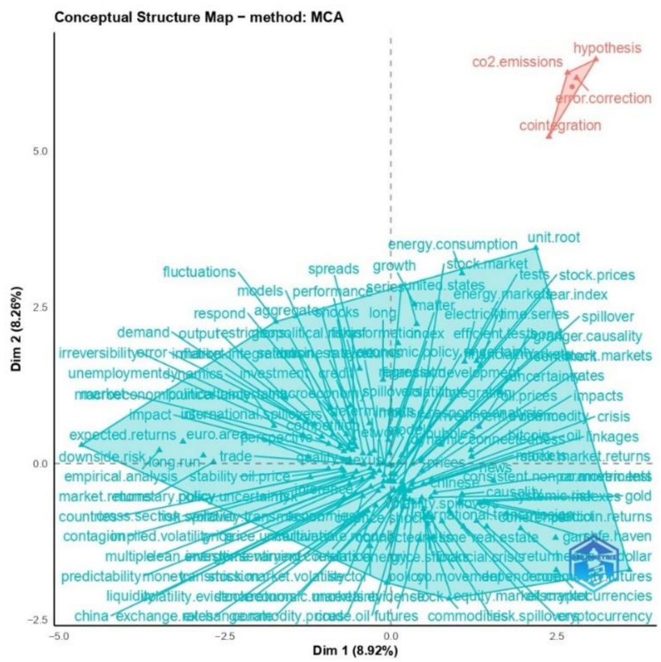


Source: own elaboration

Figure 1 shows the network analysis, this reveals the existence of clusters of collaboration between authors, with China at the center of an extensive research network. This finding indicates that Chinese institutions not only lead in scientific output, with 109 papers published between 2016 and 2024, but also play a pivotal role in shaping the research agenda in this field, supported by a sizable total of 2,320 citations. The annual growth rate of 26.36% in document production, with an average of 22.02 citations per article, underscores the significant academic impact of this research. In addition, international collaboration is remarkable, with 42.67% of articles co-authored by researchers from different countries, highlighting an interconnected and cooperative environment. The trend towards global collaboration not only facilitates the dissemination of knowledge, but also promotes the generation of innovative ideas. The diversity in document types, which includes 202 articles and other formats, as well as the wide range of keywords (633) used, reflects a rich and diverse field of research.

This dynamic of cooperation, combined with the constant growth in scientific production, indicates that researchers are increasingly willing to share their knowledge and experiences, which creates an environment conducive to the emergence of more effective and relevant solutions. The interaction between authors from different geographies not only strengthens the quality of research, but also drives the advancement of knowledge in a global academic context.

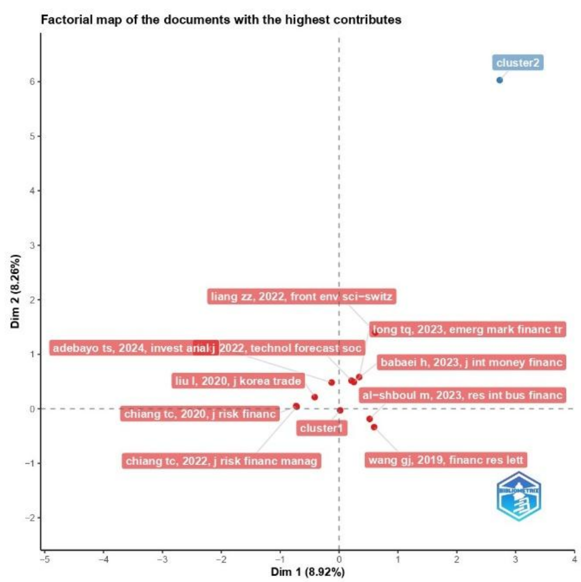
Figure 2 Conceptual Structure Map



Source: own elaboration

Multiple correspondence analysis (MCA) (See Figure 2) provides a detailed visual representation of the relationships between multiple categorical variables, allowing the latent structure of the data to be explored. In the resulting diagram, each point represents a category, and the proximity between these points reflects the strength of association between them. For example, groupings of related concepts, such as economic terms, may be identified that might be closer to each other, while opposing concepts, such as "crisis" and "stability," are placed in separate quadrants. This visual representation is particularly valuable given the steady growth of research in this field, with an annual growth rate of 26.36% between 2016 and 2024, and an expanding scholarly output that includes 225 papers from 99 diverse sources. In addition, the fact that the documents have an average age of only 2.19 years highlights the topicality and relevance of the area of study. For a more accurate interpretation of the MCA, it is essential to consider the specific context of the research, including the variables analyzed and the most commonly used keywords, such as "Economic Policy Uncertainty" (EPU), present in 125 articles. This analysis allows not only to reveal the interconnectedness of ideas, but also to identify general trends and emerging themes in the literature, thus facilitating the dissemination of knowledge and the generation of innovative ideas in a research environment characterized by strong international collaboration.

Figure 3 Contribute of documents

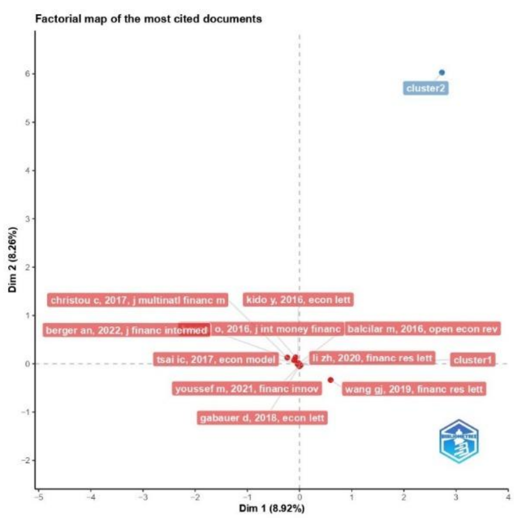


Source: own elaboration

Figure 3 shows the analyzed period spans from 2016 to 2024, with a total of 225 published documents and a notable annual growth rate of 26.36%. The majority of these documents are articles (202), indicating a trend toward the rapid dissemination of research results. The thematic diversity is evident, with 385 Plus keywords and 633 author keywords, facilitating the identification of multiple approaches in the literature. Additionally, there is strong collaboration among authors, with an average of 3.07 co-authors per document and 42.67% of international co-authorships, reflecting an interconnected research environment.

In this factorial map, each point represents a document, and its position in the two-dimensional space reflects its similarity to other documents. Dimensions 1 and 2 represent the main axes of variation in the data, meaning the dimensions that best explain the differences between the documents. The clusters in the factorial map group documents into specific topics such as financial risk and international finance, aligning with trends in scientific production. Key authors such as Gupta R and Li X stand out, leading in the number of published articles. Finally, the most cited articles, such as Gabauer D's with 209 citations, highlight the importance of certain studies in the field's evolution, suggesting that central topics like economic policy uncertainty are highly relevant to the current research community.

Figure 4 Most Cited Documents

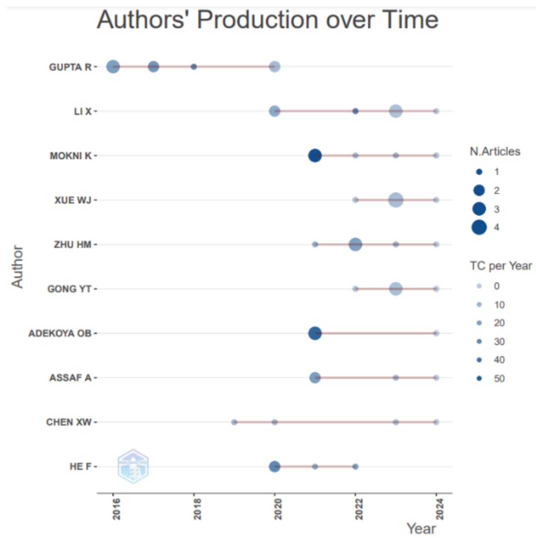


Source: own elaboration

The analyzed period spans from 2016 to 2024, with a total of 225 published documents and a notable annual growth rate of 26.36%. Most of these documents are articles (202), indicating a trend toward the rapid dissemination of research results. The thematic diversity is evident, with 385 Keywords Plus and 633 author keywords (See Figure 4), facilitating the identification of multiple approaches in the literature. Additionally, collaboration among authors is strong, with an average of 3.07 co-authors per document and 42.67% of international co-authorships, reflecting an interconnected research environment. Data shows that the average citations per document is 22.02, underscoring the relevance of these studies within the scientific community.

The clusters in the factorial map, which group documents on specific topics such as financial risk and international finance, are consistent with the trends observed in scientific production, highlighting key authors like Gupta R and Li X, who lead in the number of published articles. The position of each point in the graph indicates its similarity to other documents. Dimensions 1 and 2 represent the main axes of variation in the data, better explaining the differences between documents. Finally, the most cited articles, such as the one by Gabauer D (209 citations), emphasize the importance of certain studies in the evolution of the field, suggesting that central topics like economic policy uncertainty are relevant to the current research community.

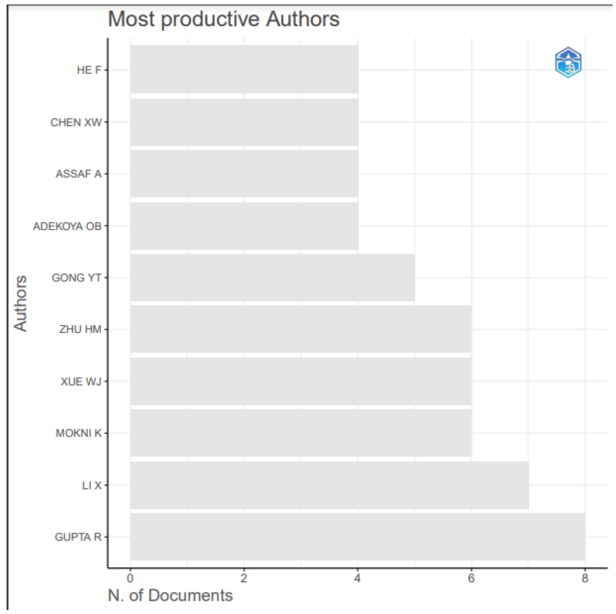
Figure 5 Authors´Production Over Time



Source: own elaboration

Figure 5 shows the scientific production of various authors during the year 2016 to 2024 of the exposed topic. The size of the circle represents the number of articles published in a specific year and its colorimetry shows the number of papers published in that year. In that order of ideas, an important variability is evidenced in the publication of articles by each author, since most of them, despite their high number of productions, not many publications are evidenced, as for example Gupta R. Additionally, it can be observed that the production of articles increased in 2020, since with the exception of Gupta R., there is no evidence from 2018 onwards. Likewise, it is exposed that in 2024 the interest of the researchers decreased, as well as the development of their articles. Thus, it can be seen that from 2020 to 2023, the topic of policy uncertainty was very much mentioned, producing several articles by various authors, mainly by Mokni K., Adekoya Ob., Li X., and Assaf A.

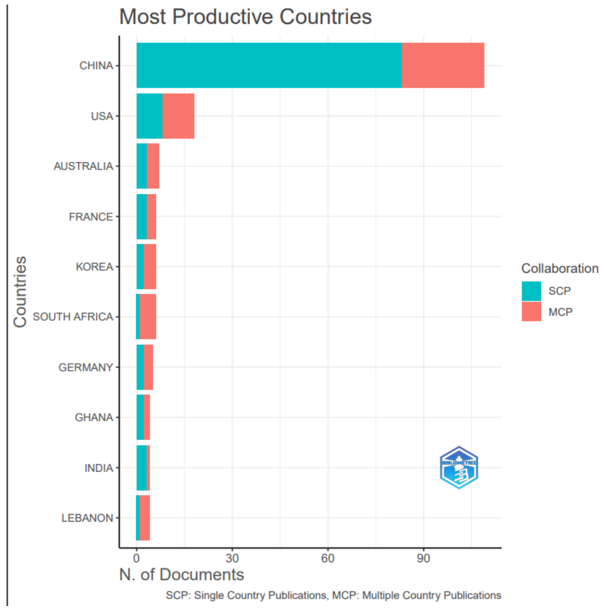
Figure 6 Most Productive Authors



Source: own elaboration

The above horizontal bar chart (See Figure 6) shows the authors who produced the most articles, showing that Guptar R. and Li X. produced a significant number of papers compared to the other authors. Zhu Hm., Xue Wj, and Mokni K. followed, who produced a total of 6 papers, followed by Gong Yt. who produced one less. Finally, He F., Chen Xw., Assaf A., and Adekoya Ob. produced 50% less than Guptar R. and Li X.

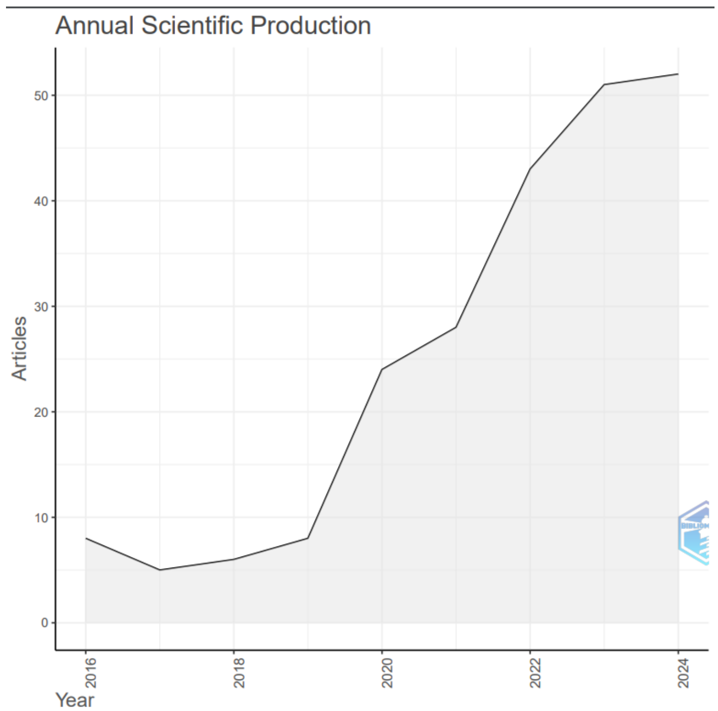
Figure 7 Most Productive Countries



Source: own elaboration

Figure 7 compares the productivity of articles in different countries in two categories, individual publications (SCP, orange color) and publications of articles in collaboration with other countries (MCP, blue color). Considering the above, it is evident that the country with the highest number of publication and collaboration of documents is China with a significant number compared to the rest of the countries. It is followed by the United States in both categories. Continuing with the development of articles, it is followed in order by Australia, France, India, Korea, Germany, Ghana, Lebanon and South Africa; however, despite the fact that the latter is the country that produced the least number of articles, it was the one that collaborated more than the other countries, except for the first two. Likewise, in terms of collaboration between countries, it is followed by Korea and Lebanon.

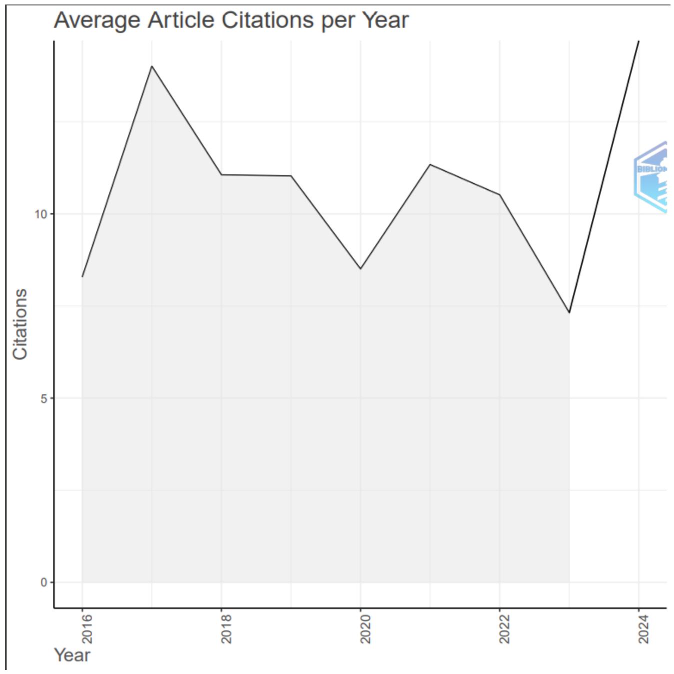
Figure 8 Annual Scientific Production



Source: own elaboration

Figure 8 represents the evolution of scientific production over the years, from 2016 to 2024. An upward trend is observed from 2019 given the significant increase obtained compared to the last years, evidencing a continuous increase in the production of scientific articles of the policy uncertaimty topic, until the last year and reaching an approximate of 55 articles in 2024.

Figure 9 Average Article Citations



Source: own elaboration

Figure 9 shows the evolution of the average number of citations per article from 2016 to 2024. A significant growth is observed from the year 2016 to 2017, subsequently there is a decline until 2018, year in which the citation of articles stabilizes, but decreases again in 2019 until 2020. In 2021 it increases a little more than in 2018. From 2022 to 2023 the average number of citations per article is at its lowest point, however, from 2024 a significant growth in citation is exposed, exposing its highest point until the last period analyzed.

4. Conclusion

In conclusion, the bibliometric analysis reveals the dynamic growth and collaborative nature of research on economic and policy uncertainty, with China emerging as a central figure in both publication volume and international partnerships. This interconnected research environment, characterized by a wide thematic range and high citation impact, underscores the global relevance of the topic.

The interaction between Climate Policy Uncertainty (CPU) and Economic Policy Uncertainty (EPU) presents profound challenges for financial market stability and investment decision-making in the current context. The lack of clarity regarding future climate and economic policies generates market volatility, prompting adjustments in investment strategies, especially in carbon-sensitive sectors such as fossil energy and transportation (Baker et al., 2016; Arouri et al., 2010). These uncertainties not only affect investors' perception of risk but also encourage greater caution in investing in high-emission sectors, while there is a growing preference for those promoting sustainable technologies and renewable energy (Ren et al., 2022).

This transition towards sectors with lower environmental impact occurs in a context where CPU, by capturing variables affected by sudden changes in climate regulation, acts as a receiver of uncertainty that influences market volatility and investors' capital allocation (Mokni et al., 2024; Choi, 2020). On the other hand, EPU, which encompasses a lack of clarity about future fiscal and monetary policies, has a broader effect on financial markets by influencing liquidity, the cost of capital, and business investment decisions (Ghirelli et al., 2021). This global economic uncertainty can result in increased caution in business activities, as companies face difficulties in anticipating future financial conditions, affecting their long-term revenues and profits (Aizenman & Jinjarak, 2019).

In emerging markets, the impact of EPU is further amplified due to factors such as exchange rate volatility, dependence on external financing, and sensitivity to international politics, which exacerbates financial risks and limits investment attraction (Huang et al., 2023; Liu & Wang, 2022). Research highlights that both CPU and EPU have a direct and significant impact on economic growth and market stability, showing how climate and economic uncertainty can be a barrier to developing a resilient financial environment (Li et al., 2023). At the same time, these uncertainty factors can be a catalyst for innovative and sustainable policies geared towards achieving sustainable development goals (Yao et al., 2023). Therefore, it is essential for governments and policymakers to work on formulating predictable and consistent regulatory frameworks that reduce investment barriers and promote the transition to a low-carbon economy (Mokni et al., 2024). Effectively addressing CPU and EPU requires international cooperation and a joint commitment to implementing clear economic and climate policies that not only minimize negative impacts on markets but also promote stable and sustainable long-term economic growth.

Ultimately, such policies can help mitigate market volatility, stabilize the financial environment, and foster greater confidence among investors, who can then invest more safely in sectors critical to environmental sustainability and inclusive economic growth (Chen et al., 2023; Dai & Zhang, 2023).

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