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Article

Do climate policy uncertainty and economic policy uncertainty promote firms' green activities? Evidence from an emerging market

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RESEARCH ARTICLE



Do climate policy uncertainty and economic policy uncertainty promote firms' green activities? Evidence from an emerging market

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ABSTRACT

This study examines the joint effects of climate policy uncertainty (CPU) and economic policy uncertainty (EPU) on the green activities (GAs) of Vietnamese listed companies from 2010 to 2022. CPU and EPU are measured by standardizing the search volume index of relevant keywords using data from Google Trends and Glimpse. Meanwhile, GAs are assessed through variables related to green finance (GF) and green innovation (GI). The findings from multivariate regression models show a positive relationship between CPU, EPU, and either GF or GI in Vietnam during the period of 2010–2022. Furthermore, the interaction between CPU and EPU positively influences both GF and GI among listed firms throughout the research period. This study suggests that governments promoting policies to enhance economic activity or address climate change can facilitate firms in sustaining their green economic activities.

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1. Introduction

The world has witnessed an unprecedented array of upheavals in recent years, ranging from the global COVID-19 pandemic and climate change to trade wars and armed conflicts (Drucker, 2022). Regardless of their size and political standing, nations, blessed with resources and resilience, are not immune to these consequences (Schofer & Hironaka, 2019; Frank et al., 2020). Among these global disruptions, climate change directly affects socioeconomic development activities across the globe, particularly in developing countries (Ali et al., 2016; Khan & Farooqui, 2021; Subroto & Datta, 2023). Beyond the evident impacts, such as economic losses and human casualties, it has also triggered stigmatization and social disruption, educational interruptions, psychological trauma and long-term developmental setbacks. These burdens further impede the recovery of developing nations in the aftermath of climate-related crises with cross-sectoral ramifications (Knowlton et al., 2011). Given this intricate landscape, countries must continually update and adapt their policies to effectively respond to unforeseen disruptions and their far-reaching consequences.

One foundational strategy introduced by governments to address the contemporary complex and interconnected socio-environmental challenges is economic policy—a widely studied subject. Atkinson

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and Milward (1996) define economic policy as the government's use of tools like taxes, spending, subsidies and interest rates to pursue development goals, while Viegli (2006) argues that economic policy aims for nominal and real stability through rules-based policymaking. Kowalski (2011) evaluates economic policy before and after the 2008 crisis, highlighting the need to rethink policy targets and tools in an increasingly globalized world. However, not all nations effectively improve and implement economic policies, resulting in unstable and inconsistent policy measures, known as 'Economic Policy Uncertainty' (EPU) (Rodrik, 1991). EPU refers to uncertainty surrounding government policies like fiscal, monetary, tax and regulatory policies that can significantly impact economic activity (Al-Thaqeb & Algharabali, 2019). EPU has gained increasing importance as globalization has made economies more interconnected and sensitive to policy changes, negatively affecting the economy (Trung, 2019; Cao, 2023), particularly in countries with weak institutions (Liu & Dong, 2020; Shabir et al., 2021). EPU also restricts access to finance (Farooq et al., 2023) and decreases industrial production and inflation in developing countries (Nyawo & Van Wyk, 2018), laying the foundation for further research on this relationship in the context of developing countries, including Vietnam.

Under global economic volatility, climate change has emerged as a significant factor impacting the global economy. Most analyses indicate that the long-term net impacts of climate change on the global economy will likely be negative (Bosello et al., 2006; Tol, 2009; Singh et al., 2022). Hence, governments across the globe must implement climate policies to address this imminent threat, which is fraught with uncertainty. One method to measure this uncertainty is through the 'Climate Policy Uncertainty' (CPU) index, which measures changes in government policies on environmental issues (Shang et al., 2022). CPU can negatively affect firms by delaying or postponing investments and reducing economic output (Schneider & Kuntz-Duriseti, 2002; Shang et al., 2022). However, some studies also show that CPU can have a positive effect on the economic performance of countries in the short term, depending on the institutional background (Alogoskoufis et al., 2021; Shang et al., 2022). Therefore, it is crucial to understand the influence of CPU and how to mitigate them.

While governments formulate economic and climate policies to address uncertainties, businesses can proactively tackle these challenges by embracing sustainable development. This can be achieved by integrating green activities (GAs) into their business operations. Saxena and Khandelwal (2012) found that most industries have a positive view of green practices and believe they provide a competitive advantage. Green finance (GF), one branch of GAs, involves utilizing private and public funds to support sustainable development addressing climate change, aiming to promote environmentally friendly investments and business practices (Lindenberg, 2014). Green innovation (GI), another branch of GAs, refers to the implementation of technologies and business models to promote sustainable development and reduce environmental impact (Liu et al., 2023). However, GAs face challenges, including policy gaps and regulatory barriers (Khan & Farooqui, 2021; Ozili, 2022). Policy uncertainty is one of the primary obstacles hindering the implementation of GAs in a business's operations, even though they are essential for developing countries aspiring to achieve sustainable development.

The term 'green activities' first emerged in the early 2000s when environmental concerns and sustainability considerations began to exert a more significant influence on the financial sector (Berrou et al., 2019). However, only in recent years have GAs gained significant attention. Current research mainly focuses on sustainable energy development and its connection with GF or economic development, as well as its implications for GAs (Liu et al., 2023). The majority of existing studies have already centered on the impacts of climate risks on GAs (Dutta et al., 2023; Clapp, 2014). The escalation of climate risk has prompted increased investments in alternative energy sources, fostering a heightened demand for green energy solutions (Ma et al., 2023). Similarly, the research conducted by Bouri et al. (2023) concentrates on climate uncertainties and their correlation with investment activities and green energy assets. However, a notable gap exists in the current body of research regarding the examination of the impact of policy uncertainties, particularly EPU and CPU, on GAs. Furthermore, the limited research available primarily delves into developed markets, such as the United States and China (Liu et al., 2023; Cui et al., 2023; Wang et al., 2023), leaving a gap in our understanding of these dynamics within emerging markets. By expanding the current discussion beyond the traditional focus on climate uncertainties, we aim to contribute a nuanced understanding of how policy uncertainties, specifically EPU and CPU, may deter businesses from adopting green practices in emerging economies. This approach not only broadens the

scope of existing research but also facilitates a more comprehensive assessment of the multifaceted factors influencing GAs in dynamic economic environments.

As developing countries, including Vietnam, need to incorporate GAs into research and application, there is a lack of studies evaluating the impact of policy uncertainties on these activities. Moreover, the institutional environment will affect the way businesses operate in emerging markets. In the context of Vietnam, a developing nation grappling with a multitude of policy uncertainties, timely strategies are imperative to mitigate these uncertainties and fortify the nation's socio-political system and economy. As Vietnam strives toward sustainable development, this study examines the impact of CPU and EPU on the GF and GI activities of Vietnamese listed companies during 2010–2022. CPU and EPU are assessed by standardizing the search volume index of related keywords on popular search engines, while GF and GI variables are measured by manually collecting data published by firms and normalizing the evaluation score based on predetermined sets of criteria.

This study makes three significant contributions to the existing literature. First, it provides additional evidence in emerging markets to reinforce the positive impact of CPU on GF, as well as the similar effect of EPU on GI, as previously demonstrated in studies (Lopez et al., 2017; Engle et al., 2020; Bouri et al., 2022; Pham & Cepni, 2022; Shang et al., 2022; Wang et al., 2023; Liu et al., 2023; Peng et al., 2023; Zhang et al., 2023). Second, the study finds new empirical evidence on the interaction between CPU and EPU on firms' GAs. It demonstrates the positive effects when EPU and CPU interact, affecting not only GF but also GI. Finally, the study introduces a measure of CPU and EPU in Vietnam by standardizing the search volume index of relevant keywords on popular search engines, and it offers a supplementary research dataset for evaluating GF and GI activities in Vietnam.

The remainder of this article is organized as follows. Section 2 reviews the previous studies and develops the hypotheses. The research design, variables, models, and research methods are presented in Section 3. The empirical results and discussion are reported in Section 4. Finally, Section 5 summarizes major findings and provides some recommendations.

2. Literature review and hypotheses development

In the realm of environmental economics and sustainable finance, the influence of CPU on enterprises' GAs stands as a critical area of investigation. Clapp (2014) underscores how policy risks, including those related to climate change, can have tangible economic impacts on investments, potentially leading to stranded assets that support fossil-fuel infrastructure. Additionally, Lamperti et al. (2021) shed light on the banking sector's climate sentiments and their role in shaping lending conditions for both green and brown firms. The study implies that CPU influences firm GAs through the credit channel, suggesting a direct link between policy uncertainties and financial decisions. Consequently, the combination of these references supports the hypothesis that CPU affects enterprises' GAs. However, it is crucial to acknowledge that conclusions drawn from various studies may present a mix of positive and negative outcomes, highlighting the complexity of these relationships in the literature.

Extensive research has focused on the positive relationship between CPU and corporate behavior, particularly in the context of GAs. CPU, especially during crisis periods, has been found to positively influence a firm's decision to reduce its carbon footprint (Lopez et al., 2017), make green investment decisions (Engle et al., 2020), and engage in GAs (Bouri et al., 2022). This positive correlation is supported by the study of Shang et al. (2022), which indicates the favorable impact of CPU on long-term renewable energy demand within the United States. In addition to studies that mainly focus on CPU, Dutta et al. (2023) indicate that climate risk positively influences the returns of clean energy companies while negatively impacting the volatility of clean energy assets. This suggests that an increase in climate risk motivates investors to divert their investments toward alternative energy sectors, reducing the risk associated with green energy investments.

Conversely, some researchers, particularly those examining CPU in emerging economies, have found evidence of a negative impact on GAs. Hu et al. (2023) suggest that corporate green investments can be significantly hindered, aligning with the findings of Ren et al. (2022), who emphasize the impediment of research and development investments in GAs and technological advancements related to sustainability. The uncertainty in the external environment, driven by policy changes and uncertainties, may lead to increased marginal investment costs for enterprises, reducing their willingness to invest in green

technologies and sustainable practices (Yang et al., 2022). Moreover, rising policy uncertainty is seen to increase the cost of equity and debt financing for listed enterprises, making it more challenging for them to secure funds needed for GI. Mao and Huang (2022) have shown that this kind of policy uncertainty leads firms to reduce their green patent applications only for green invention patent applications, which makes listed firms miss out on a wide range of benefits, from intellectual property protection to funding access. Meanwhile, the impact of CPU is also reported to vary across industries, with the mining industry experiencing significant negative impacts, while the production and supply of electricity, heat, gas and water sectors witness a notably positive influence (Ren et al., 2022).

Vietnam faces the substantial challenge of climate change, impacting various sectors and communities across the country. In this dynamic context, climate change poses a substantial threat, compelling the government and enterprises to respond through various strategies and policies. The Vietnamese government has been actively addressing climate change, evident in initiatives such as the National Strategy on Climate Change by 2050, aimed at proactively and effectively adapting to climate change, reducing greenhouse gas emissions to net zero, and dealing with vulnerabilities and risks caused by climate change. Furthermore, Vietnam's Action Plan on Methane Emissions Reduction by 2030 targets methane emissions in cultivation, animal husbandry, solid waste management, wastewater treatment, oil and gas exploitation, coal mining and fossil fuel consumption. These policies are aimed at encouraging businesses to innovate without unduly restricting investment or patents. Therefore, it is hypothesized that CPU still has a positive association with firms' GAs. Given the above arguments, the first research hypothesis is as follows:

H1: CPU has a positive impact on the GAs of listed enterprises.

Similarly, research on the effect of EPU on green business activities has produced conflicting results, with varying viewpoints. Pham and Cepni (2022) and Wang et al. (2023), have demonstrated how the relationship between the benefit of GAs and investor focus is significantly affected by EPU fluctuations, stock market volatility, oil prices and bond markets. Some studies suggest a positive association between EPU and GAs, including positive links with green bonds (Liu et al., 2023), firm green commitment (Zhang et al., 2023), and GI (Peng et al., 2023). Furthermore, research by Peng et al. (2023) indicates that the influence of EPU on GI varies significantly among provinces with varying degrees of marketization and trade openness. Specifically, provinces with higher levels of marketization and trade openness experience more pronounced positive effects of EPU on GI and vice versa. Similarly, Yang et al. (2022) corroborate that green patent applications increase with rising EPU, suggesting a positive effect of EPU on GAs in general.

On the contrary, other research has revealed a potential adverse connection between EPU and GAs. EPU has been found to have a significantly negative impact on green financial development efficiency (Sarpong et al., 2023), GI (Li et al., 2023; Fakher et al., 2023; Luo et al., 2023; Cui et al., 2023), GF (Wang et al., 2023) and overall firms' green behaviors (Hou et al., 2022). Additionally, research by Li et al. (2023) indicates that monetary policy uncertainty (MPU) significantly inhibits inclusive green growth (IGG) in the region. MPU inhibits IGG by reducing GF, ecological innovation, media attention and employment levels, with all four transmission mechanisms, demonstrating a masking effect. Moreover, a more nuanced perspective on the relationship between EPU and GAs emerges from studies highlighting its time-dependent nature. Pham and Nguyen (2022); Boutabba and Rannou (2022); Wei et al. (2022) demonstrate a time-varying relationship between green bonds and uncertainty. During times of severe uncertainty, such as at the beginning of the COVID-19 epidemic or the conflict between Russia and Ukraine, green bonds are heavily impacted by financial and economic policy uncertainties. In addition, Zhou and Du (2021) identify an inverted U-shaped relationship between EPU and firms' GI capability, with national macro EPU promoting GI but frequent changes in regional economic policies inhibiting it.

Vietnam, as an open economy dependent on international trade, is in a modern interconnected world where the environment, structures and economic policies through significant changes, it is highly vulnerable to fluctuations in the global economic landscape. However, Vietnam's economy has demonstrated remarkable resilience and dynamism in the face of external shocks and domestic challenges since 2008. This resilience suggests that, although Vietnam is influenced by EPU, the impacts may not be immediate, and they are controllable. For instance, the effects of the real estate crisis in China at the end of 2021 on Vietnamese real estate companies, like Novaland, only became apparent in the following year. Similarly, the collapse of major banks in the United States and key financial institutions in Switzerland did not

immediately disrupt Vietnam's banking sector, demonstrating the ability to predict and government adapt to upcoming changes. Furthermore, evidence supporting the manageable nature of EPU in Vietnam can be found in the country's trade openness and political stability. Vietnam's trade openness is associated with better results in GI (Peng et al., 2023). Additionally, the country's one-party system and 5-year economic and social development plans, decided during the National Party Congress, contribute to consistent and predictable policy direction, leading to lower EPU.

Therefore, in an environment of evolving economic policies, along with increasing focus on GAs of businesses, it is expected that EPU will have a positive impact on firms' GAs in Viet Nam. This is further emphasized when Vietnam's status as a country with an open economy to the world, and domestic policies well-controlled by the Party. In light of these arguments, the second hypothesis is proposed:

H2: EPU has a positive impact on the GAs of listed enterprises.

Despite a substantial body of literature on EPU and CPU separately, there remains a notable gap in our understanding of how these uncertainties interact and jointly influence a firm's GAs. Lamperti et al. (2021) suggest that when banks adhere to eco-friendly rules, akin to green Basel-type requirements, it enhances productivity and contributes to economy grow. On the other hand, incorporating adjustments for carbon risk and offering guarantees for green (public) credits not only help reduces emissions but also creates a safety net for the economy, rendering it less susceptible to negative impacts. This hints at the possibility that the joint effects of CPU and EPU can positively influence companies' GAs through financial regulation mechanisms. Drawing from the arguments above, both EPU and CPU are expected to exert a positive influence on firms' GAs. Consequently, the interaction between EPU and CPU is also anticipated to have a positive impact on the GAs of businesses in Vietnam. In conjunction with the limited existing literature and the affirmative nature of *H1* and *H2*, we propose the following third hypothesis:

H3: The joint effects of CPU and EPU have a positive influence on the GAs of listed enterprises.

3. Research design

3.1. Data and sampling

The initial sample consists of a total of 774 enterprises listed on the two most prominent stock exchanges in Vietnam, the Ho Chi Minh Stock Exchange (HOSE) and the Hanoi Stock Exchange (HNX), from 2010 to 2022. However, a subset of approximately one-third of the initially collected data was excluded from the research sample for various justifiable reasons. Firms operating within the banking and finance sectors were removed due to their distinct operational scale and management policies, which markedly differ from those of other businesses. This exclusionary measure was taken to preserve the objectivity and homogeneity of the study. Furthermore, any firms that did not disclose sufficient information on their financial statements or annual reports against the criteria established for this study were also removed to ensure a consistent standard of data quality and completeness. The secondary data, including firms' financial statements and annual reports used in the study, were provided by the FiinPro database. Additionally, to mitigate the influence of outliers, the research winsorizes the variables at the 1st and 99th percentiles. After this process, the final sample comprises 515 companies, corresponding to 6695 observations spanning the period from 2010 to 2022 (Table 1).

3.2. Empirical models and variables Definitions

To assess the impact of EPU and CPU on the GAs, we run the regression models of Ordinary Least Square (OLS), Fixed Effect Model (FEM), Random Effect Model (REM), System Generalized Method of

Table 1. Sample selection.

Total number of listed companies	774
(1) Eliminate companies in the banking and finance industry	148
(2) Eliminate companies that do not have enough information on annual reports and financial statements	111
Total number of remaining companies	515
The ratio of the sample to the total number of original samples	66.54%

Moments (SGMM) and relevant statistical tests for Equations (1–3) as follows. Model (1) and (2) are used to test the influence of CPU and EPU on firms' GAs, respectively, while model (3) is applied to examine the joint effects between CPU and EPU on firms' GAs.

$$GA_{it} = \alpha_0 + \alpha_1 GA_{it-1} + \alpha_2 CPU_t + \alpha_3 SO_{it} + \alpha_4 REV_{it} + \alpha_5 LEV_{it} + \alpha_6 LIQ_{it} + \alpha_7 AGE_{it} + \alpha_8 ROA_{it} + \alpha_9 RM_{it} + e_{it} \quad (1)$$

$$GA_{it} = \alpha_0 + \alpha_1 GA_{it-1} + \alpha_2 EPU_t + \alpha_3 SO_{it} + \alpha_4 REV_{it} + \alpha_5 LEV_{it} + \alpha_6 LIQ_{it} + \alpha_7 AGE_{it} + \alpha_8 ROA_{it} + \alpha_9 RM_{it} + e_{it} \quad (2)$$

$$GA_{it} = \alpha_0 + \alpha_1 GA_{it-1} + \alpha_2 CPU_t + \alpha_3 EPU_t + \alpha_4 C*E_t + \alpha_5 SO_{it} + \alpha_6 REV_{it} + \alpha_7 LEV_{it} + \alpha_8 LIQ_{it} + \alpha_9 AGE_{it} + \alpha_{10} ROA_{it} + \alpha_{11} RM_{it} + e_{it} \quad (3)$$

where the subscript i and t represent firm i and year t .

The dependent variable GAs is measured by two indexes: GF (GF) and GI. The two indexes are measured by manually collecting data published by firms and normalizing the evaluation score based on pre-determined sets of criteria. The criteria will be scored on a scale of 0 or 1. Enterprises that do not declare information will be assigned a score of 0, while those providing qualitative information regarding the criteria will receive a score of 1. The criteria used in the GF index are based on established and recognized indicators of green bonds, carbon pricing, renewable energy capacity, green loans, and sustainable finance commitment. The criteria used in the GI index are based on established and recognized indicators of green products, green processes, green marketing (GMKT) and investment in green research and development (Table 2).

For the independent variables, CPU and EPU for each research year are measured by standardizing the search volume index of related keywords using tools Google Trends and Glimpse. The selected keywords are random variations, grouped according to the synonym formula of '(1) climate/economic + (2) policy + (3) uncertainty'. In this study, the CPU-relevant keywords refer to climate policy, environmental

Table 2. Green innovation indicator.

Category	No	Criteria	Description
Green Product	1	DSP1	Enterprises prioritize the use of less polluting materials
	2	DSP2	Enterprises prioritize the use of materials that consume fewer resources and energy
	3	DSP3	Enterprises use the least number of raw materials to create products
	4	DSP4	Enterprises will consider the product's recycling before proceeding with production
	5	DSP5	Enterprises will consider the reuse of products before proceeding with production
	6	DSP6	Enterprises will consider the decomposition of products before proceeding with production
	7	DSP7	Enterprises are often the first to bring green products to the market
	8	DSP8	Enterprises improve environmentally friendly packaging for products
	9	DSP9	Enterprises use recyclable/reusable packaging
	10	DSP 10	Enterprises have a vision to develop sustainably
Green Process	11	DQT1	Enterprise's production process reduces harmful substances
	12	DQT2	wastewater
	13	DQT3	Enterprise's production process reduces emissions
	14	DQT4	Enterprise's production process reduces noise
	15	DQT5	Wastewater from the production process of enterprises is treated to meet standards
	16	DQT6	Wastewater from the production process after being treated is reused by enterprises
	17	DQT7	Your production process reduces the consumption of raw materials (water, electricity, coal, or oil)
	18	DQT8	Enterprises apply energy conservation technologies
	19	DQT9	Enterprises apply renewable resource technologies
	20	DQT10	Enterprises apply industrial waste recycling technologies
Green Marketing	21	DQT11	Enterprises apply technologies in the process of preventing pollution
	22	GM1	The use of environmentally friendly logos, slogans, and packaging, as well as the use of eco-certifications and labels.
	23	GM2	Advertising budget allocated to green advertising, the number of green advertising campaigns, and the reach of green advertising campaigns.
Green Investment	24	GM3	Which a firm is sponsoring environmentally sustainable events and initiatives
	25	GRD1	Firms allocate investment in research and development of environmentally sustainable technologies

regulations, and government actions concerning climate change. The EPU-relevant keywords refer to economic policies, fiscal regulations, trade agreements and major economic events. The interaction variable C^*E is constructed based on the product between the two variables CPU and EPU.

$$C * E_t = CPU_t * EPU_t \quad (i)$$

Along with dependent and independent variables, all the controlling variables are presented in Table 3.

4. Results and discussion

4.1. Descriptive Statistics

Table 4 presents descriptive statistics for twelve distinct variables, denoted as GF, GI, CPU, EPU, C^*E , LEV, SO, AGE, REV, LIQ, ROA and RM. The total sample size for all variables comprises 6695 observations.

The variable GF spans values from 0 to 0.714, with a calculated mean of 0.033 and a corresponding standard deviation of 0.087. These statistics indicate a modest presence of GF activities within the research sample, signifying that only a fraction of firms are involved in such practices. The variable of GI, representing GI, exhibits values ranging from 0 to 1, with a mean value of 0.033 and a standard deviation of 0.131. These figures suggest that the prevalence of GI activity among the firms in our sample is relatively low, with only a minority of firms actively engaging in GI endeavors.

Regarding policy uncertainty variables, CPU exhibits values ranging from 0 to 1, with a computed mean of 0.197 and a standard deviation of 0.267. This data pattern highlights the relatively low attention directed toward CPU during the period from 2010 to 2022. This is evidenced by the substantial number of Google searches related to this topic, indicating a lower level of concern among the firms. In contrast, the EPU variable demonstrates positive values ranging from 0.021 to 1, with a mean of 0.273 and a standard deviation of

Table 3. Definitions of the variables in regression models.

No	Variables	Description
Dependent variable		
1	GF	Green finance
2	GI	Green innovation
Independent and	Interaction variables	
3	CPU	Climate policy uncertainty
4	EPU	Economic policy uncertainty
5	C^*E	The interaction between CPU and EPU
Firm-level controlling variables		
6	SO	State Ownership—Proportion of state ownership or state-controlled organizations in the firm
7	LEV	Total debt divided by total equity
8	REV	Natural logarithm of revenue
9	AGE	Natural logarithm of years since the business was established
10	LIQ	Current assets divided by current liabilities
11	ROA	Net income divided by total assets
12	RM	Risk Management—A dummy variable, taking the value of 1 in the following cases and 0 otherwise: 1. The firm has a Risk Management Board/Risk Committee 2. The firm has the position of Director of Risk Management/Chief Risk Officer 3. The firm has stated a clear Risk Map

Table 3 presents the detailed calculations for each variable identified in our models as discussed in the Empirical Models section above.

Table 4. Descriptive statistics.

Variables	Obs	Mean	Std. Dev	Min	Max
GF	6695	0.033	0.087	0	0.714
GI	6695	0.033	0.130	0	1
CPU	6695	0.196	0.267	0	1
EPU	6695	0.272	0.278	0.021	1
C^*E	6695	0.122	0.282	0	1
LEV	6695	1.502	1.679	0	13.751
SO	6695	0.250	0.257	0	1
AGE	6695	3.131	0.692	0	4.356
REV	6695	27.140	1.690	17.752	33.348
LIQ	6695	2.149	2.008	0	15.811
ROA	6695	0.068	0.082	−0.624	0.8122
RM	6695	0.183	0.386	0	1

Table 4 presents descriptive statistics of the variables used in the study. The definitions of these variables are provided in Table 3.

Table 5. Correlation matrix.

	GF	GI	CPU	EPU	C*E	SO	LEV	AGE	REV	ROA	LIQ	RM
GF	1											
GI	0.256 **	1										
CPU	0.177 **	0.032 **	1									
EPU	0.208 **	0.041 **	0.931 **	1								
C*E	0.169 **	0.028 **	0.987 **	0.92 **	1							
SO	−0.01 ***	−0.05 ***	−0.06 ***	−0.06 ***	−0.06 ***	1						
LEV	−0.18 ***	−0.07 ***	−0.04 ***	−0.04 ***	−0.03 ***	0.049 ***	1					
AGE	−0.01 ***	0.005 ***	−0.02 ***	0.056 ***	−0.08 ***	0.183 ***	0.115 ***	1				
REV	0.123 ***	0.118 ***	0.071 ***	0.084 ***	0.064 ***	0.080 ***	0.221 ***	0.155 ***	1			
ROA	0.043 ***	0.072 ***	−0.07 ***	−0.09 ***	−0.06 ***	0.063 ***	−0.33 ***	−0.05 ***	0.076 ***	1		
LIQ	0.018 ***	0.025 ***	0.044 ***	0.044 ***	0.039 ***	−0.02 ***	−0.38 ***	−0.06 ***	−0.29 ***	0.288 ***	1	
RM	0.084 ***	0.014 ***	0.082 ***	0.116 ***	0.080 ***	0.032 ***	−0.04 ***	0.141 ***	0.085 ***	0.031 ***	0.021 ***	1

Table 5 presents the correlation coefficient results of the variables used in the study. The definitions of these variables are provided in Table 3. The symbols **, *** indicate statistical significance at 5%, and 1%, respectively. The definitions of these variables are provided in Table 3.

0.278. This dataset reflects a moderate level of public awareness concerning EPU in Vietnam during the specified time frame, suggesting diversity in people's perceptions of this aspect. Regarding the C*E variable, which represents the combined influence of CPU and EPU on GF and GI, it displays relatively high values ranging from 0 to 1. The mean value for this variable is 0.123, accompanied by a standard deviation of 0.282.

The AGE variable represents the number of years of establishment of the business, with an average of 3.131, corresponding to an average age of 23 years. The youngest enterprise in the sample has been established for 5 years, while the oldest enterprise is 75 years old. Vietnamese listed companies are relatively young compared to other countries and often equitized from state-owned enterprises. The REV variable shows differences in company revenue, with an average value of 27.141, corresponding to total assets of VND 754.257 billion. This variation can be explained by the diverse industries and business fields from which observed firms come. The mean value of the LEV variable is 1.503, considered a safe threshold for all businesses. The SO variable spans values from 0 to 1, with a mean of 0.251 and a standard deviation of 0.257. This variable quantifies the extent of government ownership in a given firm, with higher values indicating a larger government stake. The LIQ variable ranges from 0 to 15.81, bearing a mean of 2.149 and a standard deviation of 2.008. This variable assesses a firm's ability to meet its short-term obligations, with higher values indicating enhanced liquidity and reduced default risk. The ROA variable encompasses values spanning from −0.625 to 0.812, with a mean of 0.068 and a standard deviation of 0.082. This variable measures a firm's profitability, with higher values denoting superior profitability. The wide range observed in ROA values underscores significant variability in profitability among firms within the sample. The RM variable spans values from 0 to 1, with a mean of 0.183 and a standard deviation of 0.386. This reflects that risk management activities in businesses in Vietnam are still not a primary focus, and there is still much potential to improve operations quality in the future.

Table 5 shows the correlation coefficient results between variables in the models (1), (2) and (3) from the Pearson test. Both CPU and EPU have a positive impact on GAs, encompassing GF and GI, which is in line with our expectations. Furthermore, all independent variables exhibit correlation coefficients lower than 0.3, demonstrating the absence of collinearity in models (1), (2) and (3).

4.2. The impact of climate policy uncertainty on the green activities of Vietnamese listed companies

To assess the influence of CPU on the GAs of listed companies, we employ regression models using OLS, FEM, REM and SGMM, examining both GF and GI. Following the OLS regression, the model

Table 6. Regression results for the impact of climate policy uncertainty on the green activities of Vietnamese listed companies during 2010–2022.

Variable	Green finance (GF)					Green innovation (GI)				
	OLS	REM	FEM	SGMM	VIF	OLS	REM	FEM	SGMM	VIF
$GA_{it(t-1)}$				1.571 *** (9.39)					0.992 *** (365.91)	
CPU	0.052 *** (12.66)	0.051 *** (16.84)	0.044 *** (12.99)	0.022 *** (2.58)	1.03	0.081 * (1.59)	0.073 (3.01)	0.0525 (2.04)	0.0003 (0.88)	1.03
SO	−0.001 (−0.12)	0.002 (0.03)	0.002 (0.27)	0.013 * (1.88)	1.05	−0.028 *** (−4.35)	−0.007 *** (−1.69)	−0.006 *** (−1.42)	−0.0004 (−0.26)	1.05
LEV	−0.005 *** (−7.31)	−0.003 *** (−3.28)	−0.002 * (−1.64)	−0.001 (−0.10)	1.30	−0.006 *** (−5.68)	−0.001 (−0.82)	−0.001 (−0.21)	−0.0001 (−0.33)	1.30
REV	0.007 *** (10.06)	0.008 *** (7.04)	0.007 *** (4.84)	0.005 *** (2.55)	1.21	0.019 *** (10.49)	0.003 *** (3.78)	0.002 * (2.42)	0.0002 (0.92)	1.21
AGE	−0.003 * (−2.01)	0.008 *** (3.31)	0.026 *** (6.02)	0.006 *** (2.66)	1.08	0.001 (0.42)	0.011 *** (4.36)	0.017 *** (5.31)	0.0003 (0.64)	1.08
ROA	0.004 (0.32)	−0.034 ** (−2.47)	−0.027 * (−1.87)	−0.131 ** (−2.01)	1.24	0.050 * (2.23)	−0.039 *** (−3.60)	−0.036 *** (−3.28)	−0.006 (−0.81)	1.24
LIQ	0.001 (0.61)	0.001 (0.36)	−0.001 (−0.33)	−0.002 (−0.86)	1.31	0.001 * (1.93)	0.002 (0.43)	0.002 (0.10)	0.0003 (0.61)	1.31
RM	0.013 *** (4.72)	0.010 *** (3.01)	0.008 ** (2.38)	0.004 (0.64)	1.04	−0.001 (−0.18)	0.003 (1.22)	0.003 (1.14)	0.001 (1.27)	1.04
Constant	−0.156 *** (−8.06)	−0.224 *** (−7.14)	−0.254 *** (−6.67)	−0.110 ** (−2.34)		−0.272 *** (−9.21)	−0.107 *** (−3.82)	−0.095 *** (−3.29)	−0.005 (−0.68)	
Obs.	6695	6695	6695			6695	6695	6695		
R ²	0.2586	0.2451	0.2199			0.2279	0.2154	0.2116		
F – test		Prob > F = 0.0000					Prob > F = 0.0000			
Hausman		Prob > chi2 = 0.0000					Prob > chi2 = 0.0016			
AR(2)			0.354					0.776		
Hansen			0.649					0.534		

Table 6 presents regression results for the impact of CPU on the green activities of listed companies Equation (1). The definitions of these variables are provided in Table 3. The symbols *, **, *** indicate statistical significance at 10%, 5% and 1%, respectively.

undergoes testing for autocorrelation and heteroskedasticity. The results indicate the presence of endogeneity in the model. To address this issue, FEM and REM regressions are implemented to control for endogenous variables and create a dynamic framework within the models. However, the resulting estimates exhibit biased and are subject to disconfirmation due to variables that are not entirely exogenous. Therefore, to solve the endogeneity problem, our research models are regressed using the two-step GMM technique with the first lag as a tool to satisfy statistical requirements (Arellano & Bond, 1991).

Table 6 presents the results on the impact of CPU on the GAs of Vietnamese-listed companies during the period from 2010 to 2022. The Variance Inflation Factor (VIF) values remain within an acceptable range, all being less than 2, indicating no issues with multicollinearity. As the final result, SGMM is deemed the most appropriate regression system for these models.

The regression results presented in Table 6 reveal that CPU has a positive impact on GF within publicly listed companies in Vietnam during the period spanning from 2010 to 2022. These findings align with prior studies conducted by Lopez et al. (2017), Engle et al. (2020), Bouri et al. (2022), and Shang et al. (2022), lending partial support to hypothesis 1 positing a positive correlation between CPU performance and GAs in Vietnam. The regression coefficient between the two variables, CPU and GF stands at 0.022, signifying a remarkably high level of statistical significance at 1%. This result indicates that as CPU exhibits greater fluctuations, it correspondingly incentivizes businesses to engage more extensively in green financial activities. In the Vietnamese context, the positive relationship observed between CPU and GF can be attributed to several factors. As CPU levels increase, companies often anticipate more strict climate regulations in the future. This anticipation encourages businesses in Vietnam to proactively invest in GF, aligning their strategies with potential upcoming regulations, reducing risks and securing a competitive advantage in the evolving market. Additionally, the growing public awareness and concern about climate change drive consumer and investor preferences toward environmentally responsible products and services. Companies adopt green practices, particularly in GF, to meet this demand and position themselves as environmentally conscious enterprises. Furthermore, as CPU rises, access to green funding may become more readily available, with financial institutions and investors showing increased interest in green initiatives, supporting companies' investments in sustainable projects.

However, the research has not found evidence to prove the impact of the CPU on GI activities in Vietnam. This can be explained by the fact that fluctuations in climate response policies are not sufficient to encourage businesses to invest in innovative activities aimed at green objectives. Listed companies in Vietnam have only gone as far as accessing green financial resources provided by financial institutions or mobilizing green capital for their businesses to adapt to climate change. Furthermore, the research also demonstrates that companies with a longer operating history or robust risk management systems are more likely to participate in green initiatives. Conversely, a high level of state ownership, financial leverage and a substantial return on assets have adverse associations with GAs in Vietnamese listed companies.

In light of the potential differences between the Vietnamese stock market and other developed markets, CPU can still exert a significant impact on firms' GAs, both in Vietnam and in developed countries. On the one hand, in the context of Vietnam, as proven, CPU can positively influence the GAs of businesses for various reasons. On the other hand, in developed countries, CPU has been observed to have a positive effect on Environmental, Social, and Governance (ESG) performance, but a negative impact on firm performance and carbon dioxide emission performance (Persakis, 2023). This implies that while firms may be motivated to enhance their ESG performance in response to CPU, this uncertainty can also lead to decreased overall firm performance and increased carbon emissions. In both contexts, it is evident that CPU can pose challenges for firms' GAs. However, the specific impacts can vary depending on the economic, social, and environmental context of the country. Policymakers should take these factors into account when designing and implementing climate policies.

4.3. The impact of economic policy uncertainty on the green activities of Vietnamese listed companies

Table 7 displays the regression results regarding the impact of EPU on the GAs of listed companies on the Vietnamese stock market. The VIF values fall within an acceptable range (all less than 2), indicating the absence of multicollinearity issues. Furthermore, the results reveal that SGMM emerges as the preferred approach for investigating the impact of EPU on both GF and GI.

In contrast to the impact of the CPU on a company's GAs, the results from Table 7 reveal that changes in EPU have a positive influence solely on GI activities and do not affect GF in listed companies in Vietnam from 2010 to 2022. The regression coefficient is 0.021, with statistical significance at the 10% level, once again demonstrating consistency with the research findings of Yang et al. (2022), Peng et al. (2023), and Zhang et al. (2023). These results also provide partial support for research hypothesis 2, suggesting that the greater the variability in EPU, the more it stimulates Vietnamese companies to engage in GI activities.

Companies operating in Vietnam often regard changes in economic laws and policies as indicators of potential shifts in economic regulations and market dynamics. In response, they proactively integrate GI into their business models, viewing these strategies as a means to adapt to evolving economic conditions and mitigate overall risk. Furthermore, the increase in EPU may signal a transforming market landscape, prompting businesses to embrace sustainability as a competitive advantage. This is particularly relevant as environmentally conscious consumers and investors gain prominence. Additionally, during periods of EPU, financial institutions and investors may prioritize green initiatives, increasing the availability of capital for GI. Overall, the positive influence of EPU on GI highlights the strategic response of Vietnamese companies to navigate economic uncertainty through sustainable innovation.

EPU can have a significant influence on businesses' GAs, whether in developed or developing nations, considering the potential distinctions between the Vietnamese stock market and other markets. As indicated in the literature, escalating EPU can stimulate the improvement of enterprises' GI capabilities. The impact of EPU on GI become more obvious for firms with low financing constraints and limited financialization (Zhou et al., 2022). In developed countries, the effect of EPU on firms' GAs can vary. For instance, in a panel study of 18 developed economies, it was found that high levels of EPU have a significant influence on CO₂ emissions only in high-polluting countries but not in low-polluting ones (Vitenu-Sackey & Acheampong, 2022). This suggests that the impact of EPU on firms' GAs may hinge on the specific environmental context of the country. Therefore, in both contexts, EPU can create opportunities for

Table 7. Regression results for the impact of economic policy uncertainty on the green activities of Vietnamese listed companies.

Variable	Green Finance (GF)					Green Innovation (GI)				
	OLS	REM	FEM	SGMM	VIF	OLS	REM	FEM	SGMM	VIF
$GA_{it(t-1)}$				1.013*** (19.49)					0.996*** (443.03)	
EPU	0.060* (15.12)	0.060 (20.33)	0.058 (16.48)	0.008 (2.18)	1.05	0.011* (1.86)	0.010*** (4.01)	0.078*** (2.90)	0.021* (1.64)	1.05
SO	0.001 (0.23)	0.003 (0.73)	0.005 (0.85)	0.009* (1.79)	1.05	-0.028*** (-4.29)	-0.006*** (-1.53)	-0.005*** (-1.30)	0.0002 (0.10)	1.05
LEV	-0.005*** (-6.93)	-0.002*** (-2.74)	-0.001 (-1.58)	-0.002* (-1.85)	1.31	-0.006*** (-5.61)	-0.001 (-0.74)	-0.001 (-0.19)	-0.00002 (-0.09)	1.31
REV	0.006*** (9.61)	0.007*** (6.20)	0.007*** (4.82)	-0.001 (-0.51)	1.22	0.011*** (10.39)	0.004*** (3.64)	0.003*** (2.50)	-0.0003 (-1.29)	1.22
AGE	-0.004*** (-2.71)	0.002 (1.08)	0.009** (2.15)	0.002 (0.95)	1.08	0.001 (0.34)	0.009*** (3.45)	0.015*** (4.25)	0.0002 (0.32)	1.08
ROA	0.016 (1.09)	-0.017 (-1.26)	-0.018 (-1.30)	-0.068* (-1.67)	1.25	0.052** (2.34)	-0.037*** (-3.37)	-0.035*** (-3.17)	-0.001 (-0.10)	1.25
LIQ	0.001 (0.29)	-0.001 (-0.02)	-0.001 (-0.30)	-0.001 (-0.34)	1.31	0.002* (1.87)	0.002 (0.37)	0.002 (0.10)	-0.001* (-1.61)	1.31
RM	0.011*** (4.15)	0.005 (1.50)	0.003 (1.08)	0.008** (1.94)	1.04	-0.001 (-0.27)	0.002 (0.86)	0.002 (0.88)	0.001* (1.44)	1.04
Constant	-0.150*** (-7.79)	-0.188*** (-6.00)	-0.207*** (-5.45)	0.013** (2.34)		-0.270*** (-9.15)	-0.099*** (-3.50)	-0.088*** (-3.01)	0.008 (1.08)	
Obs.	6695	6695	6695			6695	6695	6695		
R ²	0.268	0.259	0.247			0.228	0.216	0.252		
F-test		Prob > F = 0.0000						Prob > F = 0.0000		
Hausman		Prob > chi2 = 0.0025						Prob > chi2 = 0.0015		
AR(2)			0.208					0.978		
Hansen			0.127					0.515		

Table 7 presents regression results for the impact of EPU on the green activities of listed companies Equation (1). The definitions of these variables are provided in Table 3. The symbols *, **, *** indicate statistical significance at 10%, 5%, and 1%, respectively.

firms' GAs. However, the specific effects can fluctuate depending on the economic, social, and environmental circumstances of the country.

4.4. The joint effects of climate policy uncertainty and economic policy uncertainty on green activities in Vietnamese listed companies

In addition to examining the individual influence of the CPU or EPU on GAs within enterprises, a question arises whether the simultaneous variation of both CPU and EPU promotes GAs in Vietnamese businesses. Therefore, we generate the interaction variable C*E by multiplying CPU with EPU. Table 8 presents regression results from OLS, FEM, REM, and SGMM methods, addressing the combined impact of CPU and EPU on both GF and GI in Vietnamese listed companies for the period 2010-2022. The SGMM model continues to be the most appropriate model to address Equation (3), with no issues of multicollinearity, as all VIF values remain below 2.

In the context of the two previous hypotheses, if the research only discovers evidence of either CPU or EPU influencing one of the two green business activities, namely GF or GI, then when both climate policy and economic policy experience fluctuations simultaneously, they impact both GF and GI. The findings from Table 8 demonstrate that the regression coefficients between CPU, EPU or C*E and GF and GI are consistently positive and statistically significant, ranging from 10% to 1%. This indicates that in Vietnam when changes in climate and economic policies coincide, it serves as a signal for businesses to consider shifting their business strategies towards sustainable development.

Furthermore, the convergence of these two forms of uncertainty prompts businesses to anticipate regulatory shifts and economic risks, compelling them to make proactive investments in green strategies. This intersection implies a shared emphasis on regulatory priorities, encouraging a commitment to sustainability practices. Additionally, it stimulates resource optimization and bolsters the market's receptiveness to green products and services. In summary, the interplay between CPU and EPU in Vietnam encourages companies to embrace environmentally sustainable practices as a strategic response

Table 8. Regression results for the joint effects of climate policy uncertainty and economic policy uncertainty on the green activities of Vietnamese listed companies.

Variable	Green Finance (GF)				Green Innovation (GI)				
	OLS	REM	FEM	SGMM	OLS	REM	FEM	SGMM	
GA _{it(t-1)}				1.567*** (4.91)				0.997*** (388.20)	
CPU	0.021* (1.77)	0.021* (1.50)	0.019* (1.80)	0.050* (1.58)	0.007* (1.70)	0.028** (1.95)	0.025* (1.78)	0.012** (2.27)	
EPU	0.098*** (9.06)	0.097*** (12.41)	0.095*** (11.31)	0.063*** (5.05)	0.031* (1.84)	0.021*** (3.50)	0.018*** (2.90)	0.005*** (2.74)	
C*E	0.061** (2.50)	0.057*** (3.36)	0.054*** (3.12)	0.008* (1.39)	0.028 (0.76)	0.038*** (2.90)	0.034*** (2.59)	0.008** (2.12)	
SO	0.002 (0.37)	0.005 (0.99)	0.006 (1.08)	0.006 (0.90)	−0.027*** (−4.25)	−0.006 (−1.40)	−0.005 (−1.18)	−0.00006 (−0.04)	
LEV	−0.004*** (−6.67)	−0.002** (−2.44)	−0.001 (−1.48)	0.002 (0.90)	−0.006*** (−5.51)	−0.002 (−0.58)	−0.001 (−0.11)	−0.00007 (−0.31)	
REV	0.006*** (9.45)	0.007*** (5.95)	0.007*** (4.89)	0.003 (1.02)	0.013*** (10.33)	0.004 (3.55)	0.003** (2.43)	0.0005** (2.01)	
AGE	−0.006*** (−3.38)	−0.001 (−0.44)	0.001 (0.23)	0.005* (1.50)	0.002 (0.10)	0.006 (2.24)	0.011*** (2.92)	0.0006 (0.77)	
ROA	0.021 (1.39)	−0.012 (−0.84)	−0.016 (−1.10)	−0.073 (−0.99)	0.055** (2.43)	−0.036 (−3.25)	−0.035*** (−3.14)	−0.010 (−1.12)	
LIQ	0.001 (0.19)	−0.001 (−0.15)	−0.001 (−0.28)	−0.002 (−1.15)	0.002** (1.84)	0.002 (0.30)	0.002 (0.08)	0.002*** (2.76)	
RM	0.011*** (3.97)	0.003 (0.97)	0.002 (0.55)	0.006 (0.76)	−0.001 (−0.33)	0.001 (0.65)	0.002 (0.70)	0.0004 (0.37)	
Constant	−0.151*** (−7.84)	−0.17*** (−5.61)	−0.190*** (−4.98)	−0.046 (−0.76)	−0.270*** (−9.15)	−0.092*** (−3.24)	−0.080*** (−2.74)	−0.017** (−2.08)	
Obs.	6695	6695	6695		6695	6695	6695		
R ²	0.271	0.264	0.259		0.228	0.218	0.213		
F-test		Prob > F = 0.0000				Prob > F = 0.0000			
Hausman		Prob > chi2 = 0.0349				Prob > chi2 = 0.0418			
AR(2)			0.245				0.973		
Hansen			0.482				0.880		

Table 8 presents regression results for the impact of CPU and EPU on the green activities of listed companies Equation (3). The definitions of these variables are provided in Table 3. The symbols *, **, *** indicate statistical significance at 10%, 5% and 1%, respectively.

to a complex policy landscape, ultimately promoting both economic resilience and effective environmental management.

4.5. Supplementary analysis

To extend our analysis for the impact of CPU and EPU on GAs, we introduce a new dependent variable, green management (GM). GM involves implementing eco-friendly practices and policies in a company's operation. It comprises five main components: Green Operation (GO), GMKT, Green Purchasing (GP), Green Supply Chain (GSC) and Internal Environment Management (IEM) (Sezen & Çankaya, 2013; Paul et al., 2014; Raut et al., 2019; Nguyen et al., 2021). Each component has specific criteria evaluated on a scale of 0 or 1. Companies that do not disclose information receive a score of 0, while those providing qualitative information get a score of 1. The GM score is the average score of 23 criteria across the five components.

Table 9 presents regression results for CPU and EPU's impacts on the GM variable in Vietnamese listed companies from 2010 to 2022, using OLS, FEM, REM, and SGMM methods. The SGMM model remains the most suitable choice, with no multicollinearity issues (VIF values all below 2). The results in Table 9 also confirm that both CPU and EPU, along with their interaction, affect GM, supporting our three hypotheses. However, GM's regression results in the SGMM method show a lower level of statistical significance (10%) compared to GI and GF. This complexity arises from GM's more intricate evaluation criteria, encompassing some content of GI and GF.

Amid CPU, companies may adopt GM to prepare for potential regulations and mitigate climate risks, taking advantage of investment considerations and new market opportunities. Enhanced reputation and branding, along with operational efficiencies, are additional incentives. Similarly, EPU may drive companies to proactively adopt GM, particularly as a risk mitigation strategy. Companies with weaker government connections and greater monopoly power may deviate from green technology innovation. The

Table 9. Regression results for the impact of CPU and EPU on the green management of Vietnamese listed companies.

	Impact of CPU on GM				Impact of EPU on GM				Impact of EPU and CPU on GM			
	OLS	REM	FEM	GMM	OLS	REM	FEM	GMM	OLS	REM	FEM	GMM
GM_{it-1}				4.678*** (5.67)				3.460*** (9.45)				6.555*** (4.11)
CPU	0.241 (48.67)	0.230* (49.16)	0.201** (40.04)	0.250* (1.58)								0.156* (4.91)
EPU					0.269*** (61.77)	0.264*** (63.21)	0.253*** (52.55)	0.278* (2.39)	0.036* (1.60)	0.038* (1.65)	0.041* (1.62)	0.197* (4.91)
C*E									0.372*** (33.28)	0.367*** (35.25)	0.362*** (31.64)	0.268* (4.67)
SO	0.003 (0.66)	-0.006 (-0.93)	-0.017* (-1.87)	-0.023* (0.90)	0.009* (1.92)	0.005 (0.81)	0.0008 (0.10)	-0.006*** (-1.53)	0.010** (2.24)	0.008 (1.30)	0.006 (0.70)	-0.028*** (-4.29)
LEV	-0.003*** (-3.56)	-0.004*** (-3.37)	-0.002 (-1.18)	0.022** (0.91)	-0.002** (-2.14)	-0.001 (-1.62)	-0.001 (-0.80)	-0.001 (-0.74)	0.002*** (3.19)	-0.001 (-1.52)	-0.001 (-0.43)	-0.006*** (-5.61)
REV	0.004*** (4.77)	0.006*** (4.71)	0.007*** (2.72)	0.203** (2.02)	0.003*** (3.58)	0.004*** (2.97)	0.005** (2.07)	0.004*** (3.64)	0.002*** (3.19)	0.003** (2.40)	0.004* (1.93)	0.011*** (10.39)
AGE	0.014*** (6.39)	0.029*** (8.60)	0.096*** (13.78)	0.015* (2.50)	0.006*** (3.15)	0.010*** (3.11)	0.026*** (3.81)	-0.006*** (-3.38)	0.004** (2.02)	0.003 (0.99)	-0.0004 (-0.05)	0.001 (0.34)
ROA	-0.073*** (-4.11)	-0.115*** (-5.67)	-0.106*** (-4.53)	-0.123 (-0.89)	-0.026 (-1.57)	-0.054*** (-2.92)	-0.065*** (-3.03)	0.021 (1.39)	-0.013 (-0.79)	-0.037** (-1.99)	-0.053** (-2.51)	0.052** (2.34)
LIQ	0.0003 (0.41)	0.002* (1.77)	0.002* (1.90)	-0.003** (-1.15)	-0.0005 (-0.65)	0.001 (0.91)	0.002 (1.54)	0.001 (0.19)	-0.001 (-0.81)	0.001 (0.79)	0.002 (1.59)	0.002* (1.87)
RM	0.167*** (5.53)	0.032*** (8.08)	0.048*** (9.55)	0.016* (0.76)	0.009*** (3.36)	0.019*** (5.22)	0.030*** (6.48)	0.011*** (3.97)	0.008*** (2.75)	0.016*** (4.33)	0.025*** (5.48)	-0.001 (-0.18)
Constant	-0.141*** (-6.02)	-0.239*** (-6.96)	-0.480*** (-7.56)	-0.146** (-0.76)	-0.110*** (-5.15)	-0.146*** (-4.44)	-0.229*** (-3.91)	-0.151*** (-7.84)	-0.112*** (-5.31)	-0.124*** (-3.79)	-0.156*** (-2.67)	-0.272*** (-9.21)
Obs.	6695	6695	6695	6695	6695	6695	6695	6695	6695	6695	6695	6695
R ²	0.374	0.364	0.259		0.478	0.477	0.460		0.491	0.491	0.486	
F-test		Prob > F = 0.0000				Prob > F = 0.0000				Prob > F = 0.0000		
Hausman		Prob > chi2 = 0.0000				Prob > chi2 = 0.0000				Prob > chi2 = 0.0573		
AR(2)		0.866				0.568				0.767		
Hansen		0.467				0.644				0.589		

Table 9 presents regression results for the effects of CPU and EPU on the green management of Vietnamese listed enterprises. The symbols *, **, *** indicate statistical significance at 10%, 5% and 1%, respectively.

intersection of these uncertainties compels companies to invest proactively in green solutions, promoting sustainable practices, resource optimization, and consumer interest in eco-friendly goods and services. In Vietnam, the interplay between CPU and EPU encourages ecologically friendly practices, fostering economic resilience and effective environmental management.

4.6. Robustness check

To check the robustness of the models for the three hypotheses, we adjust the calculation methods for the variables CPU, EPU and the interaction variable C*E. For the two first hypotheses, two new variables, 'Change in CPU' (CC) and 'Change in EPU' (CE) are introduced to replace CPU and EPU, respectively, to utilize data encompassing two consecutive years. This is calculated by subtracting the figures from the later year from those of the earlier year, effectively capturing the annual change. The equations for CC and CE are as follows:

$$CC_t = CPU_t - CPU_{t-1} \quad (ii)$$

$$CE_t = EPU_t - EPU_{t-1} \quad (iii)$$

As the index gap between two years can be negative, it is not appropriate for use in Hypothesis 3. Therefore, variables for each year in this hypothesis will be replaced by the corresponding data from the previous year to conduct the robustness test.

The same research method discussed above was used to conduct the robustness test.

$$GA_{it} = \alpha_0 + \alpha_1 GA_{it-1} + \alpha_2 CC_t + \alpha_3 SO_{it} + \alpha_4 REV_{it} + \alpha_5 LEV_{it} + \alpha_6 LIQ_{it} + \alpha_7 AGE_{it} + \alpha_8 ROA_{it} + \alpha_9 RM_{it} + e_{it} \quad (4)$$

$$GA_{it} = \alpha_0 + \alpha_1 GA_{it-1} + \alpha_2 CE_t + \alpha_3 SO_{it} + \alpha_4 REV_{it} + \alpha_5 LEV_{it} + \alpha_6 LIQ_{it} + \alpha_7 AGE_{it} + \alpha_8 ROA_{it} + \alpha_9 RM_{it} + e_{it} \quad (5)$$

Table 10. Robustness test results for the effects of climate policy uncertainty and economic policy uncertainty on the green activities of Vietnamese listed enterprises.

Variable	Model (4) Impact of CPU		Model (5) Impact of EPU		Model (6) Impact of CPU and EPU	
	GF	GI	GF	GI	GF	GI
$GA_{it(t-1)}$	1.521*** (9.93)	0.992*** (384.45)	1.012*** (18.82)	0.996*** (522.88)	1.738*** (4.62)	0.996*** (387.05)
CPU	0.028*** (2.50)	0.0003 (0.87)			0.092** (2.44)	0.011** (2.16)
EPU			0.008 (1.24)	0.021** (2.38)	0.100*** (3.82)	0.003** (2.03)
C*E					0.008** (2.38)	0.008** (2.22)
SO	0.011* (1.92)	-0.0003 (-0.20)	0.009* (1.84)	0.0001 (0.09)	0.007 (1.04)	-0.0004 (-0.31)
LEV	-0.00008 (-0.05)	-0.0001 (-0.35)	-0.002* (-1.91)	-0.00003 (-0.15)	0.002 (0.98)	-0.00003 (-0.15)
REV	0.004*** (2.59)	0.0002 (1.14)	-0.001 (-0.37)	-0.0002* (-1.79)	0.003 (1.18)	0.0005* (1.72)
AGE	0.005*** (2.79)	0.0001 (0.31)	0.002 (0.74)	0.0001 (0.29)	0.006* (1.70)	0.0003 (0.42)
ROA	-0.117** (-2.00)	-0.006 (-0.99)	-0.069 (-1.41)	-0.001 (-0.82)	-0.031 (-0.43)	-0.006 (-0.67)
LIQ	-0.002 (-0.91)	0.0003 (0.65)	-0.001 (-0.47)	-0.001** (-2.34)	-0.002 (-1.08)	0.001* (1.87)
RM	0.003 (0.53)	0.001 (1.26)	0.008* (1.81)	0.001 (1.13)	0.003 (0.38)	0.0017 (1.45)
Constant	-0.102** (-2.40)	-0.007 (-0.99)	0.012** (2.33)	-0.009* (1.71)	-0.052 (-0.77)	-0.013* (-1.62)
Obs.	6695	6695	6695	6695	6695	6695
Endogeneity	Yes	Yes	Yes	Yes	Yes	Yes
AR(2)	0.337	0.746	0.204	0.982	0.300	0.691
Hansen	0.457	0.505	0.235	0.632	0.378	0.489

Table 10 presents robustness test results for the effects of climate policy uncertainty and economic policy uncertainty on the green activities of listed enterprises in Equations (4–6). The symbols *, **, *** indicate statistical significance at 10%, 5% and 1%, respectively.

$$GA_{it} = \alpha_0 + \alpha_1 GA_{it-1} + \alpha_2 CPU_{t-1} + \alpha_3 EPU_{t-1} + \alpha_4 C * E_{t-1} + \alpha_5 SO_{it} + \alpha_6 REV_{it} + \alpha_7 LEV_{it} + \alpha_8 LIQ_{it} + \alpha_9 AGE_{it} + \alpha_{10} ROA_{it} + \alpha_{11} RM_{it} + e_{it} \quad (6)$$

where subscripts i and t denote the firm and year, respectively. All variables, except CC and CE in Equations (ii) and (iii), are defined in Table 3. The results presented in Table 10 reinforce our findings in the main models, affirming that CPU and EPU positively impact the GAs of Vietnamese listed enterprises from 2010 to 2022.

5. Conclusion and recommendations

This study investigates the impact of CPU and EPU on the GF and GI activities of Vietnamese listed companies between 2010 and 2022. Three different regression methods, namely OLS, FEM, and REM are employed on a sample of 515 enterprises, with 6695 observations during the research period. In our models, three variables are utilized to gauge the uncertainty index: CPU, which stands for CPU; EPU, which represents EPU; and an interactive variable C * E designed to capture the combined impact of CPU and EPU. The GAs of companies are classified into two specific categories, each represented by two measurable variables: GF and GI. The findings highlight the positive influence of CPU on GF, while EPU primarily affects GI among Vietnamese listed companies. When these uncertainty indices are combined, the joint impact of these two indices reveals a positive correlation with GAs, measured through both GF and GI. This trend can be attributed to the environment of innovative policies in Vietnam, coupled with the growing emphasis on green initiatives among businesses. This effect is further accentuated by Vietnam's status as a country with an open economy, wherein domestic policies are tightly controlled by the Party.

This study contributes to the existing literature on emerging markets by providing new evidence regarding the relationship between CPU and EPU and firms' GAs. The research findings have important implications for managers and regulators. On the one hand, balancing strategies for these major uncertainties can be developed through clear regulatory frameworks and targeted incentives. One approach involves encouraging public-private partnerships to foster collaboration in co-creating sustainable projects. Regular consultations and dialogues with industry stakeholders provide a comprehensive understanding of their specific needs, challenges and suggestions regarding climate and economic policies. Moreover, our second hypothesis suggests that during periods of economic uncertainty, firms may consider green investments as a safe option. Hence, during economic instability, the government could employ policy tools like tax incentives, subsidies, insurance, guarantees or credit enhancement to reduce risks for investors and issuers, thus encouraging firms to make green investments. However, the government should also be aware of the potential risks. If firms invest in green initiatives primarily as a hedge against policy uncertainty, they may reduce these investments as the policy environment becomes more certain. Therefore, the government should consider ways to promote sustained green investments, such as long-term policy commitments or stable incentive structures. On the other hand, enterprises should consider managerial implications to harness the potential benefits of this dual uncertainty scenario effectively. If businesses see policy uncertainty as a growth opportunity, they may face substantial setbacks by prioritizing profits and blindly pursuing innovation initiatives. Collaborative endeavors within the green sector can help enterprises collectively address common challenges and advocate for regulatory frameworks that promote sustainability. By incorporating scenario planning into their strategic decision-making processes through scenario analyses, companies can develop contingency plans and strategies adaptable to various economic and climate policy outcomes. Finally, strengthening control over enterprise capital is indisputably important. Adequate cash flow forms the foundation for maintaining daily operations, enabling enterprises to seize opportunities, make flexible decisions and foster sustainable development.

While this study has provided valuable insights and addressed some research gaps, it has limitations. First, the research sample includes only listed companies. Second, due to time constraints, macroeconomic factors like GDP growth and inflation are not considered as control variables. These factors could also be explored as interaction variables to better understand their influence on the relationship

between policy uncertainty and corporate GAs. Third, the study does not analyze the interaction between GF and GI activities, nor does it explore the reverse relationship between policy uncertainty and GAs. To address these limitations, future research could incorporate macroeconomic variables, explore interactions with political factors, and expand the focus beyond GAs to encompass broader aspects of sustainable development and corporate social responsibility.

Author contributions

All authors have made substantial contributions to the design and implementation of the research, the analysis of the results, and the writing of the manuscript. All authors have read and agreed to the published version of the manuscript.

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Data availability statement

The data used for this study includes secondary data on the characteristics of Vietnamese-listed companies from 2010 to 2022, which was obtained from the [FiinPro Platform Website](#) as well as information disclosed in annual reports, news, and company websites for calculating green activity variables. We utilized Google Trends and Glimpse for computing CPU and EPU. The datasets used in this paper will be made available upon a reasonable request to the corresponding author.

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