



Impact of climate and economic policy uncertainty,  
renewable energy consumption, oil price and CVC on  
VC cleantech funding amounts

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**Abstract**

This paper examines the impact of climate policy uncertainty (CPU), economic policy uncertainty (EPU), brent crude oil spot prices, renewable energy consumption, and corporate venture capital (CVC) on venture capital funding in the cleantech sector, focusing on United States based startups and investors between 2000 and 2024.

Our results demonstrate that EPU consistently boosts cleantech VC funding, particularly when lagged, indicating investors view the sector as a hedge against broader economic uncertainty. In contrast, CPU has a more variable subsector-specific effect, with limited broad sector influence. CVC investments, on the other hand, enhance funding, supported by a Resource-based view of a CVC offering value-adds to the young cleantech venture. An inverted U-shaped relationship between renewable energy consumption and VC funding is also identified, where initial demand increases investment but then diminishes and seems to reverse over time. Oil prices have a negative impact on VC cleantech deal funding, suggesting a complex relationship between fossil fuel markets and cleantech investment.

This research contributes to the existing literature by introducing novel factors affecting cleantech VC funding and recommends future studies to explore the dynamic (non)-linear interactions between these variables and their macroeconomic implications.

**Keywords:** Climate Policy Uncertainty, CPU, Economic Policy Uncertainty, EPU, Renewable Energy Consumption, Oil Price, CVC, VC Cleantech Funding

**Título:** Impacto da incerteza climática e de políticas econômicas, consumo de energia renovável, preço do petróleo e CVC sobre os valores de financiamento de VC em cleantech

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### **Abstrato**

Este documento investiga os principais determinantes do financiamento de capital de risco (VC) no setor de tecnologias limpas dos EUA, focando-se em startups e investidores entre 2000 e 2024. Avalia o impacto da incerteza da política climática (CPU), da incerteza da política econômica (EPU), dos preços do petróleo Brent, do consumo de energias renováveis e do capital de risco corporativo (CVC) nos montantes de financiamento. Os resultados mostram que a EPU aumenta o financiamento de VC para tecnologias limpas, enquanto a CPU tem efeito limitado, especialmente nas energias limpas. Investimentos de CVC aumentam significativamente o financiamento, refletindo seu valor estratégico. O estudo também identifica uma relação em U invertido entre o consumo de energias renováveis e o financiamento, com o investimento diminuindo à medida que o mercado amadurece. Os preços do petróleo têm impacto negativo no financiamento, indicando uma relação complexa com o investimento em tecnologias limpas. A pesquisa recomenda que estudos futuros explorem as interações dinâmicas entre essas variáveis e suas implicações macroeconômicas.

**Palavras-chave:** Incerteza de Políticas Climáticas, CPU, Incerteza de Políticas Econômicas, EPU, Consumo de Energia Renovável, Preço do Petróleo, CVC, Financiamento de Cleantech por VC

## Abbreviations

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Abbreviation	Description
VC	Venture Capital
EPU	Economic Policy Uncertainty
CPU	Climate Policy Uncertainty
Cleantech	Clean technology
CVC	Corporate Venture Capital
IVC	Independent Venture Capital
PE	Private Equity

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## 1. Introduction

In the United States as well as around the world, the impact of climate change can be seen and felt with historic droughts, wildfires, and staggering heatwaves (Kerry, 2021). A record global surface temperature increase has also been recorded by the NASA observatory, calling May 2024 the hottest May recorded (NASA Earth Observatory, 2024). With pledges such as Net Zero greenhouse emissions by 2050 by the US or the overarching prominent Paris Agreement, which is legally binding for 196 parties and aims to “limit the temperature increase to 1.5°C<sup>1</sup>” (UNFCCC, 2024), governments are adopting cleantech policies directed at cleantech firms (United Nations, 2023).

A cleantech firm aims to lower the negative impact on the environment by utilizing technology, products, or/and services and consequently reducing produced waste or encouraging consumers to use more sustainable sources for instance (Shakeel & Juszczyk, 2019).

Yet, new technologies such as clean technologies face a “valley of death”, going from government-supported research to product commercialization (U.S. Department of energy inventions & Innovations Program, 2000). To overcome the gap, innovating firms tend to turn to venture capital (VC) investors, in particular for the financing of the early and highly risky stages of product commercialization (Gompers & Lerner, 2004).

VC firms can play a crucial role in emerging startups and not only help those with needed financing but also act as supporters, which provide the knowledge, expertise, and understanding required to succeed in the marketplace (Shakeel & Juszczyk, 2019). In the past however, VC cleantech investments experienced a boom and bust cycle, with investments initiated by VC firms tripling from 2005 to 2008 and the investors then losing more than half of their investment between 2006 and 2011 (Gaddy et al., 2017). Consequently, VC investments into the cleantech sector have decreased following the cleantech bubble but are regaining (once again) interest from VC investors (van den Heuvel & Popp, 2023).

Considering the aforementioned transnational environmental objectives and the role of the cleantech sector as a catalyst for sustainable innovation, it is important to examine the determinant factors affecting the amount of VC funding allocated to cleantech startups, especially given the sector's inherently capital-intensive nature, and the particularly “deep valley of death” cleantech startups are facing (Michelfelder et al., 2022). Moreover, (Bloomberg, 2024) pointed out that U.S. has been the

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<sup>1</sup> Pre-industrial level

world's leading cleantech startup market in terms of funding for the third consecutive year since 2021, reinforcing the rationale for focusing this research on the United States.

Unpriced positive externalities and dependency on public infrastructure indicate a potential dependency of cleantech venture success on public support (van den Heuvel & Popp, 2023), which introduces a so-called policy risk with the potential to deter investors from early-stage ventures (Noailly et al., 2022). Noailly et al., 2022 found that a rise in environmental policy uncertainty is associated with a decreased probability for cleantech startups to get VC funding. However, on the other hand, cleantech or renewable energy media coverage increases cleantech VC deal numbers (Cumming et al., 2016). Uncertainty-related terms quantified by media coverage are encompassed in the Climate and Economic Policy Uncertainty indexes (CPU and EPU) (Baker et al., 2016; Gavriilidis, 2021) and will be both included in this research.

Gompers and Lerner (1999) identified GDP growth as a key control variable for VC activity, a factor also incorporated by Cumming et al. (2016). Accordingly, GDP is included as a control variable in this analysis, alongside the key variable EPU index, which also captures macroeconomic factors.

The study by (Cumming et al., 2016) identifies a curvilinear relationship between oil prices and cleantech VC investment: higher oil prices boost cleantech deal numbers, but the effect diminishes over time. Ethically, this suggests that rising oil prices are not a cure-all, as they may drive the exploitation of more costly and environmentally damaging oil reserves (Cumming et al., 2016). However, in the following research, the relevance of oil prices for cleantech deal funding amounts and not the number of deals will be assessed and accordingly analyzed as a novel factor.

Furthermore, (Gaddy et al., 2017) conclude that cleantech startups need to seek other funding than just VC and focus on leveraging governmental grants and also seek support from large companies for innovation and commercialization, while (van den Heuvel & Popp, 2023) argue that the funding gap for cleantech startups can only be plugged via targeting the demand side, such as clean energy demand for instance. The argument by van den Heuvel & Popp, 2023 to look closer at the demand side and that the funding for cleantech ventures cannot be solved solely by providing more governmental support, inspired this research to consider the demand side of the cleantech sector, which will be in the following defined as clean/renewable energy consumption as a novel factor to impact VC cleantech deal funding amounts.

Shuwaikh, Brinette, et al., (2024) find that having a CVC on board, positively affects the funding amounts and the duration of the investment, with CVCs being more patient than IVCs. Additionally,

(Shuwaikh, Brinette, et al., 2024) findings reveal that funding amount and investment duration on the other hand directly influence the exit strategies, which indicates potential link between CVC and venture's success. Moreover, Shuwaikh, Hughes, et al. (2024) argue that when external uncertainties are reduced, CVC-backed companies secure higher investment amounts than their IVC-backed counterparts.

Ghosh & Nanda (2010) paper accentuates the challenges cleantech startups face due to their capital-intensive nature and the long development timelines, which make them less attractive to traditional VCs. However, CVC investors, motivated by strategic interests rather than purely financial returns, are increasingly filling this gap (Ghosh & Nanda, 2010), as these investors are drawn to cleantech ventures not only for their potential market impact but also for their alignment with broader corporate goals such as sustainability and innovation (Ghosh & Nanda, 2010), which are essential to maintaining a competitive edge in the long term.

The dynamics of VC funding in cleantech startups can be characterized by several key economic theories. The Resource-Based View (RBV) emphasizes the competitive advantage cleantech ventures gain through access to unique resources, such as financial capital and strategic networks, with CVC providing significant value-added services (Ibrahim, 2021; Barney et al., 2001). Transaction Cost Economics (TCE) highlights how VCs seek to minimize transaction costs in high-risk, capital-intensive sectors like cleantech, with CVCs often willing to bear these costs due to long-term strategic goals (Williamson, 2010; Hegeman & Sørheim, 2021). Institutional Theory explains how governmental policies and regulations, such as the Paris Agreement, shape the cleantech investment environment, though policy uncertainty can negatively affect funding (Scott, 2008; Gaddy et al., 2017). Real Options Theory (ROT) (Myers, n.d.; Trigeorgis & Reuer, 2017) applied to the subject of this paper sees VC investments as flexible, incremental commitments, where investors can adjust based on evolving market conditions such as oil prices and renewable energy demand. Together, these theories provide a framework to better understand how VCs, particularly CVCs, navigate the challenges of cleantech investment and showcase the complex dynamics in this field.

This research contributes to the existing literature by analyzing macroeconomic and industry-specific factors—such as economic and climate policy uncertainty, GDP, oil prices, CVC investments, and renewable energy consumption—and their impact on cleantech VC funding in the U.S. It challenges established determinants of VC deal numbers, focusing instead on their relevance to funding amounts, and introduces novel demand-side factors, specifically clean energy consumption, as well as researches the non-linear relationships between the selected key factors and VC cleantech funding.

This research focuses on selected factors that influence VC funding amounts in the U.S. cleantech sector between 2000 and 2024. The findings reveal that EPU has a consistent positive impact on cleantech funding, suggesting that investors view the sector as a hedge during periods of economic uncertainty. In contrast, CPU affects cleantech startups unevenly within cleantech subsectors and has no broad sector-wide effect. CVC investments are shown to significantly increase funding for cleantech startups, highlighting the important strategic role of corporate investors. Additionally, the study reveals a non-linear relationship between renewable energy consumption and cleantech VC funding. Lastly, oil prices generally have a negative effect on cleantech funding, though the relationship remains complex.

## **2. Literature review and hypotheses**

### **2.1 Cleantech sector overview**

Pernick & Wilder (2007) describe cleantech as “any product, service, or process that delivers value” utilizing limited or no non-renewable sources and/or creating significantly less waste than existing offerings. Clean-tech can be divided into two elements clean – minimal to little environmental footprint delivered via “tech”, an apparatus through which the more clean results can be achieved (Shakeel, 2021). Cleantech can be rooted in the premise that economic productivity and growth should remain central while prioritizing environmental protection (Shakeel, 2021). The cleantech venture cycle typically includes four stages: research, development, manufacturing/scale-up, and roll-out (United Nations Environment Programme, 2016). Government funding supports stage one, while VC and private equity cover late stage one through early stage three. Public equity, M&A, and debt markets finance the later stages, with VC playing a crucial role in the development.

Total U.S. clean investments, including public and private funding, reached 76.27 bn. USD in Q2 2024, a 324% increase from Q2 2018 (Figure 2) (*Clean Investment Monitor*, 2023). Retail investments—spending by households and businesses on electric vehicles, renewable energy storage, and other clean technologies—accounted for 44% of this total, with 22 bn. USD driven by zero-emission vehicle purchases (*Clean Investment Monitor*, 2023). The U.S. government aims to boost the share of electric vehicles in total sales to 50 percent by 2030 (U.S. Department of State, 2024), which would further increase retail cleantech investments.

However, the cleantech sector has faced significant challenges in the past. The sector experienced a boom and bust in VC investments, surging from 1 bn. USD in 2004 to 5 bn. USD in 2008, only to plummet sharply after 2008 (United Nations Environment Programme, 2016). While the global

financial crisis was a major macroeconomic factor, another key issue was that only half of the capital invested in cleantech between 2006 and 2011 was returned to VC investors (Gaddy et al., 2017). This led Gaddy et al. (2017) to even argue with their research title 'Venture Capital and Cleantech: [is] The Wrong Model for Innovation'.

Cleantech, stretching over sectors such as renewable energy, energy storage, sustainable mobility, and water management, has become a key focus for global VC investment (Michael Sable, 2024). Definitions of cleantech sectors vary, with the StartUs insights Cleantech Report (2024) categorizing areas such as clean energy, climate-smart agriculture, carbon capture, and green construction etc. Global private cleantech investments reached 92 bn. USD in 2022 and 43 bn. USD in 2023 (up to Q3) (PricewaterhouseCoopers, 2023). With the latter, having a share of approximately 10% of PE and grant investment. Climate tech investment as a percentage of the total global VC and PE investment market in 2022 was around 9.16% and increased to 10.02% in 2023 (without Q4). However, the report by PricewaterhouseCoopers (2023) also points out that technologies with high emissions reduction potential, like green hydrogen, still remain underfunded. When comparing with the data from Crunchbase, which here only focuses on startups from U.S. as well as investors based (or having one location) in the U.S., we can observe the following trends (Note: Numbers when including international investors in U.S. and alternative funding types will be significantly higher.) According to Crunchbase data, U.S.-based cleantech startups saw a 226% increase in VC deal funding between 2020 and 2022, peaking at 1.26 bn. USD in 2022, before experiencing a 66% decline in 2023 (Figure 4). The sector's historical boom-and-bust cycles, as Gaddy et al. (2017) noted, underscore the need for ongoing research into factors influencing cleantech VC deal fluctuations.

## **2.2 Climate policy landscape, uncertainty, and macroeconomic factors in the United States**

The approach to climate policy in the U.S. has varied greatly depending on the administration in power. Under President George W. Bush, the policy was quite controversial; while he rejected U.S. participation in the Kyoto Protocol in 2001, his administration did invest in extensive research on the potential environmental impacts of climate change on the U.S. (Suzanne Goldenberg, 2009; The White House (Archive), 2001). During the presidency of Obama, the approach shifted towards more proactive climate policies with Clean Power Plan in 2015 and U.S. support for the historical Paris Agreement in 2015 (Pischke et al., 2018). Under the administration of Donald Trump on the other hand U.S. withdrew from the Paris Agreement and rolled back on more than 100 environmental rules (Nadja Popovich et al., 2021). The most current and significant act is the Inflation Reduction Act

(IRA) in 2022, with an injection of nearly 370 bn. USD towards clean energy, cleantech, and emission reduction initiatives (Steve Cranwell, 2024).

All these policy shifts create uncertainty, and the dependency on public infrastructure points to a potential dependency of cleantech venture success on public support (van den Heuvel & Popp, 2023), the policy uncertainty and thus the inherent policy risk can deter investors from early-stage ventures and additionally, the rise of the climate policy uncertainty is associated with decreased chances for cleantech startups to receive funding (Noailly et al., 2022). Emphasizing the importance of considering climate policy uncertainty as a factor influencing venture capital investment in cleantech startups.

Higher GDP growth and increases in R&D spending lead to greater VC activity, while the capital gains tax rate is an important driver of VC fundraising, a blanket reduction in capital gains tax rates may be an instrument for promoting VC (Gompers & Lerner, 1999). Previous research on the determinants of VC funding for cleantech has highlighted significant relationships between macroeconomic indicators and VC investment in the sector, suggesting that a positive economic outlook enhances the perceived feasibility of achieving returns on such investments (Shachmurove & Shachmurove, 2010). Additionally, other studies have explored the factors that cleantech investors consider pivotal in their investment decisions, revealing that a substantial majority of investors regard public policy and energy prices as important or critical factors influencing their choice to invest (J. Stack, 2007). Furthermore, in a recent study by (Cumming et al., 2016) the estimated coefficient on GDP was positive and statistically significant, indicating that increases in economic activity increase cleantech VC deal numbers. A 1-sd increase in GDP was associated with a 7.3% increase in cleantech VC deals per capita relative to the mean (Cumming et al., 2016).

Furthermore, the synchronicity between public discourse in the media and VC funding trends has been observed, suggesting that media attention can drive the emergence and growth of cleantech as an investment category (Migendt, 2017). Migendt (2017) also points out that the tone and sentiment in media reports can also significantly influence investor behavior and the overall flow of funding into cleantech startups. Carrying on with research findings by Cumming et al., (2016), media coverage increases cleantech VC deals – with this factor being considered in the indices of CPU and EPU. The EPU, which will be considered in the following, considers a combination of news coverage about policy-related economic uncertainty, tax code expiration data, and economic forecaster disagreement (Baker et al., 2016), while CPU solely focuses on the news coverage on terms around climate and uncertainty. Considering that media coverage increases cleantech VC deal numbers (Cumming et al., 2016), while the rise of the climate policy uncertainty is associated with decreased chances for cleantech startups to receive funding (Noailly et al., 2022) and the CPU and EPU factors

both entail media coverage and policy uncertainty factors, the impact on VC deal funding amounts is expected to be negative and positive throughout analyses, with an expected tendency for negative coefficients, implying a rise in CPU or EPU would decrease VC cleantech deal funding amounts.

Findings by Gyamerah & Asare (2024) moreover suggest that green bonds tend to serve as a hedge, rather than a haven, in times of economic policy uncertainty, which translated to our study context might imply that sustainable innovation sectors funding' might be also seen as a hedge by investors in times of broader economic uncertainty.

**Hypothesis 1: Climate and Economic Policy Uncertainty, respectively, have a negative and positive lagged impact on VC Cleantech deal funding amounts in the U.S.**

#### **2.4 Crude oil price, renewable energy consumption, and VC cleantech investments**

Ambitious new targets by the Biden administration to cut overall U.S. greenhouse gas emissions by 50 percent relative to the 2005 level by 2030, as well as 100 percent carbon pollution-free electricity by 2035 and net-zero emissions U.S. economy by 2050 (U.S. Department of State, 2024), puts the spotlight on the renewable energy production and consumption in the U.S.

Total renewable energy production in the U.S. doubled between 2000 and 2022, reaching over 8,397 trillion BTU in 2022 (EIA, 2024). Renewable energy consumption on the other hand entails hydroelectric power, wood & waste biomass, biofuels, geothermal -, solar -, and wind energy with consumption being 97.4% out of all renewable energy production in 2022 (EIA, 2024)<sup>2</sup>. Refer to Figure 3 for a comparison of renewable energy production and its corresponding consumption in the U.S. since 2000. (IRENA, 2020) Furthermore points out that the costs of renewable electricity, in particular from wind and solar, have continued to decrease and are expected to fall further as installation costs drop and performance continues to improve, making renewable technologies competitived in comparison to all fossil fuel generation sources. Moreover, according to Van den Heuvel & Popp, 2023, sufficient funding for cleantech startups can only be achieved via targeting the demand side, such as clean energy demand for instance, a factor which will be considered in the following.

Research by Cumming et al., (2016), spanning 1996 to 2010, shows that oil prices have a significant role in influencing cleantech VC deal numbers, even more important than other economic, legal or institutional variables utilized in their research. This relationship highlights the sensitivity of

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<sup>2</sup> renewable energy production is assumed to equal consumption for all renewable energy sources except wood and biofuels; plus wood prod.(which is the sum of wood consump. and densified biomass exports); plus biofuels prod. (which comprises fuel ethanol feedstock, biodiesel feedstock, renewable diesel fuel prod., and other biofuels prod.) (EIA, 2024)

cleantech investments to fluctuations in fossil fuel markets, suggesting that as oil prices rise, investors are more likely to channel funds into alternative energy technologies.

However, given that the analyzed data by Cumming et al., 2016 extends until 2010, it is essential to reassess these findings using data up to 2024 and to switch the perspective for our research purpose from deal numbers to deal funding amount.

F. Liu et al., (2023) suggest a bidirectional relationship between geopolitical risk and energy transition from a renewable energy perspective. Tambari et al., (2024) findings showcase oil price effects on renewable energy investments (REI) across six African countries. For instance in oil-exporting nations like Algeria, Angola, and Nigeria, higher oil prices discourage REI due to reliance on fossil fuel revenues, while in oil-importing countries such as Ethiopia and South Africa, rising oil prices incentivize REI by increasing the cost of oil imports, which highlights the asymmetric effects, where rising oil prices influence REI, but falling prices do not have an equivalent impact, reflecting the complex relationship between crude oil markets and renewable energy investments.

The study by (Li et al., 2023) highlights a critical caveat: renewable energy usage and R&D investments, contrary to expectations, are found to adversely affect sustainable development in G7 countries. This paradoxical outcome underscores the complexity of the relationship between traditional energy markets and the emerging renewable sector, suggesting that while oil price fluctuations remain a significant factor, the integration of renewable energy and innovation-driven growth strategies in developed economies like the G7 is not straightforward. This insight is crucial for understanding how shifts in oil prices might impact VC funding in cleantech, as the underlying economic conditions and policy environments influenced by these dynamics are potentially critical determinants of investment flows in the sector.

Recent research by (Jin & Kim, 2023) demonstrates that renewable energy plays a critical role in mitigating economic risks from volatile oil prices, particularly for net oil-importing OECD countries. Their study reveals a bidirectional relationship where higher oil prices can drive renewable energy expansion, enhancing economic resilience and energy security. Moreover, (Jin & Kim, 2023) long-run vector estimation results indicate that oil prices can pose an economic risk that diminishes gross output, while renewable energy consumption can mitigate the risk associated with oil prices.

J.P.Morgan Research (2023) forecasts a potential of 1.1 million barrels per day (mbd) deficit in global oil markets by 2025, expanding to 7.1 mbd by 2030. This imbalance could drive oil prices up to 150 USD per barrel in the short to medium term and stabilize around 100 USD per barrel in the long term, exceeding their 80 USD per barrel forecast. Despite this, the global economy is expected to endure

these higher prices, as they are below the peak levels of 2008 and 2011, and beneath the threshold that would significantly reduce demand. Given this outlook, it is crucial for future research to not only examine past predictors but also to explore the impact of forecasted oil prices on VC cleantech investments by i.e. utilizing advanced statistical models.

**Hypothesis 2: The proportion of renewable energy consumption relative to renewable energy production, as well as renewable energy consumption positively influence VC funding in cleantech startups in the U.S.**

**Hypothesis 3: Rising crude oil prices are negatively associated with VC funding amounts for cleantech startups in the U.S.**

## 2.5 CVC investments in cleantech startup sector

*Figure 1. CVC vs. IVC cleantech deals in the U.S. (excluding foreign investors/investors not located in U.S., as well as cleantech startups not located in the U.S.) – data sourced from Crunchbase<sup>3</sup>*

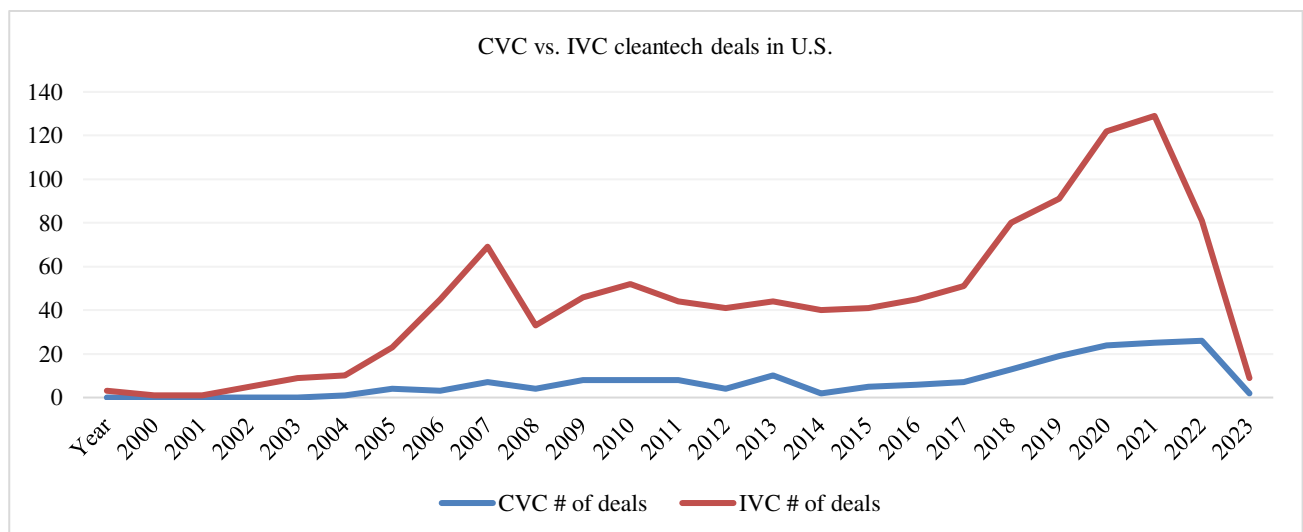


Figure 1 illustrates the number of cleantech deals completed by CVC versus IVC from 2000 to 2024 in the U.S. CVC activity in cleantech remained relatively modest in the early 2000s, with fewer than 10 deals annually until 2009. A notable surge in CVC investments occurred from 2019 onwards, with a peak of 26 deals in 2023. This reflects a growing interest in sustainable technologies from corporate investors. In comparison, IVC consistently led deal activity, with significant increases particularly

<sup>3</sup> The funding type has been filtered for: corporate round, pre-seed, seed, series A to X. Other funding rounds excluded due to the ambiguity of the founding round being (completely) attributed to a VC.

during the 2020 to 2022 period. The data suggests a growing role for CVC in fostering cleantech innovation, especially as environmental and sustainability concerns gain prominence globally.

Early CVC investment in cleantech was minimal<sup>4</sup>, with funding remaining below 100 mio. USD annually until 2009. However, from 2019 onwards, CVC funding experienced a sharp rise, peaking at over 2.2 bn. USD in 2021 and remaining strong in 2022 with nearly 1.8 bn. USD. Meanwhile, IVC consistently was higher than CVC funding. For instance, IVC investments reached 5.07 bn. USD in 2021 and 4.5 bn. USD in 2022.

Shuwaikh, Brinette, et al., (2024) point out that having a CVC on board, positively affects the funding amounts and the duration of the investment, with CVCs being more patient than IVCs. Additionally, (Shuwaikh, Brinette, et al., 2024) findings reveal that funding amount and investment duration on the other hand directly influence the exit strategies, which indicates a potential link between CVC and venture's success. Moreover, Shuwaikh, Hughes, et al. (2024) argue that when external uncertainties are reduced, CVC-backed companies secure higher investment amounts than their IVC-backed counterparts.

Another remarkable aspect, highlighted by (Shuwaikh, Hughes, et al., 2024) is that CVC funding can be improved significantly by sector fit and geographic fit between the corporate investor and their funded companies, enhancing both the range and quality options available and increasing the likelihood of a successful exit. These findings align with broader research into the motivations behind CVC investments in cleantech startups.

Hegeman & Sørheim (2021) point out that CVC investors are motivated by not only financial returns, but also exploitative learning, building legitimacy, exploring green opportunities, and responding to competitive pressures. Additionally, (HBS, 2002) argues some performed investments are strategic - specifically to increase the sales and profits of the corporation's own businesses, as to seek and identify, as well as exploit synergies between itself and a new venture. (Döll et al., 2022) research shows that a 70% of companies listed in the Corporate Sustainability Index are engaged in CVC activities. These companies allocate approximately 10% to 15% of their capital to sustainable businesses - a clear commitment to incorporating sustainability into their strategic goals through CVC initiatives.

The strategic importance of CVC is additionally emphasized by (Wadhwa et al., 2016), those who found that the technological and social capital of a firm's partners positively changes the portfolio diversity-firm innovation relationship. Corporate venture-backed firms with influential founders are more likely to form innovation-focused alliances, whereas VC-backed firms, even with influential

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<sup>4</sup> Same sample specifications as for Figure 1

founders, tend to favor exploitive alliances, highlighting the potential innovation aspect CVC investors can have on their investees (Galloway et al., 2017).

(Rossi et al., 2020) paper starting with “When corporations get disruptive, the disruptive get corporate”, shows that disruptive technologies are particularly attractive investments for CVCs and that most active CVCs are strictly focused on digital, as well as potential disruptive technologies to invest into.

Previous research, such as the study by (Shuwaikh, Hughes, et al., 2024) confirm that, when exogenous uncertainty is mitigated, CVC-backed companies experience higher investment amounts than IVC funds-backed ones. In this paper, the existing research results as to the positive association between CVC and a venture’s deal funding will be used to validate the performed analysis in this paper and to detail CVCs’ importance for VC cleantech deal funding amounts in the U.S.

**Hypothesis 4: Investments performed by CVCs have a positive impact on deal funding amounts received by cleantech startups.**

## **2.6 What makes cleantech special? – VC investments in the cleantech sector vs. other sectors**

In the United States the cleantech sector attracted significant VC investment with the funding for cleantech startups by CVCs and IVCs located in the U.S., exceeding 6.35 bn. USD in 2022<sup>5</sup>. Globally, the cleantech sector has also seen strong momentum, with significant funding rounds like the 5.2 bn. USD raised by Sweden's H2 Green Steel in 2024 or the venture Ascend Elements<sup>6</sup> with 704 mio. USD in the U.S., despite the global decline in VC investments (KPMG, 2024). Thus, even with a global VC investment drop to 75.9 bn. USD across 7,520 deals in Q1 2024, due to geopolitical tensions and lack of exits in the market (KPMG, 2024), cleantech remains a promising sector for VCs to invest in. The current cleantech’s sector success in the VC field is remarkable, also in context of around 4 percent of overall VC deals being allocated to cleantech<sup>7</sup> (Noailly et al., 2022).

Cleantech VC investments differ from others, because of their capital intensity and higher technology risks, such as scalability and exit strategies. Additionally, cleantech's societal benefits—like reduced environmental harm—are difficult for investors to fully capture, leading to positive externalities. Public goods theory states that this results in underinvestment relative to the socially optimal level,

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<sup>5</sup> Data sourced from Crunchbase. For details see the data specifications for Figure 1.

<sup>6</sup> Series D funding round

<sup>7</sup> Crunchbase’s ‘Sustainability’ industry group

as resources like air and oceans are not owned and cannot be capitalized on by private investors. (Cumming et al., 2016).

Ghosh and Nanda (2010) note that while VCs in biotechnology and information technology often sell their investments to established firms, this is less likely in cleantech. Incumbent firms in cleantech are mostly large companies focused on fossil fuels, making them less inclined to acquire cleantech startups (Cumming et al., 2016). These factors among others differentiate cleantech VC investments from those in biotech and IT, where benefits are clearer, capital requirements are lower, and risks are reduced.

Gaddy et al. (2017) argue that VC funding is not ideal for cleantech startups due to long development timelines, longer than 3-5 years typical VC investment timeline, capital intensity often exceeding typical VC limits, and the sector's dependence on commodity markets with rather thin margins. Moreover, potential acquirers, like utilities, are hesitant to invest in risky ventures, focusing on profitability over growth potential. Lastly, cleantech VC investments have also faced boom-and-bust cycles, with a sharp rise between 2005 and 2008, followed by significant losses captured by the investor in 2006 to 2011.

As to specific factors influencing cleantech ventures - Joelle Noailly et al. (2022) found that U.S. environmental uncertainty reduces the likelihood of cleantech startups, especially capital-intensive clean energy ventures, receiving VC funding. Cumming et al. (2016) on the other hand found that oil prices have a role in driving cleantech VC deals, which was even more important than other economic, legal, or institutional variables considered. This could also be attributed to the fact that approximately 70% of all cleantech investments are focused on the energy sector (PricewaterhouseCoopers et al., 2008). A recent report by StartUs Insight (2024) indicates that approximately 35% of global cleantech companies work directly on renewable energy, 10% on carbon capture, use & storage, while 12% on alternative mobility, and 6% on energy consumption management, etc.<sup>8</sup>

A VC investor can be particularly helpful when a clean technology venture faces a “valley of death”, going from government-supported research to product commercialization (U.S. Department of Energy Inventions & Innovations Program, 2000). To overcome the gap firms tend to turn to VC investors, in particular for the financing of the early and highly risky stages of product commercialization

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<sup>8</sup> According to StartUs insights (2024) the rest of cleantech firms focus on: 13% low carbon construction, 10% circular waste management, 4% sustainable automation.

(Gompers & Lerner, 2004). VC firms play a vital role in supporting emerging startups by not only providing essential financing but also offering the knowledge, expertise, and guidance necessary to thrive in the marketplace.

Moreover, (Shakeel & Juszczyk, 2019) conducted a qualitative study to explore the specific contributions of VC investors to cleantech startups. Their findings revealed that VC involvement in technology development and additional financing was minimal. However, VCs provided moderate support in areas such as certification, recruitment, cooperation, and internationalization, while offering significant assistance in corporate governance, monitoring, and industry expertise.

## **2.7 Theoretical framework**

Multiple economic theories will be reviewed to attempt and frame the dynamics influencing VC cleantech deal funding. The Resource-Based View (RBV) emphasizes the competitive advantage that firms gain from unique access to resources such as financial capital, technological expertise, and strategic networks (Barney et al., 2001).

In the context of cleantech, having a CVC investor can provide benefits to the young venture ranging from superior value-added services to sufficient monetary capital to fund startups to a successful exit without the need for any additional monetary input from outside (Ibrahim, 2021). The value-added services can be similar to those provided by IVCs, entrepreneurs, however, may prefer CVCs due to large corporations' "established distribution lines, strategic partners, deep domain intelligence, not to mention an experienced sales force and a global presence." (Ibrahim, 2021) In the context of RBV, the described value-add services offered by a CVC investor would indicate the competitive advantage the cleantech ventures gained from having a CVC on their side.

CVCs, driven by long-term strategic interests and motivations as described by (Hegeman & Sørheim, 2021) rather than purely financial returns, often provide the necessary support for cleantech startups to overcome the "valley of death" in their commercialization process, filling a critical gap that traditional VC investors may avoid due to the sector's inherent risks (Gaddy et al., 2017), as well as consequently positively affect the funding amounts and are more patient regarding the duration of investments, which on the other hand is associated with higher likelihood of IPO exit (Shuwaikh, Brinette, et al., 2024).

Going now from RBV to Transaction Cost Economics (TCE) – TCE provides an understanding of how investors seek to minimize transaction costs (Williamson, 2010), particularly intriguing in uncertain and high-risk environments like cleantech. The TCE theory proposes that each type of transaction introduces coordination costs of monitoring, controlling, and managing transactions,

while transaction costs are broadly defined as the costs of running the economic system of firms (Williamson, 2010; Young, 2013). For the purpose of this research, we will assume that choosing a cleantech startup for a VC fund is associated with transaction costs such as monitoring and managing the investment (Gompers & Lerner, 2004). Cleantech ventures have comparatively long development times and are capital intensive (Gaddy et al., 2017), and in accordance with TCE theory can be associated with high transaction costs. Furthermore, the policy uncertainty and thus the inherent policy risk can deter investors from early-stage ventures and additionally, the rise of CPU is associated with decreased chances for cleantech startups to receive funding (Noailly et al., 2022). In the context of TCE, it can be argued that the inherent policy risk requires more monitoring and thus increases transaction costs. Uncertainty avoidance is furthermore negatively associated with VC activity (Antonczyk & Salzmann, 2012). At the same time, TCE suggests that CVCs are more likely to bear these higher transaction costs because of their strategic alignment with long-term corporate goals, such as achieving sustainability or responding to competitive pressures (Hegeman & Sørheim, 2021). The unstable nature of climate and economic policies, particularly in the U.S., where policy direction has shifted dramatically across different administrations (Popovich et al., 2021), further complicates investment decisions in cleantech, making the ability to manage transaction costs crucial for success.

In consideration of our research Institutional Theory (INT) will be examined next. Institutional Theory highlights that formal institutions, such as regulations and agreements can shape the investment landscape for cleantech. (Krücken, 2017) argued that INT seeks to explain similar behavior by organisations, while institutital pressure can lead to increasingly homogenous organisational structures. Institutions are “regulations, norms, and cognitive activities that provide stability and meaning for social behavior” (Scott, 2008). Policies like the Paris Agreement and the Inflation Reduction Act (IRA) create a supportive institutional framework for the cleantech sector, which can lower entry barriers through subsidies, tax incentives, and other financial support mechanisms (United Nations, 2023). However, U.S. climate policies are volatile, such as the withdrawal from the Paris Agreement under the Trump administration, or failed attempts by the U.S. government to pass regulation to limit carbon emissions in the past (Gaddy et al., 2017). All these events created uncertainty, which likely had an impact on cleantech investor sentiment (Gaddy et al., 2017). In the context of this research, cleantech startups often depend on institutional frameworks, as well as public infrastructure and government funding and support (Gaddy et al., 2017), for their success.

Further adding to the complexity is Real Options Theory (ROT) (Myers, n.d.; Trigeorgis & Reuer, 2017), which frames VC investments as real options, where investors hold the right but not the obligation to make additional investments based on how future conditions evolve. When applying ROT to the cleantech sector, where market dynamics are complex and innovation timelines are long, investors are likely to take incremental investment approaches, waiting to see how for instance regulatory or market conditions, such as oil prices or renewable energy consumption, unfold before committing further capital. This aligns with the VC feature of conducting financing in discrete stages over time and thus instrumentalizing the incremental funding as control mechanism for the financed venture (Gompers & Lerner, 2004). Rising oil prices to a certain degree, for example, have been shown to negatively impact VC cleantech activity (Cumming et al., 2016). Furthermore, this paper considers the cleantech demand in this paper as renewable energy demand and furthermore investigates its relative proportion to total renewable energy production in U.S. and its impact on VC cleantech deal funding. (Saviotti & Pyka, 2017) investigates the occurrence of demand saturation and its implications for economic development, focusing on the effects of demand evolution and income distribution on economic differentiation. It concludes that while demand can saturate, innovation and product differentiation enable continued economic growth, highlighting the intricate relationship between demand saturation and economic progress (Saviotti & Pyka, 2017). In the context of Real Options Theory, we argue that factors such as oil price, renewable energy demand and policy changes, as well as related uncertainty can be seen as evaluation factors for the future conditions and in order to determine further increment investment (amounts). (Shuwaikh, Hughes, et al., 2024) furthermore investigated CVC as an option-creating investment and found that when exogenous uncertainty is mitigated, CVC-backed ventures receive higher funding amounts than IVC-backed ones.

Concluding the factors framing the VC funding for cleantech venture can be explained by a large portion by considering multiple theories, such as the Resource-Based View (RBV), Transaction Cost Economics (TCE), Institutional Theory, and Real Options Theory. Each theory provides insights into how VCs or CVCs, can navigate the cleantech investment landscape, influenced by macroeconomic factors such as policy uncertainty, oil prices, and renewable energy consumption. Hence by combining strategic resource deployment, economic and climate uncertainty management and understanding, institutional dependencies, and real options helps us paint a clearer picture on VC funding in the sustainable innovation sector.

## **2.8 Research importance, cleantech sector in a global context and brief outlook**

The scientific community paints the future of tomorrow rather grim - increasing climate risks, including more intense hurricanes, longer droughts, and a melting Arctic (NASA Science, 2024). The Intergovernmental Panel on Climate Change stresses that near-term mitigation efforts are critical to reducing the magnitude and risks of climate change (NASA Science, 2024). Furthermore, the U.S. aims to cut greenhouse gas emissions by 50-52% below 2005 levels by 2030, alongside pledges from other countries representing together 65% of global GDP (U.S. Department of State, 2024).

The Inflation Reduction Act (IRA) allocates nearly 370 bn. USD towards clean energy, cleantech, and emission reduction initiatives being a huge lever toward U.S.' goal of net zero by 2050 (Steve Cranwell, 2024).

Rhodium Group (2024) projects federal clean energy investment to grow by 50 and 40% for Q1 and Q2 2024 respectively. International Energy Agency (2023) analysis projects that the global market for mass produced clean energy technologies could reach around 650 bn. USD annually by 2030, which is more than triple its current size, but only if countries fully implement their announced energy and climate commitments.

J.P. Morgan Research (2023) predicts rising oil prices, forecasted to hit 150 USD/bbl by 2025, which may further boost VC deals in cleantech (Cumming et al., 2016).

With the above highlighting the vital need for continued and exhaustive research supporting cleantech's commercialization efforts.

### **3. Data**

#### **3.1 Data collection and sample selection**

This study utilizes a cross-sectional pooled dataset from Crunchbase, which entails VC investments in the cleantech sector from 2000 to April 2024, focusing exclusively on startups located in the U.S. and U.S.-based VC investors. The original dataset contained 1,527 observations but was filtered and cleaned to 1,127 after excluding records with missing key variables and non-relevant funding rounds, such as convertible notes, debt financing, and secondary market transactions. The dataset analyzed focuses on early and medium-stage ventures<sup>9</sup>, emphasizing the critical phases where both CVC and non-CVC investors are detrimental.

To isolate cultural and macroeconomic factors, foreign (C)VCs investing in U.S. cleantech startups were excluded. The data for renewable energy consumption and production in trillion British thermal units (Btu) was sourced from U.S. Energy Information Administration, while the EPU data, derived from Baker et al. (2016), and the CPU index, collected from Konstantinos Gavriilidis in "Measuring

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<sup>9</sup> (pre-seed, seed, series A to series X rounds)

Climate Policy Uncertainty,". The Brent crude oil spot price was drawn from West Texas Intermediate (WTI) via Refinitiv and the GDP data was obtained from the U.S. Bureau of Economic Analysis, specifically from their national GDP and personal income statistics. All collected data has been aggregated on a monthly frequency basis.

Summary statistics for all key variables were computed to assess the distributional properties of all variables for normal distribution before any logarithmic transformations were applied, such as for the highly skewed variables such as VC Funding Amount and EPU Index.

## **3.2 Description of variables**

### ***3.2.1 Dependent variable***

The primary dependent variable is the VC funding amount, representing the total investment received by a cleantech venture in a funding round, measured in USD. The distribution is highly skewed, with a mean of 20.7 mio. USD and a standard deviation (sd) of 83.3 mio. USD, ranging from 5,000 to 1.8 bn. USD, reflecting some exceptionally large deals. Due to this skewness, the variable was log-transformed.

### ***3.2.2 Independent variables***

#### *Climate Policy Uncertainty (CPU) index*

Noailly et al. (2022) developed the EnvPU index for their research, which tracks U.S. environmental policy uncertainty utilizing data from ten major newspapers and found that it is negatively associated with the probability of cleantech startups receiving VC funding. The CPU index used in this study differs from the EnvPU index but similarly tracks the frequency of climate policy and uncertainty-related terms in major newspapers in the U.S. The mean CPU index is 163.575, with a sd of 74.087, indicating high variability in policy uncertainty during the study period.

#### *Economic Policy Uncertainty (EPU) index*

The EPU index is derived from news coverage, tax policy data, and economic forecasts to measure economic policy uncertainty (Baker et al., 2016). With a mean of 165.205 and a sd of 73.778, the variable was log-transformed due to positive skewness. Previous studies have found a connection between macroeconomic indicators and cleantech VC funding, pointing out that a positive economic outlook boosts investment (feasibility), while climate uncertainty on the other hand reduces funding (Cumming et al., 2016; Shachmurove & Shachmurove, 2010). Thus, the EPU index is a crucial variable in this analysis.

*Proportion of total renewable energy consumption to production (PercConsumpOutProd) and Total renewable energy consumption (RenEnergyConsumption)*

The variable PercConsumpOutProd, reflecting the proportion of U.S. renewable energy produced and consumed domestically, has a mean of 0.984, a sd of 0.014, and ranges from 0.951 to 1.025. The RenEnergyConsumption variable, representing total renewable energy consumption, averages 582.335 trillion Btu with a sd of 99.115 trillion Btu.

Cumming et al. (2016) identify a curvilinear relationship between oil prices and cleantech VC investments, where initial increases in oil prices boost investment, but the effect diminishes over time. Similarly, this study explores potential curvilinear effects of renewable energy consumption on VC funding by including both a relative term (renewable energy consumption to production) and logarithmic and squared terms for total consumption. This allows the analysis to account for market saturation effects, because as highlighted by (Kanniainen & Keuschnigg, n.d.) decreasing project values, due to market saturation feed back on VC activity.

Figure 3 illustrates renewable energy consumption relative to production in the U.S.

*Brent crude oil spot price*

Serving as a proxy for broader energy market conditions, the average price during the research period was 72.159 USD per barrel, with a sd of 23.052 USD.<sup>10</sup> The study by (Cumming et al., 2016) identifies a curvilinear relationship between oil prices and cleantech VC investment. However, in the following research, the relevance of oil prices for cleantech deal funding amounts and not the number of deals will be assessed.

### **3.2.3 Control variables**

*GDP*

GDP in the U.S. with a mean of 20,369.621 bn. USD and a sd of 4,378.49 bn. USD as a variable is relatively stable and symmetrically distributed. Gompers and Lerner (1999) identified GDP growth as a key control variable for VC activity, a factor also incorporated by Cumming et al. (2016). Accordingly, GDP is included as a control variable in this analysis, alongside the key variable EPU, which also captures broader macroeconomic influences.

*Rule of Law*

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<sup>10</sup> Close price

A governance indicator by the World Bank, with a mean of 1.48, used to control the broader legal environment in which cleantech startups operate. For two blanks on Rule of Law – World Governance Indicator time series from World Bank, an average of the past three time periods/available values has been used. Rule of Law has been included as a control variable, inspired by (Cumming et al., 2016) and based on (La Porta et al., 1998) findings to include protection of legal rights as an explanatory variable for VC activity. However, the revisited/corrected anti-director rights by (Spamann, 2008), which are included in the study by (Cumming et al., 2016) were not publicly available. For that reason Rule of Law is included in this study instead, which captures the perceptions of the extent to which agents have confidence in and abide by the rules of society, and also the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Furthermore, Rule of Law has been standardized by (*World Bank Open Data*, n.d.), so no further treatment from our side is required.

#### *CVC dummy*

A binary variable indicating whether the investment was made by a CVC firm or not, which is essential for differentiating between corporate and non-corporate performed investments.

Various research associates CVC-backed companies with higher funding amounts for the ventures (Shuwaikh, Brinette, et al., 2024; Shuwaikh, Hughes, et al., 2024), based on the existing research findings, the inclusion of the CVC dummy is used predominantly as validation for this papers' research results, while still being considered and evaluated in the overall assessed context.

#### *Funding type*

Funding type is a categorical variable differentiation between various VC funding stages (i.a, pre-seed, seed, Series A to Series X rounds). The amounts per specific funding stage can widely vary depending on whether it is pre-seed or Series B funding, which is widely known and recognized within the VC industry.

The CPU and EPU will be utilized to test for H1, while renewable energy variables will be incorporated in regressions for H2, oil price for H3, and the differentiation between CVC and non-CVC investors for H4 testing.

#### **4. Research and Robustness Testing Methodology**

OLS regression with fixed effects is determined as main evaluation method in this study, in particular given the pooled cross-sectional dataset and the continuous nature of the VC funding variable. This approach is aligned with Noailly et al. (2022), who used fixed effects to analyze the impact of environmental policy uncertainty on cleantech VC deals. In contrast, the random effects model utilized by Cumming et al. (2016) is not deemed necessary here due to this study excluding cultural variables, which was the author's main reason for employment of random effects over fixed effects. The fixed effects model in this paper controls for unobserved heterogeneity across years, firms, regions, and industries, which could otherwise introduce bias into the estimates. However, the datasets per individual firm are not extensive, accordingly the fixed effects region, year, and industry, controlling for time invariant factors, are generally favored to the firm fixed effects for this particular study and context. Each model displayed in the appendix is estimated using OLS with robust standard errors. Regressions with firm fixed effects are conducted as one of the robustness tests.

Negative lags were applied to individual independent variables to focus on the delayed impact of select factors, instead of a positive lag of the dependent variable for which the lag would have applied to all factors included. Several studies on oil prices and renewable energy (D. Liu et al., 2021; Pal & Mitra, 2015; Syed et al., 2023; Noailly et., 2022) have used varying lag lengths in their analyses. For example, Pal and Mitra (2015) excluded (too) short lags due to insignificance, while Shin et al. (2014) employed 12-week lags. The optimal lags by (Pal & Mitra, 2015) for ADF were selected by Schwarz information criterion. Following a review of the literature, the decision was made to adopt 1, 3, and 6-month lags for simplicity and compatibility with the OLS fixed effects model, rather than to comply with nonlinear autoregressive distributed lag models.

Further robustness tests are considered by conducting sensitivity analyses to account for possible non-linear relationships with curvature, especially in the context of oil price volatility but also for renewable energy consumption and its impact on VC funding.

Further robustness tests involve splitting the dataset into two time frames: First, from 2000 to 2015 (410 observations) and second, from 2016 to 2024 (717 observations). This split is due to a key event - the U.S. signing of the Paris Agreement in 2016 (UNFCCC, 2024). Moreover, to assess the impact of omitted variables, random factors, and data noise on baseline regression results, a placebo test with 600 random samples was conducted, comparing coefficients and p-values to the baseline. For extra robustness, each placebo test was repeated 500 times.

The correlation matrix examines the relationships among key variables and due to the high correlation of the Rule of Law variable with some other variables, all regressions were conducted both with and without it. Since the differences in coefficients were negligible, with only a higher standard error for the model constant, most regressions displayed in the appendix include the Rule of Law to mitigate potential omitted variable bias.

### **Model 1: Assessment of Impact of Climate and Economic Policy Uncertainty (H1)**

The model A1 exemplifies the below specifications. Further models A, (A2-A4) are an extension or modification of A1 to either isolate the effects of either CPU or EPU or for robustness testing. To test the first hypothesis, which examines the influence of Climate Policy Uncertainty (CPU) and Economic Policy Uncertainty (EPU) on VC Cleantech funding amounts, the following model is specified:

$$\begin{aligned} \ln VC Funding Amount_{it} &= \beta_0 + \beta_1 CPU index_t + \beta_2 Ln EPU index_t + \beta_3 GDP_t + \beta_4 Rule of Law_t + \beta_5 CVC_{it} \\ &+ \beta_6 Funding Type + \delta_{region} + \gamma_{year} + \alpha_{industry} + \varepsilon_{it} \end{aligned}$$

### **Model 2: Assessment of renewable energy consumption, its relative proportion to renewable energy production, and oil price' impact on VC Cleantech deal funding amount (H2 & H3)**

The model B1 is defined by the below specifications. Further models B are an extension or modification of B1 to either test for non-linear relationship and curvature (B2b) or for robustness testing.

To test the second and third hypothesis, which examines the influence of renewable energy consumption, its relative proportion to renewable energy production, and oil price' impact on VC Cleantech funding amounts, the following model is specified:

$$\begin{aligned} \ln VC Funding Amount_{it} &= \beta_0 + \beta_1 Perc Consump Out Prod_t + \beta_2 Tot Renew Energy Consump \\ &+ \beta_3 Oil Spot Price + \beta_4 GDP_t + \beta_5 Rule of Law_t + \beta_6 CVC_{it} + \beta_7 Funding Type \\ &+ \delta_{region} + \gamma_{year} + \alpha_{industry} + \varepsilon_{it} \end{aligned}$$

The PercConsumpOutProd, which describe the relative proportion of renewable energy consumption to production in the U.S. is seeks to better understand the relationship between renewable energy

consumption, production, symbolising renewable energy market dynamics and its impact on VC cleantech deal funding.

#### **Model 1 and 2: Analysis of Impact of CVC investors on VC Cleantech deal funding amount (H4)**

Shuwaikh, Brinette, et al. (2024) argue that ventures backed by CVC generally receive greater funding and also experience extended investment durations compared to those supported by IVCs. Additionally, Shuwaikh, Hughes, et al. (2024) argue that when external uncertainties are reduced, CVC-backed companies secure higher investment amounts than their IVC-backed counterparts. Considering past research findings, CVC will be included in all models and will be predominantly used for the validation of study results. See the CVC dummy variable being included in Model 1 and 2 specifications above.

## **5. Results and analyses**

### **5.1 Pairwise Correlations**

The pairwise correlations between the variables used in the models are presented in Table 3. VCFundingAmount exhibits a weak positive but significant correlation with RenEnergyConsumption at 0.059, suggesting that higher total renewable energy consumption is modestly linked to an increase in VC funding for cleantech startups. Similarly, VCFundingAmount shows a positive correlation with CPUindex of 0.072, indicating a small relationship between higher uncertainty in climate policy and increased cleantech VC investments. Interestingly, PercConsumpOutProd demonstrates a negative correlation of -0.071 with VCFundingAmount, which may imply a counterintuitive relationship where higher consumption-to-production proportion correlates with slightly reduced VC funding in the sector.

RuleofLaw and GDP have a strong negative correlation (-0.833), signifying that governance perceptions may inversely relate to the size of the U.S. economy, likely due to cyclical fluctuations in governance standards during periods of economic growth or contraction. Due to RuleofLaw showcasing high correlations with multiple independent variables, all regressions have been conducted by excluding and including Rule of Law as a control variable. However, no mentionable difference in regression outcomes has been observed apart from an increased standard error for the constant of each model. For that reason most models in the appendix display the results including Rule of Law, considering the argumentation by (Cumming et al., 2016) based on (La Porta et al., 1998) findings to include protection of legal rights as an explanatory variable for VC activity.

However, the revisited/corrected anti-director rights by (Spamann, 2008) and considered in the research by (Cumming et al., 2016) were not publicly available. Fort that Rule of Law is included in this study, which captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and also the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.

## **5.2 Main research results**

An important consideration in interpreting the results is that due to the non-normal distribution of certain variables, including VC funding amount and the EPU index, the coefficients for models involving non-linear relationships and log transformations of independent variables will not be interpreted in absolute terms. Instead, a relative percentage-based interpretation of the corresponding log variables may be cautiously applied.

### **H1: Climate and Economic Policy Uncertainty, respectively, have a negative and positive lagged impact on VC Cleantech deal funding amounts.**

CPU does not showcase a consistent significance throughout the analysis. For instance, in Table 4, model A1 and Table 5, model A2, CPU is statistically insignificant with a coefficient (-0.002) for  $t_0$ . Indicating that climate policy uncertainty does not have an impact on VC cleantech, when considered broadly. However, once we differentiate between subsectors, in Table 5, model A3a, CPU is statistically significant with -0.003 at 10% level for the Clean Tech subsector. No evidence of CPU's impact on the hand can be found for the clean energy subsector analysed in mode A3b. These findings contradict Noailly et. al (2022) for the broad clean tech sector, but confirms their finding for clean technology focus subsector, indicating the relationship between CPU and VC cleantech deal funding may be less uniform but nuanced once subsectors are considered.

Interestingly, when introducing lag effects in the regression (Table 5), the impact of CPU becomes insignificant, highlighting the immediate reaction of VC investors to policy uncertainty.

In light of past policy uncertainty and its fluctuations in U.S. such as with Trump's withdrawal from the Paris Agreement, it is important to understand that the investor's reaction to a policy uncertainty event may be dependent on the cleantech subsector they are in, leading to partial acceptance of CPU's impact in H1, when differentiated between subsectors.

In contrast, when looking at EPU, the index is statistically significant throughout many models and particularly when lagged in time. In Table 4, model A1, EPU is significant at one month lag with

0.474 at 5% significance level and with 0.310 at 10% level for the 6 month lag. The 0.474 coefficient indicates that a 1% increase in the EPU index (lag of 1 month) corresponds to an approximate 0.47% increase in cleantech funding. This suggests that economic policy uncertainty positively influences cleantech VC funding, supporting the idea that, during periods of economic uncertainty, investors may turn to the cleantech sector as a stable, long-term investment opportunity, which corresponds to the finding by (Peng et al., 2022) on green innovation on a firm level and EPU index, and connecting to (Gyamerah & Asare, 2024) stating that when economic policy is uncertain, green bonds typically act more as a hedge than as a haven.

Hypothesis 1 for the positive effect of economic policy uncertainty on VC cleantech funding, particularly when lagged in time, is accepted.

### **H1: Robustness**

CPU has a statistically significant negative impact on cleantech startups in Model A3a (Table 5), supporting the hypothesis for this sector. However, this impact does not appear for clean energy startups in Model A3b, suggesting variability in how different subcategories respond to policy uncertainties. Furthermore, the sample for clean tech startups (Model A3a) only includes 767 observations, while clean energy (Model A3B) only has 360 observations. The number of observations may not be enough for statistically significant conclusion and would need to be repeated with a larger sample. There is lack of significance for CPU's effect on broader cleantech startup throughout the rest of robustness tests. However, the placebo test in Figure 7 offers overall visual evidence confirming the robustness of the results from Model A3a, with Kernel distribution coefficients evenly distributed around zero and a moderate spike of p-values around zero, which indicates some noise but still with most p-values lying outside of statistical significance range (>14%),.

In contrast to CPU, EPU consistently impacts cleantech funding positively across sectors, with statistically significant values ranging from 0.474 to 0.501, particularly in models with lagged variables. Additionally, EPU index with a lag of one and six months is statistically significant for the period (2016-2024) and the placebo tests (Figure 6), show that by comparing randomized values to the actual results, the EPU's positive coefficient is far from the values generated by randomization, providing strong evidence that the positive influence of economic policy uncertainty on cleantech funding is not due to random fluctuations or chance.

In contrary to findings by Cumming et al. (2016) of GDP's significant positive effect on VC cleantech deal numbers, GDP does not seem to have an impact on VC cleantech deal funding. This implies that

macroeconomic indicators may be less relevant for the VC cleantech deal funding amounts than the absolute deal numbers.

**H2: The proportion of renewable energy consumption relative to renewable energy production, as well as renewable energy consumption positively influence VC funding in cleantech startups in the U.S.**

The relative total renewable energy consumption to production shows consistently negative statistical impact on VC cleantech deal funding, with coefficients in Table 6, model B1, ranging from -9.210 to -9.889. The relative impact of the coefficient is difficult to interpret considering the variable is a percentage, however the pronounced negative impact can provide us some insights when considered along the variable for the renewable energy consumption, and interpreted as an indicator for renewable energy market saturation.

Renewable energy consumption is statistically significant, when one month lagged across multiple models, with a coefficient of 0.004 at 5% stat. significance level, which points towards a positive relationship between renewable energy consumption and VC deal funding amounts. When analysed for non-linear relationship, we detect an inverted U-relationship with a high positive coefficient and negative curvature of -4.039 (Table 7, Model B2b). This corresponds to the described findings above of negative relationship with PercConsumpOutProd, here interpreted as market saturation. Initially renewable energy consumption is positively associated with the VC cleantech funding amounts but once market matures the effect reverts. This effect might be also explained with falling renewable energy costs, in the wind and solar sectors (IRENA, 2020). Our explanation suggests that once the costs for renewable technology decline, the barriers to entry are reduced, which leads to increased competition and potentially lower expected returns. This scenario would furthermore discourage VCs from entering the market during periods of higher renewable energy consumption, as the growth prospects would be considerably grim. Furthermore, the research findings confirm the assumption by Van den Heuvel & Popp (2023) that demand side is crucial for VC cleantech sector funding.

**H2: Robustness**

The described results for RenEnergyConsumption and PercConsumpOutProd prove to be robust across multiple model specifications. However, for PercConsumpOutProd, the statistical significant is only found for the time frame (2009-2015), illustrated in Table 11, while RenEnergyConsumption is only significant in time frame (2016-2024), Table 12, showing potential evolution of the relationship of renewable energy consumption and VC cleantech deal funding throughout time. When looking at the conducted placebo test in Figure 5 and 8, for the latter the analysis reveals that 92.8% of

the placebo p-values are greater than 0.05 and 78.2% are greater than 0.10, indicating that the placebo-generated effects are not statistically significant in the vast majority of cases. Meaning that the placebo effect does not have a meaningful impact on cleantech funding, even though there is some noise in the data, which is also enforced by the coefficient findings in the Kernell distribution, which are largely around zero vs. the baseline coefficient in Model B2b) of 51.193.

### **H3: Rising crude oil prices are negatively associated with VC funding amounts for cleantech startups in the U.S.**

We find a negative relationship between brent crude oil price and VC funding amounts for cleantech ventures, with the oil spot price coefficient of -0.100 at 10% significance level in Table 6, Model B1. This contrasts with Cumming et al. (2016), who found that rising oil prices encouraged an increase in the number of cleantech VC deals due to the substitution effect as renewable energy becomes more attractive relative to fossil fuels. However, while the number of deals may increase, the results here suggest that the total funding amounts may decrease as investors shift focus toward other energy sources. Cumming et al. (2016) furthermore argued that while initially rising oil prices stimulate the number of cleantech VC deals, this effect slows over time, which they attributed to the incentive to exploit more costly fossil fuel deposits, due to high oil prices, which then makes the exploitation viable. This divergence also suggests that while investors may continue to engage in cleantech deal activity during periods of high oil prices, the funding committed may shrink due to the attractiveness of higher-cost fossil fuel projects.

The non-linear relationship tested in Table 7, Model B2a shows with a coefficient of -0.077 for  $\text{LnTotRenEnergyConsumptionSQ}$ , significant at the 10% level, that the negative effect of oil price on the VC cleantech deal funding amount slows down over time.

However, in Model B2b, oil prices do not exhibit statistical significance, which might raise the question as to the robustness of this finding.

### **H3: Robustness**

The negative relationship between oil prices and VC funding amounts remains consistent in Model B1 and Model B2a, with the squared term enforcing that rising oil prices weaken at higher levels. Placebo Test results from Figure 5 indicate the robustness of Model B1 results. The placebo test confirms that the observed negative coefficient for oil prices in cleantech VC funding is genuine, as it lies outside the distribution of placebo-generated coefficients. The distribution of placebo p-values further supports the statistical significance of this relationship, ruling out random variation.

Nevertheless, there is no statistical significance of the variable found in Model B2b and in the robustness tests in Tables 11 and 12. This indicates a complex not conclusive relationship between oil prices and VC cleantech deal funding which aligns with a wide range of literature discussing the complex relationship of oil prices to various factors (D. Liu et al., 2021; Pal & Mitra, 2015, 2015).

**H4: Investments performed by CVCs have a positive impact on deal funding amounts received by cleantech startups.**

The research findings strongly support H4, showing that having CVC backing as a cleantech venture positively impacts the received funding amount. Throughout tables 4 to 7, CVC is almost at all specifications statistically significant at 5 or 10% level with coefficient ranges in Table 4 for instance. This aligns with the findings by Shuwaikh, Hughes, et al. (2024), which highlighted that CVC-backed companies benefit from greater funding and longer investment durations. The positive association between having a CVC investor on board of a venture and the received funding amount, points out the profound importance of CVC investors in the cleantech space, and the leveraged synergies between startups and corporate strategic goals.

The research in this paper displays a consistent finding with broader research, such as (Shuwaikh, Brinette, et al., 2024; Shuwaikh, Hughes, et al., 2024) and thus is used as successful validation for conducted analysis.

**H4: Robustness**

The robustness tests confirm the consistency of the positive impact of CVC investments across almost all model specifications. The statistical significance of the CVC coefficient remains stable, reinforcing the findings of Shuwaikh, Hughes, et al. (2024), who emphasized that CVC-backed companies secure higher funding when exogenous uncertainties are reduced.

The robustness tests in Tables 9 to 12 reveal some nuanced results regarding CVC investments. Contrary to the positive and consistent findings in earlier models (Tables 4 to 7), the CVC dummy variable shows no significant effect in these later tables. Specifically, across Tables 9 to 12, CVC investments are found to be statistically insignificant in most instances. Also, in Table 8 (model A4), when firm fixed effects were added the CVC dummy was not significant. However, considering the overwhelming consistent statistical significance across all other conducted models and the reinforcing placebo test displayed in Figure 6, research findings validate Hypothesis 4, confirming the critical role of CVC in increasing deal funding amounts for cleantech startups in the U.S.

**Further remarks**

RuleofLaw as control variable suggested by (Cumming et al., 2016) for their VC cleantech deal number analysis, has not been significant in this research, focusing on the VC cleantech deal funding amounts. FundingType as a control variable on the other hand, specifying the exact type of funding (Seed, Series A to Z, etc.), the startup received, was consistently positively statistically significant among almost all model specifications.

## **6. Limitations and future research**

This research contributes to the ongoing discussion and research (Cumming et al., 2016; Gaddy et al., 2017; Noailly et al., 2022; Shuwaikh, Hughes, et al., 2024, 2024; van den Heuvel & Popp, 2023) on factors, that have a pronounced impact on VC cleantech investment, by including selected factors proven to have impact on VC deal numbers but not analyzed for their relevance for VC cleantech funding amounts so far, as well as by introducing a novel factor – renewable energy consumption as a determinant for VC cleantech deal funding.

Despite all the aforementioned findings gained, some limitations and opportunities for future research remain.

Due to potential autocorrelation between renewable energy consumption and production, the latter has not been considered in this analysis but also, because of causality separation difficulties between what energy is produced directly by the cleantech sector and what is not. However, in future research it would be of interest to use advanced statistical methods to better understand the relationship between production and consumption, as well as market saturation of the renewable energy sector, and VC cleantech deals and funding in general.

Noailly et al. (2022) developed and utilized their own environmental uncertainty index in their research, which may be more nuanced than the CPU index used in this research. Future studies could consider utilizing different environmental policy uncertainty aspects capturing indices, to understand their impacts on various cleantech subsectors for instance.

Further analysis of oil price fluctuations, as well as future oil price predictions such as done by J.P. Morgan Research (2023), in relationship to VC cleantech deal funding amounts, can be researched, in particular by employing advanced econometric models, such as GARCH-MIDAS.

Lastly, not all cleantech companies, and not all cleantech subsectors, may be equally exposed to policy risk. Some firms may be more vulnerable to shifts in regulatory frameworks than others, depending on their dependence on governmental support or public infrastructure. Future research

could segment cleantech firms based on their susceptibility and reliance on governmental support to better understand how the impact of policy uncertainty changes then.

## **7. Conclusion**

This paper examined climate, as well as economic policy uncertainty (CPU and EPU), Brent crude oil price, and renewable energy consumption, as well as CVC, as to their impact on VC cleantech deal funding amounts in the United States from 2000 until April 2024.

The results indicate that EPU consistently enhances cleantech VC funding, especially when lagged in time, suggesting that investors view the sector as a hedge during periods of broader economic uncertainty. In contrast, CPU has a more limited and variable impact, affecting cleantech startups unevenly, and lacking significance for the clean energy subsector, highlighting potential varying investor sensitivity in some cleantech subsectors to climate policy uncertainty.

In line with broader research, CVC is found to enhance the funding amounts received by cleantech ventures, which is also used as validation for other results in this study. This positive relationship receives a frame by Resource-Based View, which characterizes CVC according to the additional value-adds they can provide to the cleantech firms.

When employing a novel factor in this research, renewable energy consumption in the U.S., an inverted U-shaped relationship between renewable energy consumption and VC cleantech deal funding is discovered. Initially, increased consumption seems to boost the funding amounts but eventually, due to potential market saturation, the effect slows down and even reverses.

Oil prices, meanwhile, generally exert a negative influence on cleantech VC funding, as rising prices may drive the exploitation of more costly oil reserves (Cumming et al., 2016), thus the relationship remains complex.

This research contributes to the existing literature by analyzing the established factors for VC cleantech deal numbers, for their impact on the funding amounts, as well as introducing a novel factor into the literature, renewable energy consumption, and finding an inverted U-shaped relationship between consumption and funding in the context of venture capital funding of cleantech ventures.

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## Appendix

**Table 1. Variables definition**

Variable	Definition
VCFundingAmount	The funding amount for venture capital (VC) deals in U.S. cleantech startups is considered, focusing exclusively on investments made by U.S.-based Venture Capital funds across pre-seed, seed, and all subsequent series funding rounds.
PercConsumpOutProd	Percentage of total renewable energy consumption in U.S. out of total renewable energy production in U.S.
TotRenewEnergyConsump	Total renewable energy consumption in United States in trillion Btu.
CPUindex	Climate Policy Uncertainty is quantified through a media coverage index, which tracks the frequency of terms such as "climate," "uncertainty," "policy," and their synonyms across major U.S. newspapers.
OilSpotPrice	Crude Oil West Texas Intermediate Spot Price in United States, in USD per barrel.
EPUindex	This index measures policy-related economic uncertainty using three components: (1) a normalized news coverage index from ten major U.S. newspapers focused on economic and policy uncertainty terms, (2) data on temporary federal tax provisions from the Congressional Budget Office, and (3) disagreement among economic forecasters on government-influenced variables like CPI and government purchases. Each component is normalized by its pre-2012 sd, and the overall index is calculated as a weighted average of these components.
GDP	U.S. Gross domestic product.
RuleofLaw	World governance indicator by the World Bank – Rule of Law, measures the perception of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. (GDP not included in the indicator).
CVC (dummy)	Corporate Venture Capital Investor (or not).
FundingType (categorical)	Funding type of the VC cleantech deal. Ranging from pre-seed, seed, series a to series x. However, excluding governmental grants, crowdfunding, private equity, Pre-IPO, Post-IPO, debt financing and in general all other cleantech startup late-stage funding.

**Table 2. Descriptive Statistics**

Variable	Obs <sup>1</sup>	Mean	Std. Dev.	Min	Max	p1	p99	Skew.	Kurt.
VCFundingAmount	1127	20700000	83300000	5000	1.8 bn	50000	139.2 mio.	18.204	376.878
PercConsumpOutProd	1127	0.984	0.014	0.951	1.025	0.952	1.017	0.037	2.730
RenEnergyConsumption	1127	582.335	99.115	301.895	749.438	333.981	735.066	-0.834	2.852
CPUindex	1127	163.575	74.087	28.162	411.289	43.656	346.612	0.0576	2.972
OilSpotPrice	1127	72.159	23.052	19.78	140.97	20.31	123.26	0.0212	2.448
EPUindex	1127	165.205	73.778	44.783	503.963	55.63	427.915	1.658	6.944
GDP	1127	20369.621	4378.490	10318.2	28629.2	12112.8	27957	-0.015	1.872
RuleofLaw	1127	1.480	0.110	1.335	1.631	1.335	1.631	0.127	1.292
CVC (dummy)	1127	0.126	0.332	0	1	0	1	2.254	6.081

*This section provides a detailed summary of the descriptive statistics for the dependent, independent, and control variables included in the analysis, **prior to the application of logarithmic transformation**. Fixed effects are not considered in this summary. The descriptive statistics encompass the number of observations, mean, standard deviation, minimum, and maximum values, as well as the 1st and 99th percentiles. Furthermore, measures of skewness and kurtosis are reported to assess the distributional properties of each variable.*

<sup>1</sup> *The number of observations throughout the main analysis is constant at 1127 apart from where explicitly stated otherwise.*

**Table 3. Correlation matrix**

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VCFundingAmount	1.000							
PercConsumpOutProd	-0.071**	1.000						
RenEnergyConsumption	0.059**	-0.603***	1.000					
CPUindex	0.072**	-0.576***	0.615***	1.000				
OilSpotPrice	0.019	0.095***	-0.030	-0.101***	1.000			
EPUindex	0.025	-0.362***	0.357***	0.464***	-0.349***	1.000		
GDP	0.068**	-0.625***	0.897***	0.717***	0.003	0.316***	1.000	
RuleofLaw <sup>2</sup>	-0.057*	0.570***	-0.710***	-0.695***	0.212***	-0.541***	-0.833***	1.000

*This table shows pairwise correlations between the main variables included in the models. \*, \*\*, and \*\*\* denote statistical significance, respectively, at the 10%, 5%, and 1% levels.*

<sup>2</sup> *Due to high correlation of RuleofLaw control variable with other independent variables, all regressions have been conducted by including and excluding the RuleofLaw control variable. However, as the main regression results nearly did not differ (by excl. incl. RuleofLaw) apart from the stat. significance and slight increase in standard errors in the constant, most of the results below are presented by including the RuleofLaw control var. to avoid omitted variables bias.*

## Main Analysis Results and Robustness Tests

**Table 4. Multivariate OLS regression analysis with fixed effects year, region and industry**

**Model A1)** examines the relationship between Climate Policy and Economic Policy Uncertainty and their impact on the amount of VC funding received by Cleantech startups in U.S.

LnVCFundingAmount	(t0)	Lag applied	Lag(t-1)	Lag(t-3)	Lag(t-6)
CPUindex	-0.002 (0.001)	YES	-0.001 (0.001)	-0.001 (0.001)	0.001 (0.001)
LnEPUindex	0.182 (0.209)	YES	0.474** (0.205)	0.999 (0.194)	0.310* (0.188)
GDP	0.001 (0.001)	NO	0.001 (0.001)	-0.001 (0.001)	0.001 (0.001)
RuleofLaw	6.584 (26.171)	NO	10.350 (25.346)	-9.668 (25.326)	0.316 (24.256)
CVC (dummy)	0.226* (0.119)	NO	0.230* (0.117)	0.232* (0.119)	0.236** (0.119)
FundingType	0.555*** (0.043)	NO	0.550*** (0.042)	0.550*** (0.042)	0.550*** (0.042)
Region FE	-	-	-	-	-
Year FE	-	-	-	-	-
Industry FE	-	-	-	-	-
Constant	1.100 (42.510)	-	-6.087 (41.160)	27.668 (41.008)	10.745 (39.150)
R-squared (robust)	0.242	-	0.244	0.241	0.242

*This table shows the results of multivariate robust OLS with fixed effects, along the corresponding levels of statistical significance. Statistical significance is denoted by \*, \*\*, and \*\*\*, at the 10%, 5%, and 1% levels, respectively. The dependent variable, LnVCFundingAmount, is measured contemporaneously (t0). Lags are measured in months. The VC deal funding amount and EPU index have been transformed with natural log as the variables were highly skewed and characterized by a high kurtosis. The funding type variable is categorical.*

**Table 5. Multivariate OLS regression analysis with fixed effects year, region and industry****Model A2)** assesses the effect of Climate Policy Uncertainty (excl. EPU) on VC Cleantech deal funding amounts in U.S.

LnVCFundingAmount	(t0)	Lag applied	Lag(t-1)	Lag(t-3)	Lag(t-6)
CPUindex	-0.002 (0.001)	YES	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)
GDP	0.001 (0.001)	NO	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
RuleofLaw	0.802 (25.020)	NO	-7.190 (23.961)	-11.594 (24.980)	-4.107 (24.334)
CVC (dummy)	0.228* (0.119)	NO	0.230* (0.119)	0.233* (0.119)	0.231* (0.119)
FundingType	0.259*** (0.051)	NO	0.550*** (0.042)	0.550*** (0.042)	0.550*** (0.042)
Region FE	-	-	-	-	-
Year FE	-	-	-	-	-
Industry FE	-	-	-	-	-
Constant	11.192 (40.373)	-	24.122 (38.650)	31.224 (40.90)	19.181 (39.243)
R-squared (robust)	0.241	-	0.240	0.240	0.240

**Model A3a)** assesses the effect of Climate and Economic Policy Uncertainty by isolating the effect of either Clean Energy or Clean Tech focused startups on VC Cleantech deal funding amounts in U.S.Clean Tech startups isolated in the regression below.<sup>1</sup>

LnVCFundingAmount	(t0)	Lag applied	Lag(t-1)	Lag(t-3)	Lag(t-6)
CPUindex	-0.003* (0.002)	YES	-0.001 (0.001)	-0.002 (0.001)	0.002 (0.001)
LnEPUindex	0.124 (0.269)	YES	0.535** (0.249)	0.124 (0.226)	0.449** (0.215)
GDP	0.001 (0.001)	NO	0.001 (0.001)	-0.001 (0.001)	0.001 (0.001)
CVC (dummy)	0.169 (0.133)	NO	0.161 (0.133)	0.168 (0.134)	0.176 (0.134)
FundingType	0.600*** (0.052)	NO	0.590*** (0.052)	0.592*** (0.052)	0.597*** (0.052)
Region FE	-	-	-	-	-
Year FE	-	-	-	-	-
Industry FE	-	-	-	-	-
Constant	10.856*** (2.236)	-	9.154*** (2.059)	12.005*** (1.917)	9.679*** (1.711)
R-squared (robust)	0.283	-	0.283	0.280	0.287

**Model A3b)** assesses the effect of Climate and Economic Policy Uncertainty by isolating the effect of either Clean Energy or Clean Tech focused startups on VC Cleantech deal funding amounts in U.S.Clean Energy startups isolated in the regression below.<sup>1</sup>

LnVCFundingAmount	(t0)	Lag applied	Lag(t-1)	Lag(t-3)	Lag(t-6)
CPUindex	0.001 (0.002)	YES	0.004 (0.003)	0.001 (0.003)	-0.004 (0.002)

LnEPUindex	0.139 (0.396)	YES	0.078 (0.412)	-0.146 (0.387)	-0.166 (0.402)
GDP	0.001 (0.001)	NO	0.001 (0.001)	-0.001 (0.001)	0.001 (0.001)
CVC (dummy)	0.353 (0.253)	NO	0.346 (0.245)	0.339 (0.248)	0.361 (0.254)
FundingType	0.441*** (0.078)	NO	0.447*** (0.078)	0.438*** (0.078)	0.447*** (0.076)
Region FE	-	-	-	-	-
Year FE	-	-	-	-	-
Industry FE	-	-	-	-	-
Constant	13.359*** (3.482)	-	13.490*** (3.544)	14.336*** (3.245)	14.546*** (2.788)
R-squared (robust)	0.215	-	0.221	0.214	0.223

*This table shows the results of multivariate robust OLS with fixed effects, along the corresponding levels of statistical significance. Statistical significance is denoted by \*, \*\*, and \*\*\*, at the 10%, 5%, and 1% levels, respectively. The dependent variable, LnVCFundingAmount, is measured contemporaneously (t0). Lags are measured in months.*

*The VC deal funding amount and EPU index have been transformed with natural log as the variables were highly skewed and characterized by a high kurtosis.*

*<sup>1</sup>Total N of observations for clean tech start-ups in the dataset is 767. The clean energy start-ups have a total of 360 observations out of the total sample studied in this research.*

**Table 6. Multivariate OLS regression analysis with fixed effects year, region and industry**

**Model B1** examines the effects of brent crude oil spot price, the proportion of renewable energy in total U.S. energy production, and U.S. renewable energy consumption on VC funding amounts in cleantech deals.

LnVCFundingAmount	(t0)	Lag applied	Lag(t-1)	Lag(t-3)	Lag(t-6)
PercConsumpOutProd	-9.892* (5.638)	no	-9.210* (5.547)	-9.889* (5.801)	-9.249* (5.530)
RenEnergyConsumption	0.003 (0.002)	yes	0.004** (0.002)	0.001 (0.002)	-0.001 (0.002)
OilSpotPrice	-0.100* (0.005)	yes	-0.005 (0.006)	0.004 (0.005)	-0.001 (0.002)
GDP	0.001 (0.001)	no	0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
RuleofLaw	16.388 (27.159)	no	13.622 (27.141)	-9.119 (24.120)	-5.048 (24.048)
CVC (dummy)	0.239** (0.119)	no	0.245** (0.118)	0.240** (0.120)	0.241** (0.119)
FundingType	0.550*** (0.042)	no	0.550*** (0.042)	0.550*** (0.042)	0.550*** (0.042)
Region FE	-	-	-	-	-
Year FE	-	-	-	-	-
Industry FE	-	-	-	-	-
Constant	-4.144 (44.015)	-	-0.677 (44.480)	37.191 (39.358)	30.131 (39.203)
R-squared (robust)	0.245	-	0.245	0.243	0.242

*This table shows the results of multivariate robust OLS with fixed effects, along the corresponding levels of statistical significance. Statistical significance is denoted by \*, \*\*, and \*\*\*, at the 10%, 5%, and 1% levels, respectively. The dependent variable, LnVCFundingAmount, is measured contemporaneously (t0). Lags are measured in months. The VC deal funding amount and EPU index have been transformed with natural log as the variables were highly skewed*

**Table 7. Multivariate OLS regression analysis with fixed effects year, region and industry**

**Model B2a)** investigates the impact of (5) brent crude oil spot price (Ln and squared), (2) the proportion of renewable energy consumption out of total U.S. energy production, and (3) U.S. renewable energy consumption (Ln) on Venture Capital (VC) funding amounts in cleantech deals.

LnVCFundingAmount <sup>1</sup>	(t0)	Lag applied	Lag(t-1)	Lag(t-3)	Lag(t-6)
PercConsumpOutProd	-10.198* (5.634)	NO	-9.502* (5.514)	-9.612* (5.780)	-8.901 (5.530)
Ln RenEnergyConsumption	1.670 (1.227)	YES	2.296* (1.244)	0.332 (0.038)	0.334 (1.171)
LnOilSpotPriceSQ	-0.077* (0.045)	YES	-0.038 (0.047)	0.029 (0.038)	-0.020 (0.033)
GDP	0.001 (0.001)	NO	0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
RuleofLaw	19.978 (28.363)	NO	15.528 (28.255)	-7.768 (24.185)	-6.483 (24.018)
CVC (dummy)	0.235** (0.119)	NO	0.244** (0.118)	0.241** (0.120)	0.242** (0.119)
FundingType	0.550*** (0.042)	NO	0.550*** (0.042)	0.550*** (0.042)	0.550*** (0.042)
Region FE	-	-	-	-	-
Year FE	-	-	-	-	-
Industry FE	-	-	-	-	-
Constant	-17.63 (48.746)	-	15.039 (48.818)	32.820 (40.273)	30.335 (39.409)
R-squared (robust)	0.244	-	0.244	0.243	0.242

**Model B2b)** variables (2), (3) and (5) all log-transformed and squared to check for a non-linear relationship (with curvature) on Venture Capital (VC) funding amounts in cleantech deals.

LnVCFundingAmount <sup>1</sup>	(t0)	Lag applied	Lag(t-1)	Lag(t-3)	Lag(t-6)
LnPercConsumpOutProd	-14.296 (12.015)	NO	-13.173 (11.652)	-10.837 (11.398)	-11.880 (11.559)
LnPercConsumpOutProdSQ	-111.738 (257.366)	NO	-69.834 (242.935)	-36.283 (239.090)	-61.979 (241.371)
Ln RenEnergyConsumption	-24.551 (33.413)	YES	-49.433 (36.139)	0.796 (32.902)	51.193* (26.950)
Ln RenEnergyConsumptionSQ	2.071 (2.646)	YES	4.067 (2.864)	-0.036 (2.622)	-4.039* (2.167)
LnOilSpotPrice	1.976 (3.473)	YES	-0.830 (3.195)	0.348 (2.710)	-3.305 (2.247)
LnOilSpotPriceSQ	-0.326 (0.422)	YES	0.063 (0.394)	-0.016 (0.341)	0.399 (0.288)
LnGDP	1.027 (2.919)	NO	0.306 (3.038)	-1.111 (2.735)	-0.335 (2.767)
CVC (dummy)	0.238** (0.119)	NO	0.238** (0.118)	0.241** (0.120)	0.254** (0.120)
FundingType	0.550*** (0.042)	NO	0.547*** (0.042)	0.549*** (0.042)	0.551*** (0.042)
Region FE	-	-	-	-	-
Year FE	-	-	-	-	-

Industry FE	-	-	-	-	-
Constant	73.037 (107.965)	-	161.954 (116.579)	15.598 (110.827)	-138.842 (92.552)
R-squared (robust)	0.245	-	0.246	0.243	0.245

*This table shows the results of multivariate robust OLS with fixed effects, along the corresponding levels of statistical significance. Statistical significance is denoted by \*, \*\*, and \*\*\*, at the 10%, 5%, and 1% levels, respectively. The dependent variable, LnVCFundingAmount, is measured contemporaneously (t0). Lags are measured in months.*

<sup>1</sup>*The VC deal funding amount and EPU index have been transformed with natural log as the variables were highly skewed and characterized by a high kurtosis.*

<sup>2</sup>*Regressions were estimated both with and without LnRuleofLaw. The inclusion of LnRuleofLaw resulted in an increase in standard errors, and the constant being not statistically significant. Apart from the impact on the constant, the overall regression results did not differ (only miscellaneous). As to avoid omitted variable bias, regression results including (Ln)RuleofLaw and without are displayed in the analysis.*

**Table 8. Multivariate OLS regression analysis with fixed effects firm and region**

**Model A4** evaluates the effect of Climate Policy Uncertainty, excluding Economic Policy Uncertainty (EPU), on Venture Capital (VC) funding amounts for cleantech deals in the U.S., employing different fixed effects compared to Model A2.

LnVCFundingAmount <sup>1</sup>	(t0)	Lag applied	Lag(t-1)	Lag(t-3)	Lag(t-6)
CPUindex	0.064 (0.159)	YES	0.103 (0.151)	0.165 (0.163)	0.002* (0.001)
GDP	3.360*** (0.645)	NO	3.317*** (0.644)	3.144*** (0.647)	3.084*** (0.631)
RuleofLaw	-2.657** (1.330)	NO	-2.566* (1.334)	-1.781** (0.874)	-1.595* (0.884)
CVC (dummy)	0.083 (0.132)	NO	0.081 (0.132)	0.081 (0.131)	0.082 (0.130)
FundingType	0.259*** (0.051)	NO	0.260*** (0.506)	0.259*** (0.050)	0.262*** (0.050)
Region FE	-	-	-	-	-
Firm FE	-	-	-	-	-
Constant	-17.925*** (6.222)	-	-17.684*** (6.224)	-14.675** (6.552)	-14.332** (6.505)
R-squared (robust)	0.587		0.587	0.589	(0.590)

**Model A4** examines the impact of Economic Policy Uncertainty, independently of Climate Policy Uncertainty (as in Model A1), on Venture Capital (VC) funding amounts for cleantech deals in the U.S., utilizing different fixed effects compared to Model A1.

LnVCFundingAmount <sup>1</sup>	(t0)	Lag applied	Lag(t-1)	Lag(t-3)	Lag(t-6)
LnEPUindex	0.146 (0.142)	yes	0.308** (0.137)	0.303** (0.141)	0.089 (0.143)
GDP	3.903*** (0.558)	no	3.884*** (0.556)	3.795*** (0.559)	3.867*** (0.131)
CVC (dummy)	0.080 (0.131)	no	0.075 (0.131)	0.076 (0.131)	0.084 (0.131)
FundingType	0.267*** (0.050)	no	0.263*** (0.500)	0.268*** (0.050)	0.268*** (0.050)
Region FE	-	-	-	-	-
Firm FE	-	-	-	-	-
Constant	-24.884*** (5.259)	-	-25.35*** (5.232)	-24.495*** (5.215)	-24.230*** (5.240)
Adj. R-squared	0.586		0.589	0.588	(0.590)

*This table shows the results of multivariate robust OLS with fixed effects, along the corresponding levels of statistical significance. Statistical significance is denoted by \*, \*\*, and \*\*\*, at the 10%, 5%, and 1% levels, respectively. The dependent variable, LnVCFundingAmount, is measured contemporaneously (t0). Lags are measured in months.*

<sup>1</sup>The VC deal funding amount and EPU index have been transformed with natural log as the variables were highly skewed and characterized by a high kurtosis.

**Table 9. Robustness test – Multivariate OLS with fixed effects region, industry and year for 2000-2015<sup>1</sup> for models A)**

LnVCFundingAmount <sup>2</sup>	(t0)	Lag applied	Lag(t-1)	Lag(t-3)	Lag(t-6)
CPUindex	-0.005 (0.003)	YES	-0.004 (0.003)	-0.004 (0.003)	0.003 (0.003)
LnEPUindex	0.250 (0.289)	YES	0.444 (0.296)	0.407 (0.294)	-0.215 (0.322)
GDP	-0.001 (0.001)	NO	0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
CVC (dummy)	0.033 (0.266)	NO	0.076 (0.266)	0.072 (0.266)	0.058 (0.266)
FundingType	0.515*** (0.061)	NO	0.505*** (0.061)	0.518*** (0.062)	0.512*** (0.062)
Region FE	-	-	-	-	-
Year FE	-	-	-	-	-
Industry FE	-	-	-	-	-
Constant	14.987*** (4.715)	-	14.552*** (4.676)	14.190*** (4.822)	17.365*** (4.988)
R-squared (robust)	0.228	-	0.228	0.228	0.224

**Table 10. Robustness test – Multivariate OLS with fixed effects region, industry and year for 2016-2024<sup>1</sup> for models A)**

LnVCFundingAmount <sup>2</sup>	(t0)	Lag applied	Lag(t-1)	Lag(t-3)	Lag(t-6)
CPUindex	-0.002 (0.001)	YES	-0.000 (0.001)	-0.001 (0.001)	-0.000 (0.001)
LnEPUindex	0.175 (0.296)	YES	0.556* (0.289)	-0.076 (0.256)	0.541** (0.243)
GDP	0.001 (0.001)	NO	0.001 (0.001)	-0.001 (0.001)	0.001 (0.001)
CVC (dummy)	0.281 (0.183)	NO	0.272 (0.183)	0.287 (0.183)	0.302* (0.183)
FundingType	0.572*** (0.043)	NO	0.565*** (0.043)	0.567*** (0.043)	0.568*** (0.043)
Region FE	-	-	-	-	-
Year FE	-	-	-	-	-
Industry FE	-	-	-	-	-
Constant	9.917*** (3.195)	-	7.586** (3.209)	12.673*** (2.823)	8.591*** (2.656)
R-squared (robust)	0.252	-	0.254	0.251	0.256

<sup>1</sup>The final robustness tests involve splitting the dataset into two time frames: 2000-2015 (410 observations) and 2016-2024 (717 observations). This division is motivated by a key event in environmental policy, the U.S. signing the Paris Agreement in 2016 (UNFCCC, 2024). This table shows the results of multivariate robust OLS with fixed effects, along the corresponding levels of statistical significance. Statistical significance is denoted by \*, \*\*, and \*\*\*, at the 10%, 5%, and 1% levels, respectively. The dependent variable, LnVCFundingAmount, is measured contemporaneously (t0). Lags are measured in months.

<sup>2</sup>The VC deal funding amount and EPU index have been transformed with natural log as the variables were highly skewed and characterized by a high kurtosis.

**Table 11. Robustness test – Multivariate OLS with fixed effects region, industry and year for 2000-2015<sup>1</sup> for models B)**

LnVCFundingAmount <sup>2</sup>	(t0)	Lag applied	Lag(t-1)	Lag(t-3)	Lag(t-6)
PercConsumpOutProd	-18.828* (10.214)	NO	-17.310* (10.141)	-20.817** (10.446)	-15.719 (10.254)
RenEnergyConsumption	0.003 (0.004)	YES	0.004 (0.005)	0.003 (0.004)	0.005 (0.004)
OilSpotPrice	-0.009 (0.007)	YES	-0.006 (0.008)	0.010 (0.008)	0.005 (0.006)
GDP	0.001 (0.001)	NO	0.001 (0.001)	0.001 (0.001)	-0.001 (0.001)
CVC (dummy)	0.074 (0.266)	NO	0.088 (0.266)	0.082 (0.265)	0.101 (0.266)
FundingType	0.518*** (0.062)	NO	0.523*** (0.062)	0.520*** (0.062)	0.528*** (0.062)
Region FE	-	-	-	-	-
Year FE	-	-	-	-	-
Industry FE	-	-	-	-	-
Constant	30.735*** (10.010)	-	29.178*** (10.119)	35.038*** (10.374)	29.804*** (10.016)
R-squared (robust)	0.232	-	0.230	0.235	0.234

**Table 12. Robustness test – Multivariate OLS with fixed effects region, industry and year for 2016-2024<sup>1</sup> for models B)**

LnVCFundingAmount <sup>2</sup>	(t0)	Lag applied	Lag(t-1)	Lag(t-3)	Lag(t-6)
PercConsumpOutProd	-5.280 (6.645)	NO	-5.529 (6.515)	-5.409 (6.704)	-5.819 (6.489)
RenEnergyConsumption	0.003 (0.002)	YES	0.004* (0.002)	0.000 (0.003)	-0.002 (0.003)
OilSpotPrice	-0.013 (0.009)	YES	-0.005 (0.008)	-0.000 (0.007)	-0.005 (0.006)
GDP	0.001 (0.001)	NO	-0.001 (0.001)	-0.001 (0.001)	0.001 (0.001)
CVC (dummy)	0.292 (0.183)	NO	0.295* (0.184)	0.290 (0.184)	0.293 (0.183)
FundingType	0.566*** (0.043)	NO	0.563*** (0.043)	0.567*** (0.043)	0.568*** (0.043)
Region FE	-	-	-	-	-
Year FE	-	-	-	-	-
Industry FE	-	-	-	-	-
Constant	14.432** (7.282)	-	14.943** (7.440)	17.358** (7.078)	17.908** (7.065)
R-squared (robust)	0.254	-	0.254	0.251	0.253

<sup>1</sup>The final robustness tests involve splitting the dataset into two time frames: 2000-2015 (410 observations) and 2016-2024 (717 observations). This division is motivated by a key event in environmental policy, the U.S. signing the Paris Agreement in 2016 (UNFCCC, 2024). This table shows the results of multivariate robust OLS with fixed effects, along the corresponding levels of statistical significance. Statistical significance is denoted by \*, \*\*, and \*\*\*, at the 10%, 5%,

and 1% levels, respectively. The dependent variable,  $\ln VCFundingAmount$ , is measured contemporaneously ( $t_0$ ). Lags are measured in months.

<sup>2</sup>The VC deal funding amount and EPU index have been transformed with natural log as the variables were highly skewed and characterized by a high kurtosis.

## Figures

Figure 2. Actual total clean investment by segment (quarterly) in the United States in USD

This figure illustrates the actual public and private investment in clean technologies in the U.S. from 2018 through Q2 2024. The investments are categorized into three segments: clean manufacturing, clean energy & industry, and retail. Retail investments reflect the spending by American households and businesses on electric vehicle purchases, renewable electricity, storage, and other clean technologies.

(Clean Investment Monitor, 2023)

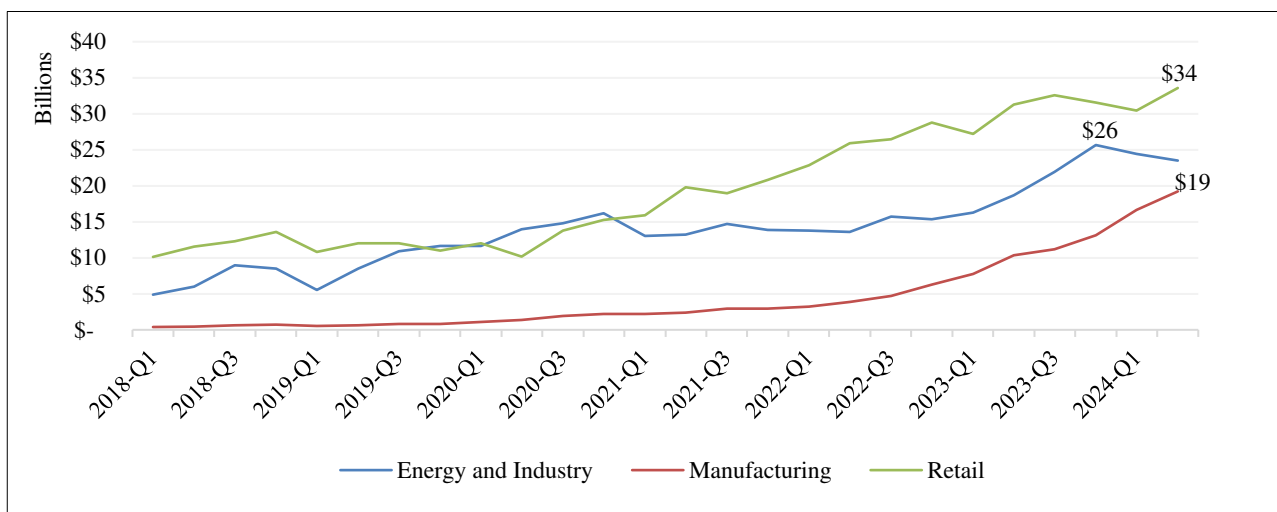


Figure 3. Total renewable energy consumption vs. production in trillion Btu in US

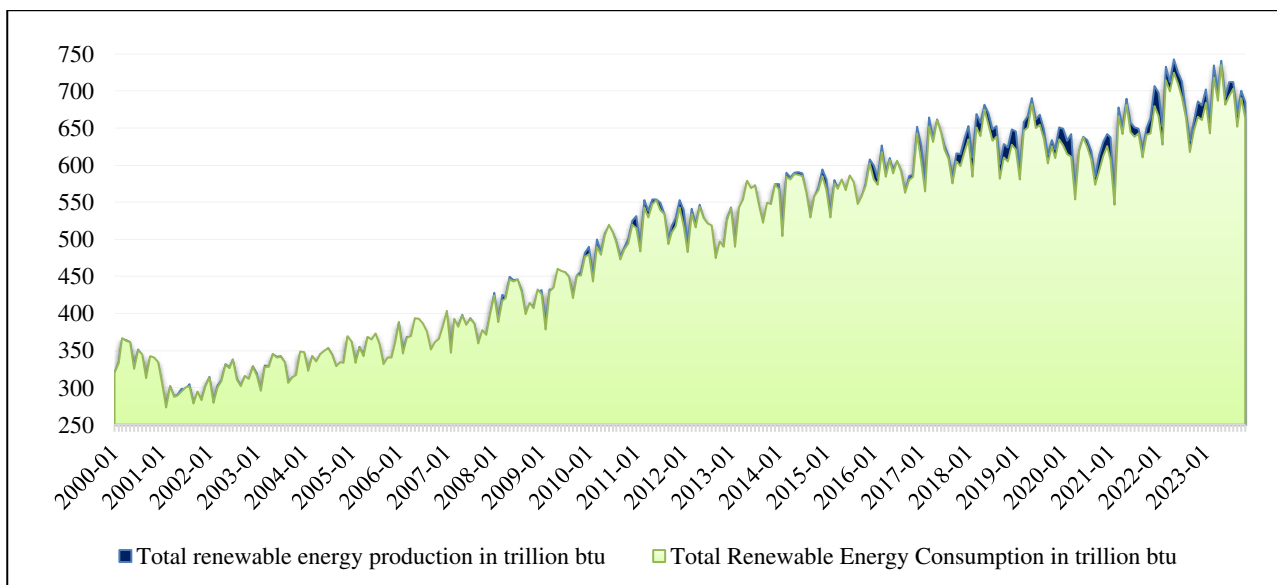


Figure 4. VC cleantech deal funding in mio. USD in the U.S.(only U.S based investees and investors considered) vs. Brent crude oil price USD/bb

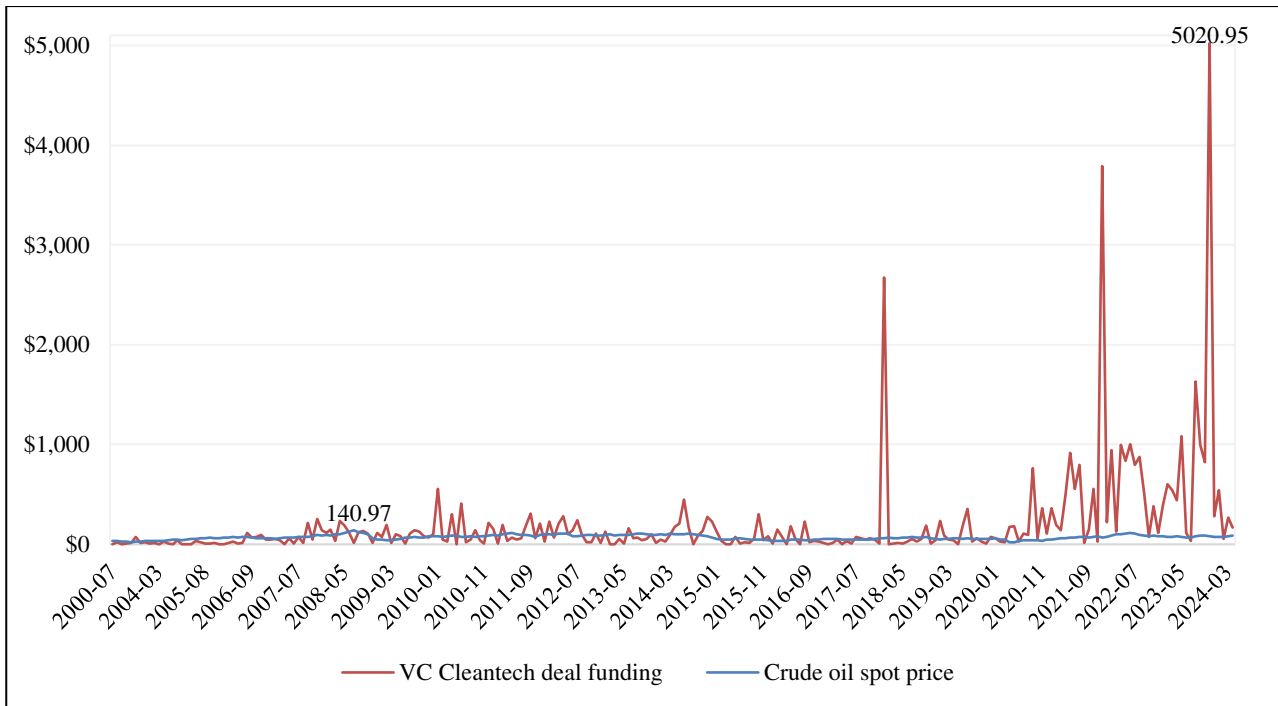


Figure 5. Placebo test for Model B1 ( $t_0$ ) (PercConsumpOutProd, OilSpotPrice and CVC testing)

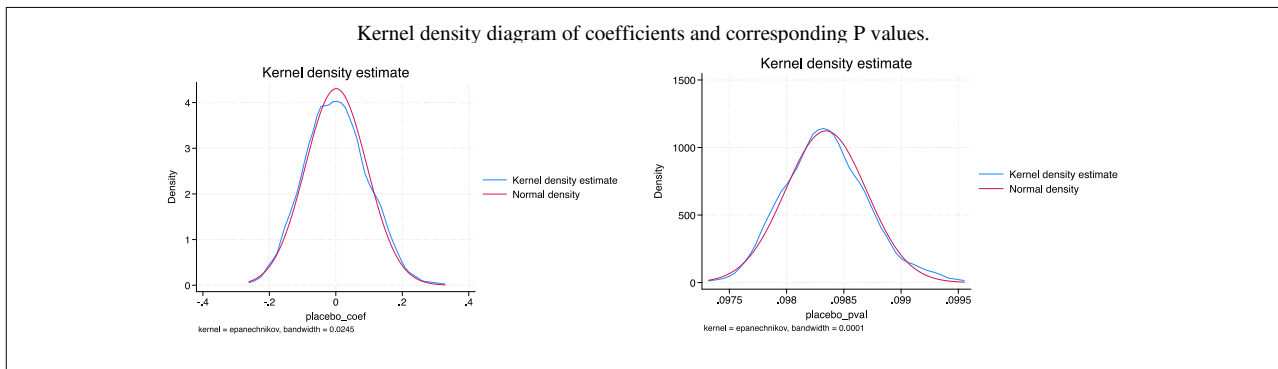


Figure 6. Placebo test for Model A1 lag ( $t_{-1}$ ) (LnEPUindex and CVC testing)

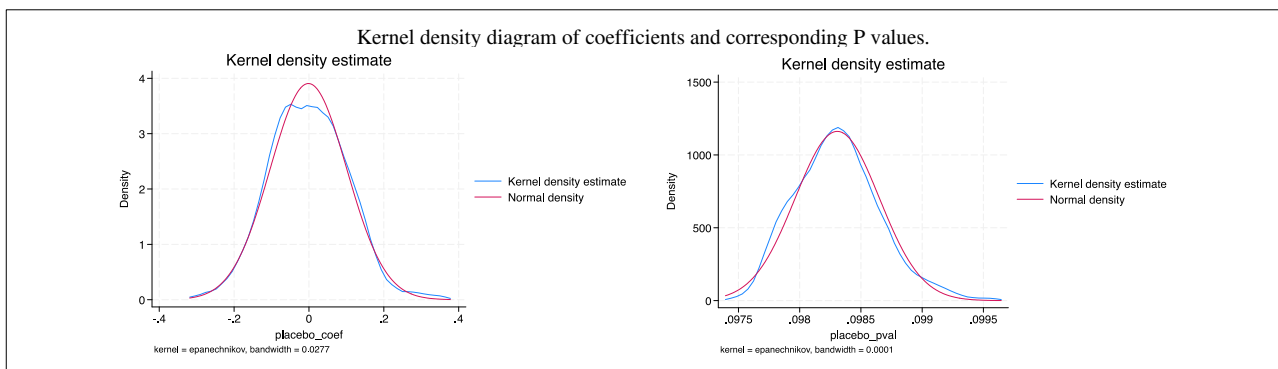


Figure 7. Placebo test for Model A3a) lag (t0) (CPU index for subsector Cleantech)

This diagram displays the distribution of 500 coefficients generated through randomized placebo tests. The coefficients simulate what the effect of the Climate Policy Uncertainty (CPU) index on cleantech VC funding would look like if no true relationship existed.

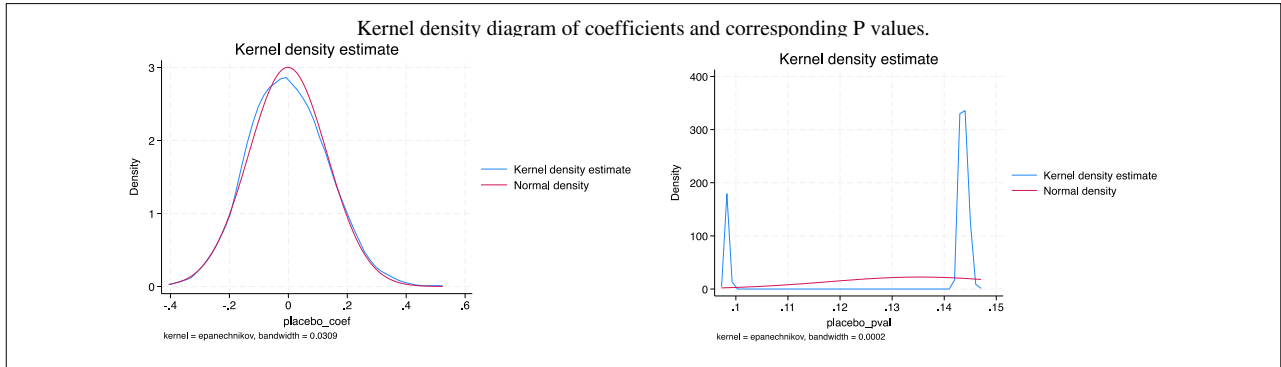


Figure 8. Placebo test for Model B2b) lag (t-6) (testing for Total renewable energy consumption (non-linear curvature relationship))

Description: 92.8% of the placebo p-values are greater than 0.05 and 78.2% are greater than 0.10, which indicates that the placebo effect does not have a significant effect in most cases, even though there is some noise in the data.

