Does Venture Capitalist Value Green Innovation?:

Evidence from State Climate Adaptation Plans

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Hyeonjoon Park[1]

Abstract

This study examines whether startups react to climate risk by increasing the level of green innovation and how venture capital (VC) investors consider climate risk in their investment decisions. By using the State Climate Adaptation Plan (SCAP) as an exogenous shock that alters the level of perceived climate risk, this paper finds that startups react to the SCAP by increasing the level of green innovation and raising incremental capital from VC investors while brown startups get penalized by the enhanced environmental regulation and raise less funding from VCs. However, the sudden increase in demand for green innovation leads green startups to fail to balance their innovation portfolio, leaving them to have less amount of overall innovation. This makes a significant discrepancy from startups financed by experienced VCs which outperformed in terms of innovation outcome and exit performance. Finally, the early-stage startups that cannot increase green innovation immediately tend to face financial constraints after the SCAP whereas startups in energy industries increase green innovation but fail to raise additional VC investment.

JEL classifications: G11, G24, G34, G38, O31

Keywords: Venture capital, green innovation, climate risk, monitoring, State Climate Adaptation Plans, round amount, exit performance

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1. Introduction

Global society is experiencing striking historical rises in temperatures every summer nowadays, and accordingly, climate risk is receiving unprecedented attention not only from a specific sector but from every aspect of human society. Recently, the United Nations (UN) organized a climate talk and warned of the bleak outlook of worsening climate impacts and the substantial lack of progress on cutting emissions. António Guterres, the secretary-general of the UN, declared the current climate disaster as “the world was on a highway to climate hell with our foot on the accelerator". According to the reports from National Oceanic and Atmospheric Administration (NOAA), climate risk is worsening the consequences of natural disasters such as hurricanes, drought, flooding, and winter storms, leading to $2.2 trillion in losses since 1980. In the recent five years between 2017 to 2021, the aggregate annual loss of economic turmoil due to the climate risk skyrocketed up to $765 billion which was eight times higher than in the 1980s. This new phenomenon of climate risk-driven economic cost brought huge financial demand for sustainable business operations and eco-friendly green innovation technology.

As the fact that climate risk imposes a considerable cost to the world’s economy is no longer Pandora’s box, one prominent change was detected where developed countries acknowledged the need for loss and damage and started to make macroscopic policy changes. Recently, the Biden administration changed 401K Rules and released the final rule under the Employee Retirement Income Security Act (ERISA) to favor environmental, social, and governance (ESG) funds. This change is undertaken with an expectation to make fiduciaries consider climate change and ESG factors when making investment decisions and exercising shareholder rights.

Investors taking into account climate risk as one of the major components in investment decisions has been widely examined from prior literature and led to mixed findings. Prior studies introduce significant evidence that market participants including institutional investors as well as retail investors do address climate risk in their investment strategy (Dyck, Lins, Roth, and Wagner, 2019; Hartzmark and Sussman, 2019; Krueger, Sautner, and Starks, 2020; Andriosopoulos, Czarnowski, and Marshall, 2021; Bauer, Ruof, and Smeets, 2021; Burt, Harford, Stanfield, and Zein, 2022; Cheng, Chu, Deng, Huang, 2022). However, the interpretation of addressing climate risk is controversial. Part of the literature suggests that the incorporation of a climate risk-driven investment strategy brings innovative rewards to the financial market and allows investors to effectively distinguish between green and brown companies (Hsu, Liang, and Matos, 2018; Addoum, Ng, and Ortiz-Bobea, 2020; Baldauf, Garlappi, and Yannelis, 2020; Choi, Gao, and Jiang, 2020; Engle, Giglion, Kelly, Lee, and Stroebel, 2020; Pástor, Stambaugh, and Taylor, 2021; Avramov, Cheng, Lioui, and Tarelli, 2022; Huang, Li, Lin, and McBrayer, 2022). On the other hand, many studies point out the unexpected negative externalities induced by addressing climate risk factors in investment decisions, which signals a demand for a cautious approach to environmental risk (Di Giuli and Kostoversky, 2014; Alok, Kumar, and Wermers, 2020; Andriosopoulos, Czarnowski, and Marshall, 2021; Cohen, Gurun, and Nguyen, 2021; Kovacs, Latif, Yuan, and Zhang, 2021; Apergis, Poufinas, and Antonopoulos, 2022; Bartram, Hou, and Kim, 2022; Pástor, Stambaugh, and Taylor, 2022). Meanwhile, there is also prior literature pointing out the irrelevancy of climate risk to financial investment output and sustainability does not affect fundamentals, cost of capital, and risk (Humphrey, Lee, and Shen, 2012; Addoum, David, and Ortiz-Bobea, 2020).

Even with the prevalence of efforts examining the linkage between climate risk and its impact on the financial market, most of the studies are undertaken in the public firm setting while leaving the effect of climate risk within the private sector relatively less frequently examined. This paper aims to fill out this gap of environment risk by studying how climate risk impacts green innovation made by early entrepreneurs and whether venture capital (VC) investors reward this or not by changing their investment strategy. By using state climate adaptation plans (SCAP) as an exogenous shock which can alter the level of environmental regulation and accompanied compliance cost and impact operating local small entities within the states, this study extends the line of studies in climate risk and make it possible to verify its economic impact on private firms. Since the SCAP is a staggered adoption plan made by different states in the United States, it provides a suitable setting to use the difference-in-differences ("DiD") methodology to investigate its impact on local startups and VC investors. By conducting a novel dataset that merges VentureXpert from Refinitiv's Securities Data Company (SDC) Platinum and the United States Patent and Trademark Office (USPTO), this paper investigates whether startups react to state climate policies and whether VC investors show a significant change in investment preference on an enhanced level of climate risk.

The main results show that the SCAP significantly impacts local startups to increase the level of green innovation output. The green startups turn out to be more likely to increase their innovation focus on green technology and this allows them to raise more capital from VC investors after the SCAP is adopted. On the contrary, after the climate risk within the state gained attention through the adoption of SCAP, brown startups tend to get penalized by VCs and find it difficult to raise funding and experience a decline in the amount of investment.

However, this preference for green startups with a larger amount of green technology does not represent the investment strategy delivered by experienced VCs, who maintained their strategy of investing in green startups with an increase in the overall level of innovation performance measured by weighted patent outcomes. In fact, unlike the green startups funded by experienced VC investors, most of the green startups in the sample failed to balance their level of overall innovation output while focusing their innovation scope on enlarging green innovation only. Due to this change, although SCAP significantly contributed to triggering a green innovation boom among the affected local startups, only the green startups backed by experienced VC investors had a successful exit in the long run. The SCAP also led startups at their early-stage that cannot immediately enlarge green innovation output to face financial constraints by switching VC investors' preference to green innovation. This paper further finds supportive evidence of the disconnect in ESG funding where startups in energy industries tend to increase green innovation after the SCAP but get excluded from raising the increased amount of VC funding.

The main findings of this paper contribute to three strands of literature. First, this study initiates an investigation on climate risk using private companies so that can extend the line of previous literature on climate risk which was mainly focused on the public firm scope. Second, this study gives supportive evidence of the true value of green innovation, especially using data from the private sector which is a key source of innovation in the whole technology industry. Third, this study re-confirms how the value-adding service and certification effect of VC investors are critical for startups' performance in terms of their business operation, innovation, and successful exit (Megginson and Weiss, 1991; Nahata, 2008; Krishnan, Ivanov, Masulis, and Singh, 2011; Tian, 2011; Atanasov, Ivanov, and Litak, 2012; Tian, 2012; Bernstein, 2015, Bernstein, Giroud, and Townsend; 2016, Bernstein, Korteweg, and Laws, 2017; Gompers, Gornall, Kaplan, and Strebulaev, 2020). Therefore, this study is one of the first to examine the link between climate risk and green innovation at the private firm level and shed light on a relatively unexplored question of whether the climate initiative and green technology will be helpful for entrepreneurs and thus welcomed by VC investors or not.

2. Institutional Background and Hypothesis Development

2.1. Institutional Background

According to Ray and Grannis (2015), due to the lack of federal-level climate action, a number of states made a proactive effort to mitigate the current and potential climate risk by adopting climate adaptation plans. As of 2019, 15 states had initiated and finalized state-level climate adaptation plans. Table 1 shows the specific adoption years of the SCAP for 15 U.S. states.

The plans encompass various dimensions of goals including infrastructure, commercial, industrial, and manufacturing activities, water supply and quality, ecosystem dynamics, renewable energy regulations, and alternative fuels. The range of the number of goals for each state adaptation plan varies with 20 for Maryland and 373 for Massachusetts, with an average of 136 per plan. These goals can be distinguished into three main categories including planning and capacity building, law and policy, and post-implementation monitoring and each of the three categories can potentially influence the current and future business operations within these states. The first planning and capacity building category is highly relevant to raise future awareness of climate risk for local businesses and investors. The second law and policy category can directly impact stakeholders by creating and revising legislation or regulations. Finally, the third post-implementation monitoring category can affect the cost of capital and quality of local businesses. Therefore, the SCAP can impose direct and indirect impacts on business models and lead to an economically substantial change for both entrepreneurs and investors within the states.

Due to this wide range of goals, unlike the forms of federal acts, these state climate adaptation plans share the common objective of reducing climate risk but show heterogeneity in terms of enforcement rather than a simple cap-and-trade policy. The impetus of these plans is made through a combination of executive orders by the governors, legislative mandate, and appeal to relevant stakeholders in the industry (Kovacs, Latif, Yuan, and Zhang, 2020). For instance, one of the state policies made in California in accordance with SCAP, senate bill 535, seeks to reduce greenhouse gas emissions and promotes funding to the most environmentally impacted communities. Whereas the Massachusetts Environmental Policy Act (MEPA) was initiated and set a new threshold for greenhouse gas emissions that are equivalent to the level of the U.S. Environmental Protection Agency established. The Georgetown climate center[2] provides a detailed overview of the steps

[2] Georgetown Climate Center: https://www.georgetownclimate.org/adaptation/plans.html

each state is taking to prepare for the impacts of climate change and the undertaken SCAP adoption is categorized as the form of state law and policy, state agency plans, and local and regional plans.

2.2. Hypothesis Development

This study uses the staggered adoption of SCAP as a climate initiative and examines its impact on green innovation made by entrepreneurs and VC industries. A climate adaptation plan may compose a transition in conditions of locations for businesses and impose either positive, negative, or no impact based on each perspective of local startups and VC investors.

First, if the SCAP turns out to be successful in reducing the level of perceived corporate climate risk for the specific region where startups are located, local startups can view this as a good signal that they can react by becoming more eco-friendly by enlarging the level of green innovation output. If the VC investors do care about environmental risk and consider the SCAP as a new signal of a 'public safety net', a reduction in the level of perceived climate risk can be beneficial which can attract more investment made from VC investors and motivate startups to become more eco-friendly by enlarging the green innovation at the same time (Hsu, Liang, and Matos, 2018; Addoum, Ng, and Ortiz-Bobea, 2020; Baldauf, Garlappi, and Yannelis, 2020; Choi, Gao, and Jiang, 2020; Engle, Giglion, Kelly, Lee, and Stroebel, 2020; Avramov, Cheng, Lioui, and Tarelli, 2022; Huang, Li, Lin, and McBrayer, 2022).

On the other hand, new regulatory changes can be a substantial burden for local startups in terms of new compliance costs and would make them face more financial constraints. This may lead to unintended negative externalities as Bartram, Hou, and Kim (2022) point out, leaving startups to seek a much better place to continue their business. Thus, a climate adaptation plan will deteriorate startups' willingness to implement riskier projects whereas raising the demand for additional capital from investors. At the same time, if the VC investors do not appreciate climate risk, the SCAP can discourage investors from making additional investments and pull out their money from subsequent investment rounds (Di Giuli and Kostovetsky, 2014; Alok, Kumar, and Wermers, 2020; Andriosopoulos, Czarnowski, and Marshall, 2021; Cohen and Nguyen, 2021; Kovacs, Latif, Yuan, and Zhang, 2021; Bartram, Hou, and Kim, 2022; Apergis, Poufinas, and Antonopoulos, 2022).

Finally, if the VC investors do not account for the climate risk as a major component when making investment decisions, the SCAP may impose any significant economic change for both startups and investors (Humphrey, Lee, and Shen, 2012; Addoum, David, and Ortiz-Bobea, 2020).

Panel A of Figure 1 shows the annual trend of the total number of green patent applications made by startups. It is possible to observe that the level of green innovation dramatically increases for both groups of total sample and startups funded by experienced VCs after the adoption of the SCAP compared to the trend before the plan was initiated. Meanwhile, Panel B of Figure 1 shows how the amount of VC investment green startups received compared to brown startups after the SCAP adoption. The trend shows that VCs do invest much in green startups whereas brown startups get penalized by receiving much less amount of investment after the initiation of the SCAP.

Thus, this study begins with the first story and examines whether the SCAP facilitates green innovation made by local startups and whether VC investors reward such green startups or not. If the climate adaptation plan turns out to be a successful climate initiative and provides optimal conditions for startups to initiate more environmentally friendly policies, startups will increase their level of green innovation output. Whether VC investors put weight on climate risk and perceive the adoption of SCAP as good or not, startups must show their capabilities they can carry on their business under the modified climate policies undertaken by states. Since it is well known that one of the main roles of VC investors is screening and selecting private companies so they can add value, startups will likely tend to enlarge the green innovation output compared to *ex-ante* (Kaplan and Stromberg, 2001; Brander, Amit, and Antweiler, 2002; Chemmanur, Krishnan, and Nandi, 2011). This way, startups can prove their abilities to run businesses aligned to the SCAP adoption and benefit from the new climate policies the states undertake.

H1*: The SCAP adoption will increase the level of green innovation output made by startups.*

Since the climate adaptation plan aims to reduce future corporate climate risk by setting strict environmental regulations and incentivizing businesses to incorporate eco-friendly operations, green startups will be able to expect a competitive advantage compared to entrepreneurs that are brown or non-green. Accordingly, these green startups would take advantage of receiving VC investment if the VC investors do admit the importance of compliance with SCAP and prefer startups with more sustainability. Since the startups with a lack of environmentally friendly policy or brown startups will be excluded from all benefits given by the states after the SCAP which makes it difficult to add value during the VC investment duration, VC investors would likely avoid investing in startups that deviate from the direction of the SCAP.

H2*: Due to the SCAP adoption, green startups will be rewarded by VC investors with a larger amount of investment whereas brown startups will be penalized.*

While the SCAP adoption would bring a preferable environment that could promote green innovation, prior literature suggests evidence of ESG innovation disconnect which is prevalent in energy industries such as oil, gas, and energy-producing companies (Cohen, Gurun, and Nguyen, 2020; Unsal and Yildrim, 2021; Li, Neupane-Joshi, and Tan, 2022). Although the energy industry is usually considered the most principal area with a strong level of toxic emissions, these energy firms are also one of the largest drivers of green innovation at the same time. However, it is known that energy sectors are usually excluded from ESG funds' investment, and this was a huge puzzle for ESG-focused policymakers. This study tries to examine whether this disconnect exists in the VC industry as well and examines the energy startups after the SCAP adoption.

H3*: Energy startups will increase green innovation after the SCAP but will not be able to obtain larger amounts of investment from VC investors.*

Finally, this study aims to examine whether the green startups with a higher level of green innovation *ex-post* SCAP would perform well and have successful exit outcomes. As well-known from ESG literature, the result of corporations with ESG policy is highly controversial in the public firm setting. As prior literature stresses that the ESG policy does not necessarily lead firms to enhanced firm value and green innovation does not contribute to increasing shareholder wealth, little is known whether the eco-friendly private companies with a high level of green innovation would be welcomed by the public market or not (Servaes and Tamayo, 2013; Di Giuli and Kostovetsky, 2014; Masulis and Reza, 2015; Buchanan, Cao, and Chen, 2018; Andriosopoulos, Czarnowski, and Marshall, 2021).

H4*: Green startups will have a successful exit compared to brown startups after the adoption of SCAP.*

This research contributes to drawing attention to climate risk which is a well-examined risk factor under the public firm setting and answers the question of whether this is also the case for private equity, especially focusing on early entrepreneurs and the VC industry (Dyck, Lins, Roth, and Wagner, 2019; Hartzmark and Sussman, 2019; Krueger, Sautner, and Starks, 2020; Andriosopoulos, Czarnowski, and Marshall, 2021; Bauer, Ruof, and Smeets, 2021; Burt, Harford, Stanfield, and Zein, 2022; Cheng, Chu, Deng, Huang, 2022). The objective of this study is to fill the gap between the literature on climate risk and venture capital by using the state-level climate adaptation plan as an exogenous shock. The remainder of the paper is as follows. Section 3 discusses the data used for this study. Section 4 presents the empirical specification as well as findings on green innovation output, VC investment strategy on the green, brown and early-stage startups, energy industry, and exit performances, and lastly, section 5 concludes.

3. Data

3.1. Data Collection on Investments by Venture Capital

The first step in setting up the main dataset is to construct a full sample of data on startups and VC investment for each round year. To construct a universe of VC investment data, this paper mainly uses VentureXpert from Refinitiv's Securities Data Company (SDC) Platinum as a primary data source. The SDC is chosen as the main data source of VC investment as it is said to offer better coverage of investment from prior literature including Maats, Metrick, Yasuda, Hinkes, and Vershovski (2011) and Kaplan and Lerner (2017). Therefore, this study utilizes VentureXpert data that covers VC fund investment made up by each startup company at each given round year.

3.2 Data Collection on Innovation Measures

To initiate empirical tests on innovation measures, this paper incorporates various data sources that capture the variation among the number of applied patents and citations received between 1953 and 2019. Data on innovation information is mainly collected from two sources, the Patent Assignment Dataset offered by the United States Patent and Trademark Office (USPTO) and PatentsView, which is a data platform that uses bulk data from the USPTO. Patent Assignment Dataset covers detailed information on patent assignments and other transactions recorded at the USPTO since 1970. PatentView is an analysis platform supported by USPTO where this study obtains access to citation records for unique patents applied or granted.

For solid matching procedure, this paper constructs each unique assignee number by each patent assignee name and organization name received citation record. These unique assignee numbers are assigned to corresponding startups in VentureXpert as well by using the fuzzy match procedure. By acknowledging so-called application-to-reward lags for citation data from Hall, Jaffe, and Trajtenberg (2001), the sample dataset for patents consists of 16,639,585 patents issued to 970,139 patent assignees where the dataset for citation contains 34,124,236 citation records received by 24,109 unique organizations.

3.3 Data Collection on Green Innovation

In order to sort out green patents from the innovation data obtained from USPTO and PatentsView, this study follows the classification algorithm explained by Haščič and Migotto (2015). By using the technology class in which each patent application is classified, it is possible to verify which industry category the specific patent applies to. According to the guidelines provided by Organization for Economic Co-operation and Development (OECD), the categories include a wide array of industries that can contribute to sustainability and environmental technologies such as environmental management, biodiversity protection, water-related adaptation technologies, and climate change mitigation. The patents that fall into such categories are defined as green innovation outcomes.

3.4 Data Collection on Environmental Violation

To analyze the startups with any environmental violation record, this paper collects the corporate violation history data from the Violation Tracker dataset, created by the Corporate Research Project of Good Jobs First. The dataset provides more than 520,000 violation records made from 5,175 unique companies since 2000, gathered from over 40 federal regulatory agencies with detailed information on violation date, agency imposing the penalty, and primary offense category. Among the offense category, this research selects the violation record that falls into the category of '*environmental-related offers*' and exclusively sorts out any corporate violation that is relevant to SCAP adoption. This yielded 79,435 environmental violation records made from 2,548 unique companies between 2000 and 2022.

3.5 Linking Innovation and Venture Capital Investment

Combining patent and citation databases with VentureXpert is not comparable to handling datasets of public firms since these private companies cannot be matched by using unique public identifiers unless they become public at the end. Therefore, this study merges patent and citation information to startups listed in VentureXpert by using the assignee name, organization name, and company name as unique links. Since company or organization names provided from multiple data sources can be noisy and inconsistently written, this study divides the merge procedure into the following two stages. First, all company names obtained from VentureXpert and assignee names or organization names from USPTO are converted to lowercase and unnecessary prefixes, suffixes, and symbols are removed. Second, a fuzzy match process is used between the company names and assignee names or organization names to find the closest match by computing Generalized Edit Distance (GED) score.[2]

Although the matched samples are manually checked and turn out that a threshold of GED score equal to 10 brings less than a 2% of error rate from matching, in order to retrieve the most solid matching outcome, this paper employs the strictest level of the threshold by leaving only the pairs of matched names that have GED score equals to zero, otherwise, considering the match as imperfect. Since the GED score becomes positive if either name does not have a perfect identical match, this allows a strict threshold that this study is using the most thoroughly matched pairs from the fuzzy match procedure.

3.6 Analysis Sample, Variable Definitions, and Summary Statistics

The final sample includes U.S.-based startup and VC firm pairs from merged VentureXpert and USPTO datasets. This paper excludes startups located outside the U.S. and operate in any industry of utilities (SIC codes 4900-4999) or financials (SIC codes 6000-6999). The full sample with VC and company pairs downloaded from VentureXpert merged with innovation data consists of 38,645 unique startups and 123,541 round-year observations between 1977 and 2019, where 16,518 startups (approximately 43% among the startups between 1977 and 2019) are matched to their innovation records with at least one patent or citation data. As discussed by González-Uribe (2020), the reason behind the small portion of matched outcomes to innovation record is because of the relatively small size of the venture capital industry as well as the liquidation of startups before engaging in any patent applications.

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[2] According to Teres (2011), the Generalized Edit Distance (GED) score is a generalization of the Levenshtein edit distance, which is a measure of dissimilarity between two strings. The GED score returns values that are multiples of 10, and the higher the GED score the less likely the two strings match.

The main independent variable is a dummy variable defined to indicate whether a specific startup is in a state where the SCAP is adopted. By following Henderson and Ono (2008), this study uses the startup's headquarter state as a geographical location proxy. This paper constructs a *SCAP* dummy variable equal to one for the year of adoption as well as the subsequent state-years, or otherwise equal to zero. The specific details of SCAP adoption such as initiation and finalized year are accessible in Table 1 which lists the adoption years of SCAP by state.

There are two main sets of dependent variables in this study. The first set includes variables that capture startups' green innovation defined as the natural logarithm of one plus the green patent applications (*Green Patent*) as well as the ratio of green innovation to total patent applications (*Green Patent / Patent*). In order to bypass the truncation bias suggested by Hall, Jaffe, and Tranjtenberg (2001), the *Patent* is defined as a proxy for weighted patents by following Fich, Harford, and Tran (2021), as a natural logarithm of one plus patent counts weighted by the mean number of patents granted in the same year and technology class defined by the United States Patent Classification. The second set includes VC investment measures such as the round amount of investment (*Round Amount*) and size of the syndication (*Syndicate Size*). *Round Amount* is defined as the natural logarithm of the round amount disclosed, whereas *Syndicate Size* is defined as the natural logarithm of the number of investors within a round. These variable definitions are standard in VC and innovation literature (Chmmanur, Loutskina, and Tian, 2014; Bernstein, 2015; Bernstein, Giroud, and Townsend, 2016; Balsmeier, Fleming, and Manso, 2017; Kogan, Papanikolaou, Seru, and Stoffman, 2017; González-Uribe, 2020, Gu, Huang, Mao, and Tian, 2022).

I employ control variables based on Gu, Huang, Mao, and Tian (2022) and maintain them in my model specification. To account for potential variation within headquarters states which may correlate with SCAP adoption, this study includes state-level macroeconomic control variables. These variables include: the unemployment rate in a startup company's state of location (*Unemployment*), the state's GDP growth rate over the fiscal year (*GDP Growth*), and the percentage of the startup company's state of location's representatives in the U.S. House of Representations who belong to the Democratic Party each year (*Political Rep*). I also include deal-level controls in order to account for the possible source of variation within each startup and VC pair. These include: the geodetic distance between the startup and VC (*Distance*), the natural logarithm of one plus years between the current round year and year the startup received its first investment plus one (*Age*), and a dummy variable indicating round state level is in early-stage

(*Early Dummy*). In order to address the potential concern that a startup's innovation outcome is highly correlated with the level of innovation a startup had before receiving VC investment, this paper includes the aggregate number of patent applications startups had before the year they begin to receive VC investment (*Patent Before VC*).

Table 2 shows summary statistics for the dependent and independent variables used in this study. Panel A reports averages, standard deviations, 25th, 50th, and 75th percentiles, and the total number of observations for each of the variables. Furthermore, all the reported continuous variables are winsorized at the 1% level in each of their distributions' tails so that can handle extreme outliers. Appendix Table A1 offers specific variable definitions. While Panel B shows the comparison of these variables between the green and brown startups in terms of average and standard deviation. Green startups are defined as startups that had green patent applications at least three years before they received the first VC round of investment. Including three years before the first VC investment is to allow VCs to recognize the *ex-ante* green innovation outcome of a specific startup and perceive the startup as a green startup at the year of SCAP adoption. Brown startup is defined as a startup that has an environmental violation record during the VC investment horizon. The *t*-tests on the equality means show that the two groups of startups have a strongly significant difference among the variables except for the physical distance between a startup and a lead VC investor.

4. Results

4.1 Empirical Strategy

The main model specification is to focus on the relationship between the SCAP adoption indicator and variables relevant to VC monitoring and startups' green innovation outcome. To initiate the test, this paper employs a staggered difference-in-differences ("DID") methodology to compare variation in VC investment and innovation among startups headquartered in states that adopt UFTA with startups that are headquartered elsewhere. This empirical design resembles the econometric model used by Gu, Huang, Mao, and Tian (2022) and Guernsey, John, and Litov (2022) and captures variation caused by staggered adoption of the SCAP across different periods and states.

The empirical specification this paper estimates is as follows:

$$y_{ijst} = \beta_1 SCAP_{st} + \gamma' \mathbf{X}_{ijst} + \eta_i + \omega_s + \delta_{jt} + \varepsilon_{ijst} \quad (1)$$

where y proxies for VC investment and innovation for startup i, operating in industry j, headquartered in s, in year t. In particular, $SCAP$ is an indicator that equals to one if state s adopted SCAP by year t, and **X** is a vector of control variables (summarized in Section 3.6) which can potentially correlate with my measures on VC investment and innovation. η_i denotes lead VC fixed effects, ω_s shows state fixed effects, and δ_{jt} are three-digit standard industrial classification (SIC) industry-by-year fixed effects. This paper includes lead VC and state fixed effects to control for unobserved, time-invariant heterogeneity across the lead VCs, and states, and industry-by-year fixed effects to account for unobserved, time-varying heterogeneity across industries, respectively. This high dimensional fixed effect model specification using state-level variation aligns with empirical strategies widely introduced from prior studies (Acharya, Amihud, and Litov, 2011; Gormley and Matsa, 2014, 2016; Karpoff and Wittry, 2018; Klasa, Ortiz-Molina, Serfling, and Srinivasan, 2018; Gu, Huang, Mao, and Tian, 2022; Guernsey, John, and Litov, 2022). Finally, I cluster the standard errors at the level of headquarters states of the location to control for potential issues with grouped error terms as SCAP protection is assigned at this level (Guernsey, John, and Litov, 2022).

As the main dataset consists of pairs of startups and VC investors, this study includes lead VC and industry-by-year fixed effects to prevent potential bias that could be triggered from unobserved variation within lead VC investors and industry. As discussed by Gompers (1996) and Bernstein, Giroud, and Townsend (2016), the lead VC investor is the main agent who engages in VC monitoring for a specific startup company, and this justifies controlling unobservable lead VC characteristics in my model specification. Therefore, this paper identifies lead VC investors as the VC firm that was involved in the investment the longest. However, if there are still any ties among VC firms within a startup, this study selects the VC firm that made the most amount of investment.

4.2 State Climate Adaption Plan on Green Innovation

The main empirical test of this study begins by examining the effect of SCAP adoption on green innovation made by affected startups. I mainly employ *Green Patent* which captures the number of green patent applications to gauge how the startups react by changing the level of green innovation after the climate adaptation plan is initiated. I also add the ratio of green innovation to the total number of patents, *Green Patent / Patent*, and the total number of weighted patent applications, *Patent*, so that I can capture the trend of patents that have commercial value compared to the green patent application *per se*. Additionally, I start my specification without any controls for odd-numbered columns and my fully specified baseline model with state- and deal-level controls for even-numbered columns. All columns include startup and lead VC fixed effects, industry-by-year fixed effects, and state fixed effects.

I observe that after the SCAP, startups increase their green innovation by 0.7 percentage points with statistically significant at 1% level from Column 1. This can be interpreted as startups located in states where SCAP was initiated experiencing an increased level of green innovation by 70% (=0.007/0.010) relative to the sample average. This magnitude from the SCAP on the green innovation remains robust after further including state- and deal-level controls, shown in Column 2, with *t*-statistics ranging between 2.51 and 2.88. In Column 2, the fully specified model shows a point estimate of 0.006 and is statistically significant at the 5% level. This gives evidence that SCAP adoption leads to an increase in green innovation made by startups located in affected regions by approximately 60% (=0.006/0.010) compared to the sample average.

From Columns 1 and 2, I confirmed that the SCAP adoption is positively associated with an increase in the level of green innovation made by local startups. Considering the small portion of green patent applications to the total number of patent applications, a 60% increase on average as a reaction to the state climate initiative is an economically significant increase. In order to verify that SCAP adoption exclusively leads to an increase in the portion of green innovation while leaving the total innovation outcome unchanged, I separately test whether the increasing trend is consistent when using the fraction of green innovation to the total amount of innovation outcome, *Green Patent / Patent*, while imposing no impact on standalone innovation outcome, *Patent*. The point estimate of *Green Patent / Patent* is consistent with the findings from Columns 1 and 2, showing positive and statistically significant coefficients. For the fully specified baseline model in Column 4, the portion of green innovation tends to rise by 0.1 percentage points, implying that the startups located in the states where the SCAP is initiated tend to increase their green innovation output by 50% (=0.001/0.002) relative to sample mean. However, when it comes to the weighted patient outcomes, the SCAP turns out to have no significant impact with a point estimate of negative 1.2 percentage points from Column 6. This finding supports evidence on the first hypothesis that the state-level climate adaptation plans contribute to exclusively increasing the level of green innovation for affected local startups while leaving no impact on the overall innovation output itself.

4.3 State Climate Adaption Plan and VC Investment in Green Startups

With supportive evidence confirming that SCAP adoption leads to an increase in the green innovation made from local startups, I next test whether VC investors welcome this new shift in the level of eco-friendly innovation and allocate more VC investment to green startups or not. In order to provide a useful starting point, I test whether green startups are more likely to obtain VC financing after the SCAP adoption.

To solidly investigate the likelihood of VC financing on green startups, I construct a hypothetical dataset that consists of a potential universe of startup and VC round-year pairs by following the approach from prior literature (Bottazi, Da Rin, and Hellmann, 2016; Gompers, Mukharlyamov, and Xuan, 2016; Gu, Huang, Mao, and Tian, 2022; Kwon, 2022). The first prior step to implement this test is to identify all potential startup and VC pairs that could possibly be considered as counterparts of actual VC investment made to green startups. To consolidate reliability in terms of finding counterparts, for each green startup and VC pair, I define the counterfactual startup and VC pair observations that have been made within 30 days prior to the actual round of investment made to the startup with the same industry. For instance, if a specific green startup in a software industry raised VC investment on February 1st, 2000, all the comparable startups in the software industry that obtained VC investment between January 1st and February 1st, 2000 are included as the hypothetical sample. The basic assumption of this test is to allow the VCs included in the sample similar possible portfolio companies at the closest time when the actual investment is made. This yields approximately more than 175,000 observations in the hypothetical dataset.

Table 4 presents the results of the likelihood of green startups at the round-level regressions. The dependent variable across the columns is *Investment*, which is equal to one for the actual green startup that raised VC investment and zero otherwise. Columns 1 to 4 present the result of likelihood on four different specifications in terms of including state- and deal-level controls. All four columns show positive and statistically significant coefficient estimates on the SCAP dummy. For example, the regression coefficient from Column 1 suggests that after the SCAP adoption, green startups are more likely to raise VC investment by 1 percent, which is statistically significant at the 1% level. This magnitude remains robust throughout the specifications until I include all state- and deal-level controls in Column 4. Considering the unconditional probability of VC investment which is 2%, this finding is economically sizable as it represents a 50% increase in the likelihood of VC investment in a green startup after the SCAP adoption. To rule out the possibility of the VC investment being based on unobservable heterogeneity within a specific state, industry, and lead VC investors, I keep the three main fixed effects in all the presented specifications. This finding gives initial evidence for the second hypothesis where the green entrepreneurs will be rewarded by VC investors and have more accessibility to VC financing after the climate adaptation plan is initiated.

The findings from the overall level of green innovation and the likelihood of VC investment in green startups justify the need to further examine how green startups react to the SCAP adoption. Specifically, unlike the findings from Table 3 which suggests the overall green innovation output from total sample increases after the initiation of the SCAP, I narrow down the scope to the green startup and how the SCAP adoption brings significant change to green startup innovation and the investment they receive from VC investors. To do this, I use the identical three measures of *Green Patent*, *Green Patent / Patent*, and *Patent* to investigate the change in innovation activity among green startups and *Round Amount* and *Syndicate Size* to test how the VC investors change their investment strategy on green startups after the SCAP adoption. *Round Amount* captures the investment made from VC to startup per round and is defined as the natural logarithm of the disclosed round amount of investment whereas *Syndicate Size* measures the size of the syndication using the number of VC investors within rounds and is defined as the natural logarithm of one plus the round number of investors.

Table 5 presents the findings of innovation output and VC investment in green startups after the SCAP adoption. The specifications are identical to the structure of Table 3 but with a green startup interaction term. The odd-numbered columns include any controls where the fully specified baseline model with state- and deal-level controls are on even-numbered columns. All columns include startup and lead VC fixed effects, industry-by-year fixed effects, and state fixed effects. Panel A of Table 5 shows the findings of innovation output made by green startups after the climate adaptation plan. The results suggest that the uprising trend in green innovation found from the entire sample in Table 3 gets more pronounced for green startups as well. For example, the coefficient of Column 2 is positive and statistically significant at the 1% level, suggesting that green startups increase the green innovation output by 6.3 percentage points after the SCAP adoption. This means that green startups located in the states where SCAP is initiated increase green innovation output by 630% (=0.063/0.010) compared to the sample mean.

It is possible to consolidate this growth of green innovation by the result from the portion of green innovation among the total innovation output within a green startup. The coefficient of the portion of green innovation from Column 4 is also positive and statistically significant at the 1% level, showing that green startups increase the portion of green innovation compared to total innovation output by 8.5% (=0.017/0.002) relative to the sample mean. Considering the unconditional average, both findings provide supportive evidence that the SCAP adoption imposes an economically sizable change in green innovation output for green startups.

However, the coefficient from Columns 5 and 6 suggests that the SCAP adoption led green startups to experience a decline in the weighted patent application. The point estimate from the fully specified model in Column 6 indicates that green startups' weighted patent applications decrease by 16.4 percentage points after the SCAP adoption, implying the 118% (=-0.164/0.139) decline relative to the sample average. Although the SCAP adoption led to technological developments in green innovation, the decline in weighted patents for such green startups is also economically large. This is plausible in the sense that the new green innovation may require huge input, and startups would find difficulty balancing the overall innovation output. This implies that if the public market participants do not perceive green innovation as adding shareholder value and are not welcomed, green startups who decided to put weight on green innovation without balancing innovation outcomes may face hardship in the long run (Servaes and Tamayo, 2013; Di Giuli and Kostovetsky, 2014; Masulis and Reza, 2015; Buchanan, Cao, and Chen, 2018; Andriosopoulos, Czarnowski, and Marshall, 2021).

With the significant rise in the level of green innovation confirmed among green startups after the SCAP adoption from Panel A, I next examine the hypothesis of whether the VC investors would reward this trend of green innovation by allocating more investment to green startups or not. The findings from Panel B of Table 5 present supportive evidence. The coefficient from the fully specified model of Column 2 is positive and statistically significant at the 5% level, suggesting that green startups tend to receive the round amount of investment increase by 13.3 percentage points. Compared to the average round amount of investment of $14.7 million in the total sample, this implies that green startups raise 1.6% (0.133/8.159), which is $0.24 million larger than non-green startups. Although there is no significant change in the size of the syndication, this finding from VC investment supports the hypothesis that VC investors welcome green startups with a higher level of green innovation and reward them by allocating a much round amount of investment.

However, to provide strict evidence that VC investors incorporate climate risk for their investment choice and prefer to allocate budget to green startups after the SCAP adoption, I define brown startups in order to compare how the VC investors treat them relative to the green startups. I repeat the identical exercise using brown startups and present my findings in Table 6. Panel A of Table 6 suggests that after the SCAP adoption, brown startups tend to experience a decline in green innovation outcomes. The coefficient in Column 2 is negative and statistically significant at 10%, suggesting that brown startups show a decrease in green innovation by 2.8% (=-0.028/0.010) relative to the sample average. While the portion of green innovation for brown startups also turns out to be negative while the coefficient for total weighted patent outcomes is also negative from Columns 4 and 6, both findings are statistically insignificant. Although it's marginally significant, the decline in green innovation for brown startups can be due to the new climate adaptation plan accompanied by higher compliance costs and enhanced regulations. New climate policy may be a burden for brown startups where they can find it difficult to maintain the previous innovation output.

Panel B of Table 6, however, presents solid evidence that VC investors pull out their money from startups that are against the line of new state climate policy adoption. The coefficient in Column 2 is negative and statistically significant at a 1% level, indicating that brown startups receive less amount of round investment from VC investors by 10.8% (-0.880/8.159) compared to the sample average. Considering the total average round amount of investment, this cutdown is approximately $1.59 million which could lead the brown startups to critical financial constraints after the SCAP is adopted. The coefficient in Column 4 is also negative and marginally significant at the 10% level, suggesting that the size of syndication tends to shrink for brown startups after the SCAP. Although the larger syndication is often interpreted as a sign of risk-sharing and enhanced peer monitoring from VC investors (Brander, Amit, and Antweiler, 2002; Tian, 2011; Gompers, Mukharlyamov, and Xuan, 2016; Tian, Udell, and Yu, 2016), under the critical amount of reduction in VC investment, it is likely that the number of VC investors participated is also declining for such brown startups.

Overall, both results from Tables 5 and 6 provide supportive evidence for the hypothesis that SCAP will reward green startups while penalizing brown startups. It turns out that SCAP adoption provided a beneficial environment for green startups and such green startups became even greener by enlarging the level of green innovation. Accordingly, SCAP made it possible for green startups to raise more capital from VC investors while syndication size remains unchanged. Meanwhile, SCAP turns out to be detrimental for brown startups leading them to decrease the level of green innovation output and most significantly, experience a critical reduction in the round amount of investment.

4.4 State Climate Adaption Plan and Experienced VCs

While the SCAP turns out to promote a higher level of green innovation for local green startups and allows them to raise more VC investment compared to non-green and brown startups, it is uncertain whether the green innovation will eventually lead startups to beneficial outcomes in the long run. The true value of green innovation is said to be controversial from prior literature where the results suggest that a firm's ESG policy and green innovation do not necessarily bring enhanced firm value and shareholder wealth (Servaes and Tamayo, 2013; Di Giuli and Kostovetsky, 2014; Masulis and Reza, 2015; Buchanan, Cao, and Chen, 2018; Andriosopoulos, Czarnowski, and Marshall, 2021;). However, it is widely known that one of the main virtues of VC investors is to provide not only the funding itself but numerous value-added services to startups during the investment horizon and help them to be more successful in terms of profitability, network, and innovativeness (Megginson and Weiss, 1991; Gompers and Lerner, 1999; Hsu, 2004). Thus, in the spirit of Sørensen (2007), I investigate whether the experienced VC investors behave the same way as the overall VC investors out in the market did after the SCAP adoption and compare their investment behavior compared to the findings so far. If the experienced VCs also show similar investment trends and reward green startups, that will strengthen the justification that green innovative startups are considered as promising investment opportunities for VC investors and increase the demand for VCs to address climate risk for their investment decision. Whereas if the experienced VCs deviate from the previous findings of general VC investment in green startups, that implies the doubt on green innovation's benefit is valid for the private sector as well.

By following Sørensen (2007) and Kwon (2022), I define experienced VCs as the VC investors who led their portfolio companies to exit via IPO above the market average. The assumption is that VCs leading more IPOs proves that such VC investors are superior in terms of experience and more likely to add value to portfolio companies. Panel A of Table 7 reports the results on innovation from all startups that received investment from experienced VCs and the VC investment behavior for such startups after the SCAP adoption. The coefficient from Column 2 suggests that, unlike the previous findings where SCAP immensely increased the green innovation, startups that received investment from experienced VCs do not show the same pattern. However, while there is no significant change detected from green innovation for startups backed by experienced VCs, it is possible to confirm that their weighted patent applications remain unchanged from Column 4. This trend of change in innovation is what makes it different for startups funded by experienced VCs compared to the findings from green startups using a total sample. While the coefficient from Columns 5 and 6 suggests that experienced VCs also increase their investment in startups after the SCAP adoption, as indicated from Columns 7 and 8, the rounds experienced VCs got involved are more likely to experience larger syndicate sizes as well. This means the experienced VCs increase their amount of investment by 1.3% (=0.105/8.159) relative to the sample average, which is approximately $0.19 million. Considering the amount of investment additionally flowed into green startups by all VC investors from Table 5, this amount of increase is comparable while the level of green innovation signals a potential difference between investment decisions from experienced VCs and the overall market.

I next narrow down the scope and repeat the comparison I executed from Tables 5 and 6, by examining how the green startups and brown startups received investment from experienced VCs show different consequences after the SCAP adoption. Panel B of Table 7 shows that there is a prominent gap between the two groups. First, the green startups receiving funding from experienced VCs do not show any significant change either in green innovation or VC investment after the SCAP. The coefficients are all negative while statistically insignificant, which is different from the pattern when the same test is initiated using the total sample. Meanwhile, the coefficient of weighted patents from Column 2 is positive and statistically significant at a 1% level, indicating that green startups backed by experienced VCs tend to show a distinct pattern from what's shown in Table 5. The point estimate suggests that such green startups experience an increase in weighted patent applications by 16.4%, which is 118% (=0.164/0.139) larger than the sample average. The innovation output from Columns 1 and 2 suggests that if the green startups are funded by experienced VCs, rather than heavily relying on increasing green innovation while giving up on weighted patents, they tend to focus on increasing the overall level of weighted patents which can be beneficial in terms of commercializing them at the stage of exit. Rest of the Column 3 and 4 suggests that there is no significant change in VC investment for green startups backed by experienced VCs after the SCAP adoption.

While the findings from green startups are heterogeneous from the case when using the total sample, the findings from brown startups are still in line with the result from Table 6, suggesting that such startups experience a significant decline in green innovation by 5.7% (=-0.057/0.010) while receiving less amount of VC investment by 11.8% (=-0.965/8.159) after the initiation of SCAP. It is possible to confirm that brown startups are still finding difficulties raising capital from experienced VCs as well. This is not surprising considering the capabilities of experienced VCs in terms of screening and monitoring.

The findings of Table 7 indicate evidence that while it is true that overall VC investors increase their funding to green startups and such startups increase their green innovation output as a response to SCAP, this does not represent experienced VC's investment strategy. According to the findings on innovation outcome from Table 7, it turns out that such experienced VC investors do not recklessly allocate funding to green startups and do not share the same viewpoint from other VC investors considering green innovation as a desirable outcome that their portfolio companies should pursue. This implies that the disconnect in green innovation can be confirmed by the private sector as well and experienced VC investors may consider green innovation as not the most effective way compared to the overall weighted patent outcome that could be commercialized at the stage when startups make successful exits in the future.

4.5 State Climate Adaption Plan and Early-Stage Startups

With the fact that SCAP adoption can impose two contrasting scenarios for startups and the VC industry, I next test how early-stage startups react to SCAP adoption. Although the SCAP contributed to facilitating green innovation from local entrepreneurs, the findings of its irrelevancy in increasing the weighted innovation and impact on brown startups imply the possibility that the adaptation to new regulatory threshold and compliance cost is not negligible for startups. This result justifies examining early-stage startups when the startups' demand for VC financing is higher than ever in order to grow their business. At the same time, considering the importance of screening the role of VCs, raising early round VC investment after the SCAP adoption can be relatively difficult for startups compared to the periods before SCAP when there was no additional climate-related regulation to comply and no need to show the color of business by increasing the green innovation output.

In order to examine the impact of SCAP adoption on early-stage startups, I define early-stage startup if a specific round of startup that is confirmed at 'startup/seed' or 'early-stage'. Panel A of Table 8 presents the findings on the innovation performance of these startups in their early rounds. The coefficient from Column 1 suggests that startups in their early rounds tend to have a decline in green innovation after the SCAP. However, this finding disappears when the fully specified model is used by including the state- and deal-level controls, and the same insignificant change can be confirmed from the portion of green innovation compared to the total amount of innovation. Unlike green innovation, it is possible to observe that these early-stage startups tend to have a significant increase in weighted patents by 7.3%. This coefficient from Column 6 is positive and statistically significant at the 1% level, suggesting that these startups at their early rounds have 53% (=0.073/0.139) larger weighted patents compared to the sample average. This finding from innovation is plausible in the sense that changing the direction of innovation and increasing new green innovation all of a sudden can be a substantial burden for early-stage startups in terms of cost and time. Whereas, according to the findings in Table 5 where green startups with a significant change in green innovation tend to raise more VC investment, this trend of innovation may cause early-stage startups to find it difficult to obtain larger VC investment.

Panel B of Table 8 reports the findings from a change in VC investment in early-stage startups. As expected, the coefficient from Columns 1 and 2 suggests that startups at their early-stage raise less amount of VC investment after the SCAP adoption. The point estimate in Column 2 is negative and statistically significant at the 10% level. This is a -6.7% decline and can be interpreted as a 0.8% (=-0.067/8.159) decrease relative to the sample mean, which is approximately $0.11 million. On the other hand, the size of syndication tends to increase according to the result from Columns 3 and 4. The coefficient from Colum 4 shows that the size of the syndication increases by 8.9 percent, which is a 7.7% (=0.089/1.162) increase relative to the sample mean. According to the traditional story of monitoring, both findings from round amount and size of syndication show that VC investors perceive investment to early-stage startups as risky and tend to decrease the amount of investment while sharing the risk with participants within syndication.

4.6 State Climate Adaption Plan and Energy startups

Confirming the impact of SCAP on green innovation, I next examine whether such a finding is consistent with startups in energy industries. Prior literature points out the existence of a disconnect in ESG funds by suggesting that the oil, gas, and energy industries were mostly recognized as sectors with the most toxic emissions and are in fact, one of the greatest engines of green innovation as well while shunned by ESG funds (Cohen, Gurun, and Nguyen, 2020; Unsal and Yildrim, 2021; Li and Neupane-Joshi, and Tan, 2022). In order to investigate whether this is consistent with the private sector, I reiterate the test using startups in energy industries. Panel A of Table 9 reports the findings on the innovation outcome of startups in the energy industry. The coefficient in Column 2 suggests that startups in the energy industry increase green innovation by 7.5% after the SCAP adoption, which is 750% (=0.075/0.010) higher compared to the sample average. The point estimate from Column 4 supports this finding, suggesting that the portion of green innovation to total innovation outcome increased by 2.4%, which is twelve times (=0.024/0.002) higher than the sample average. Considering the small sample average, the increase is economically immense, while the SCAP has no effect on weighted patent applications of such energy startups.

However, unlike the confirmed previous findings, the preference for VC investment in green innovation after the SCAP adoption does not hold for energy startups. Panel B of Table 9 shows that the SCAP adoption does not impose significant change in VC investment for energy startups. Although the coefficient in Column 1 turns out to be marginally significant, the point estimate no longer remains robust when state-and deal-level controls are included in Column 2. As the syndicate size also shows any significant change against the SCAP, the finding suggests that even with a dramatic increase in green innovation outcomes after the SCAP, energy startups fail to get rewards from VC investors by receiving larger amounts of funding. This finding gives evidence that the disconnect of ESG funding tends to remain consistent with the private sector as well.

4.7 State Climate Adaption Plan and Startup's Exit Performance

According to the findings so far, the SCAP adoption turns out to have a significant impact on the level of green innovation made by local startups. The green startups that focused their direction on green innovation successfully raised more VC investments while brown startups were penalized by VC investors, raising less amount of investment. However, subsequent analysis shows that this is not the case for green startups funded by experienced VCs and these startups focused to increase weighted patents rather than enlarging green innovation. Given the discrepancy between these two distinct investment strategies, the final question remains as to whether green innovation adds value to a startup's exit performance or not. If green innovation is recognized as a good signal for the public market, the startups that received larger amounts of investment after the SCAP will be likely to have a successful exit compared to non-green startups. However, if green innovation is not an essential component for startups and is considered to be skeptical from the public market, the startups funded by experienced VCs will outperform in terms of exit performance and reconfirm the validity of value-adding service delivered by VC investors' monitoring (Megginson and Weiss, 1991; Nahata, 2008; Krishnan, Ivanov, Masulis, and Singh, 2011; Tian, 2011; Atanasov, Ivanov, and Litak, 2012; Tian, 2012; Bernstein, 2015, Bernstein, Giroud, and Townsend; 2016, Bernstein, Korteweg, and Laws, 2017; Gompers, Gornall, Kaplan, and Strebulaev, 2020).

Table 10 reports the exit performance of startups after the SCAP adoption. Prior literature mentions that exit via IPO or M&A is considered the most profitable and can be exclusively achieved by successful startups (Sahlman, 1990; Brau, Francis, and Kohers, 2003; Chaplinsky and Gupta-Mukherjee, 2016). Thus, I define both IPO and M&A as two channels of a successful exit and examine whether the SCAP adoption impacts the likelihood of a startup. Among the M&A deals, I distinguish the transaction based on whether the acquirer is public or private in order to check whether there is a different viewpoint toward startups with a higher level of green innovation.

Panel A of Table 10 reports the findings of exit performance for all startups after the SCAP adoption. Regardless of the increase in green innovation, it turns out that the SCAP adoption doesn't impact the successful exit of the affected local startups. The only coefficient that is statistically significant is from Column 4, suggesting startups are 2.4% less likely to get acquired by public acquirers after the SCAP. Other than the M&A to public acquirers, the SCAP does not impose a significant impact on exit performance for local startups.

For fastidious analysis, I repeat the test to compare whether there is a significant difference in exit performance for startups funded by experienced VCs. First, Panel B shows the findings from all green startups. The coefficient from Column 2 turns out to be marginally statistically significant with a negative point estimate, suggesting that green startups are less likely to exit via IPO by 1.1%. Considering the massive increase in green innovation and accessibility to VC funding, the findings imply that such green startups did not experience a corresponding amount of change in the level of exit performance. However, Panel C shows that this is not the case if the green startups were funded by experienced VCs. The coefficient at the triple interaction term from Columns 1 and 2 is positive and statistically significant at the 5% level, suggesting that such green startups backed by experienced VCs are likely to have 3.2% of a higher successful exit and 1.7% of higher IPOs. Although the coefficient from Column 4 suggests that these green startups are still less likely to get acquired by public acquirers by 10.8%, it is possible to confirm there is a significant difference in exit performance if the green startup obtained funding from experienced VC investors. This finding proposes evidence that green innovation amplified due to the SCAP adoption does not bring value to the startup's exit performance whereas the certification effect and monitoring provided by VC investors still works as the value-adding channel.

In order to provide a direct comparison to brown startups, Panel D and Panel E reports the identical test executed using brown startups. As expected from the poor innovation outcomes and accessibility to VC investment, Panel D shows that brown startups are less likely to have successful exits via IPO. The coefficients from Columns 1 and 2 are both negative and statistically significant at the 1% level, suggesting that brown startups have less successful exits by 15.4% and IPO by 10.2%. However, this decline in likelihood disappears when the brown startups are funded by experienced VCs. Panel E reports the findings and none of the coefficients from Columns 1 and 2 are statistically significant.

4.8 Robustness Check

For the robustness check, I begin by examining the validity of DiD estimator. Prior literature points out that the solid examination of parallel trends for the dependent variable between treated and control groups in the pre-period before the treatment designation is crucial to test the fundamental assumption of the DID estimator (Angrist and Pischke, 2009; Roberts and Whited, 2013). Table 11 presents the results of the parallel trend of the main dependent variables.

To execute the test of the validity of the parallel trend assumption, I employ the widely used approach in the state-level quasi-natural experiment literature (e.g., Lemmon and Roberts, 2010; Acharya, Baghai, and Subramanian, 2014; Bruhn and Love, 2014; Gormley and Matsa, 2016; Serfling, 2016; Klasa, Ortiz-Molina, Serfling, and Srinivasan, 2018; Mann, 2018; Bernstein, Lerner, and Mezzanotti, 2019) and define false timing indicators for *SCAP* dummy. *Year Before1*, *Year Before2*, and *Year Before3* are false indicators that switch on to one by supposing the SCAP was adopted one-, two-, or three years before the real adoption took place, respectively, and zero otherwise; *Year 0* is an indicator equal to one in the current round year that SCAP was adopted, and zero otherwise; *Year 1*, *Year 2*, and *Year 3 and After* are false indicators switch on to one in the one-, two-, or three-or-afterward years since the SCAP was initiated, respectively, and zero otherwise. I interact these timing dummies to the *Green Startup* indicator and append my dependent variables in order of *Green Patent*, *Green Patent / Patent*, and *Round Amount*. Each column reports results estimated using my fully specified baseline model.

Across the three columns in Table 11, I do not find any significant evidence that startups had a significant impact on their *Green Patent*, *Green Patent / Patent*, and *Round Amount* during the pre-SCAP periods. In contrast to the post-SCAP period, none of the coefficients on each *Year Before1*, *Year Before2*, and *Year Before3* turned out to be economically and statistically significant. Meanwhile, I observe increases for all *Green Patent*, *Green Patent / Patent*, and *Round Amount* within one or two years after the SCAP has been initiated. This result shows there is a significant increase in my main dependent variables for startups located in states where SCAP was initiated compared to the startups headquartered elsewhere with unobserved, time-varying state and industry factors controlled.

My next robustness check moves on to test the stacked approach instead of my original setting of allowing staggered adoption of SCAP. In order to approach my main findings from a different angle than allowing the staggered adoption which I used from my main analysis, I follow Gormley and Matsa (2014) and construct corresponding cohorts of treated and control startups for five years before and after each year of SCAP adoption per treated state. I combine all the cohorts to construct pooled dataset and regress my three main dependent variables on the *SCAP* indicator with lead VC-cohort, industry-by-year-cohort, and state-cohort fixed effects. The results are shown in Panel A of Table 12.

The results from all three columns support my expectations and previous findings. First, the findings on innovation remain robust as confirmed by the coefficient of *Green Patent* and *Green Patent / Patent* which are positive and statistically significant at 5% and 1%, respectively from Columns 1 and 2. Although the significance is relatively weak, the coefficient of the *Round Amount* is also positive and significant at the 10% level. As all three coefficients show an identical sign with acceptable statistical significance, the findings of Panel A support the main findings obtained when staggered adoption of SCAP is undertaken.

My last test for robustness is to fix state- and deal-level control variables on their first appearance per startup (its "base year") from VentureXpert data under the staggered setting. Panel B from Table 12 reports the results. Again, all the results from innovation measures including *Green Patent* and *Green Patent / Patent* are positive and statistically significant at the 1% level. The coefficient of the *Round Amount* is also positive and statistically significant at the 5% level. Overall, my main findings on the main dependent variables are robust even when approached from a different angle than the staggered setting and with fixed state- and deal-level control variables.

5. Conclusion

This paper investigates how the state-level climate initiative impacts local startups' green innovation output, the amount of VC investment they raise, and eventual exit performance. At the same time, based on the question of whether VC investors appreciate the value of green innovation, this study examines how VC investors allocate capital to startups with a sudden increase in green innovation outcomes. By employing SCAP adoption as a state-level climate policy, this paper finds that SCAP contributes to lead economically sizable increase in green innovation made by local startups. The startups outperformed in having a higher level of green innovation and became successful in raising a larger amount of VC investment whereas brown startups reciprocally get penalized by VC investors, having significant trouble raising capital from VCs.

However, it turns out that there is a discrepancy in VCs' preference for green startups with the facilitated level of green innovation, especially for experienced VCs. Unlike most of the VC investors who reacted to SCAP adoption and allocated more capital to green startups with immense green innovation, startups funded by experienced VCs rather increased the level of overall weighted patent application while leaving the level of green innovation unchanged. Although the experienced VCs also avoided investing in brown startups, the existence of disparity in investment strategy from experienced VC investors provides initial evidence on the preference of such experienced VCs and they disagree that it is advisable for startups to concentrate on green innovation as a reaction to the SCAP adoption in the long run.

This study further confirms that the switch in VCs' preference for green innovation brought by the SCAP caused early-stage startups to face financial constraints as they cannot change their innovation portfolio immediately to green innovation. It turns out that these early-stage startups with higher weights on traditional overall weighted innovation are less likely to raise a larger amount of VC investment. Meanwhile, by investing in startups within energy industries, this study reconfirms that the ESG fund disconnect mentioned from prior literature consistently holds for the private sector.

Finally, the findings from exit performance suggest that the SCAP adoption did not make a significant impact on the local startups, except for reducing the likelihood of acquisitions made by public acquirers. However, there was a distinctive gap in exit performance if the green startup was funded by experienced VCs, leading them to be more likely to experience successful exit and IPO. This gap was found in brown startups as well who become less likely to have successful exit outcomes while the likelihood remains unchanged if backed by experienced VCs. Overall, the paper is much in line with the precious role of VC in terms of monitoring portfolio companies and reconfirms that value adding service and certification effect consistently holds when green innovation gets market’s rapid attention.

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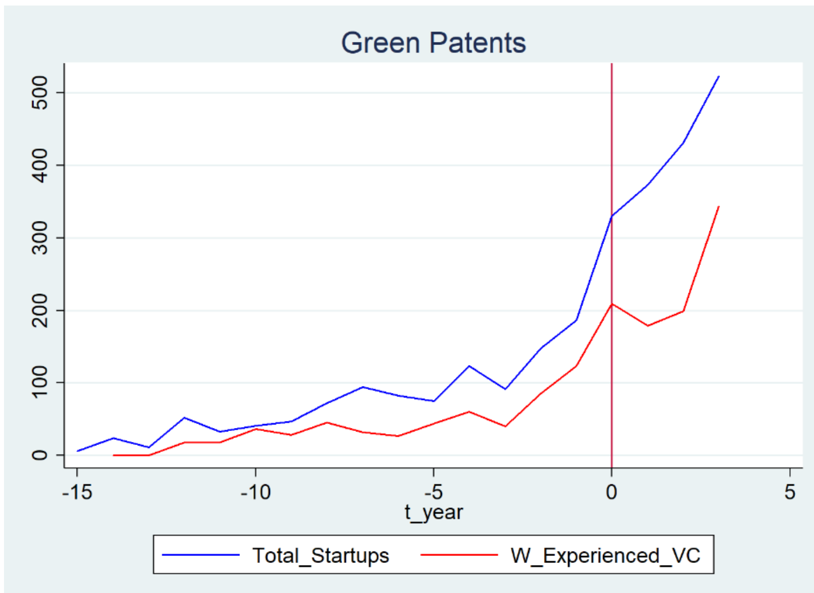
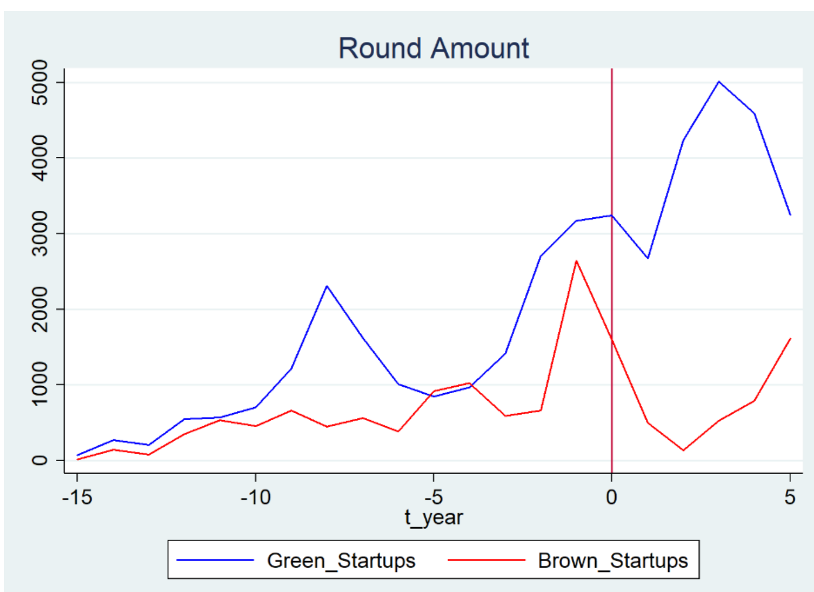
Figure 1

Aggregate Trend in Green Innovation and Round Amount of VC Investment

Panel A of this figure presents a visual trend of aggregate green patent applications and round amount of VC investment ($ Million) between [-15, 5] window based on the SCAP adoption. Panel A presents the green patent applications made by a total sample of startups and startups funded by experienced VC each year. Panel B presents round amount of VC investment raised by green startups and brown startups each year.



Panel A. Green Patent Applications



Panel B. Round Amount of Investment

Table 1

Adoption Years of State Climate Adaptation Plan by State

This table lists adoption years of State Climate Adaptation Plan (SCAP) by state. If a state has multiple adaptation plans, earliest year of initiation is selected.
Source: https://www.georgetownclimate.org/adaptation/plans.html

State	Adoption Year	Finalized Year
AK	2007	2010
CA	2008	2009
CO	2008	2011
CT	2008	2013
DE	2013	2015
FL	2007	2008
ME	2009	2010
MD	2007	2008
MA	2008	2011
NH	2007	2009
NY	2009	2010
OR	2009	2010
PA	2008	2011
VA	2007	2008
WA	2009	2012

Table 2

Summary Statistics

This table shows summary statistics for my main dependent and independent variables used in this study. Appendix Table A1 provides specific details of variable definitions. All continuous variables are winsorized at 1% and 99% levels.

Panel A: Total Sample

Dependent variables:	N	Mean	St. Dev.	P25	Median	P75
Green Patent	117,441	0.010	0.082	0.000	0.000	0.000
Green Patent/Patent	117,441	0.002	0.021	0.000	0.000	0.000
Patent	117441	0.139	0.422	0.000	0.000	0.000
Round Amount	84,079	8.159	1.813	7.003	8.343	9.393
Syndicate Size	117,441	1.162	0.485	0.693	1.099	1.386

Independent variables:	N	Mean	St. Dev.	P25	Median	P75
SCAP	117,441	0.337	0.473	0.000	0.000	1.000
Unemployment	117,441	6.232	2.147	4.800	5.600	7.300
GDP Growth	117,441	5.334	3.052	3.552	5.175	6.950
Political Rep	117,039	0.602	0.209	0.500	0.615	0.717
Distance	78,786	942.234	1,375.429	10.400	263.150	1,607.4
Age	81,326	1.314	0.589	0.693	1.099	1.792
Early Dummy	81,341	0.360	0.480	0.000	0.000	1.000
Patent Before VC	117,441	1.075	1.491	0.000	0.000	1.946

Panel B: Comparison Between Green and Brown Startups

	Green Startups Obs. = 1,226		Brown Startups Obs. = 438		Difference
	Mean	St. Dev	Mean	St. Dev	
Green Patent	0.203	0.315	0.000	0.000	-0.203***
Green Patent/Patent	0.050	0.084	0.000	0.000	-0.050***
Patent	0.667	0.833	0.189	0.518	-0.478***
Round Amount	8.586	1.765	8.933	2.251	0.347***
Syndicate Size	1.219	0.510	1.031	0.440	-0.187***
Distance	943.857	1,355.747	935.065	956.018	-8.792
Age	1.500	0.637	1.406	0.743	-0.095**
Early Dummy	0.309	0.462	0.118	0.323	-0.190***
Patent Before VC	3.438	1.482	1.236	1.675	-2.202***

Table 3

The Effect of SCAP Adoptions on Green Innovation

This table shows results from staggered panel regressions related to the effect of SCAP adoptions on green innovation. The dependent variables for the first two columns specify *Green Patent* whereas *Green Patent/Patent* for the next, and *Patent* for the last two columns. I measure the *Green Patent* variable using the natural logarithm of one plus green patent counts. The *Green Patent/Patent* is defined as the natural logarithm of fraction of green patents over patent applications. The *Patent* is the natural logarithm of one plus patent counts weighted by the mean number of patents granted in the same year and technology class. *SCAP* indicator equals one if a startup's state of location has adopted the SCAP, and zero otherwise. State-level controls include: *Unemployment*, *GDP growth*, and *Political Rep*. Deal-level controls include: *Distance*, *Age*, *Early Dummy*, and *Patent Before VC*. Appendix Table A1 presents specific variable definitions. Industry dummies are defined by three-digit SIC codes. All continuous variables are winsorized at the 1% level in both tails. *t*-statistics (clustered by state of location) are reported in parentheses. *10%, **5%, and ***1% significance level.

	Green Patent		*Green Patent/Patent*		*Patent*	
	(1)	(2)	(3)	(4)	(5)	(6)
SCAP	0.007***	0.006**	0.002***	0.001**	0.004	-0.012
	(2.88)	(2.51)	(2.73)	(2.26)	(0.25)	(-0.70)
Unemployment		0.000		-0.000		0.009**
		(0.13)		(-0.49)		(2.26)
GDP Growth		-0.000		-0.000		-0.001
		(-0.07)		(-0.28)		(-0.97)
Political Rep		-0.005		-0.001		-0.046*
		(-1.06)		(-0.59)		(-1.96)
Distance		0.000		0.000		-0.000*
		(1.08)		(1.27)		(-1.92)
Age		-0.002***		-0.001***		-0.008**
		(-2.70)		(-3.10)		(-2.19)
Early Dummy		-0.002		-0.000		-0.028***
		(-1.43)		(-0.96)		(-4.58)
Patent Before VC		0.010***		0.002***		0.165***
		(22.42)		(15.59)		(25.46)
Lead VC FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	75,735	75,735	75,735	75,735	75,735	75,735
Adjusted R^2	0.222	0.241	0.256	0.267	0.206	0.407

Table 4

Likelihood of VC Investment on Green Startups

This table shows results from staggered panel regressions related to the effect of SCAP adoptions on the likelihood of VC investment on green startups. The dependent variable is an indicator equals to one if a VC made investment and zero otherwise. *SCAP* indicator equals one if a startup's state of location has adopted the SCAP, and zero otherwise. State-level controls include: *Unemployment*, *GDP growth*, and *Political Rep*. Deal-level controls include: *Distance*, *Age*, *Early Dummy*, and *Patent Before VC*. Appendix Table A1 presents specific variable definitions. Industry dummies are defined by three-digit SIC codes. All continuous variables are winsorized at the 1% level in both tails. *t*-statistics (clustered by state of location) are reported in parentheses. *10%, **5%, and ***1% significance level.

	Investment			
	(1)	(2)	(3)	(4)
$SCAP$	0.010***	0.011***	0.008**	0.010***
	(3.28)	(3.54)	(2.55)	(3.07)
$Unemployment$		-0.001		-0.002
		(-1.05)		(-1.65)
$GDP\ Growth$		0.000		0.000
		(0.46)		(0.83)
$Political\ Rep$		-0.009		-0.013
		(-1.19)		(-1.65)
$Distance$			-0.000	-0.000
			(-0.09)	(-0.06)
Age			-0.000	-0.000
			(-0.10)	(-0.16)
$Early\ Dummy$			0.004***	0.004***
			(3.01)	(3.03)
$Patent\ Before\ VC$			0.020***	0.020***
			(13.89)	(13.77)
Lead VC FE	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Observations	175,696	175,696	175,696	175,696
Adjusted R^2	0.287	0.287	0.316	0.316

Table 5

The Effect of SCAP Adoptions on Green Startups

This table shows results from staggered panel regressions related to the effect of SCAP adoptions on green startups. In Panel A, *Green Patent* is measured using the natural logarithm of one plus green patent counts. The *Green Patent/Patent* is defined as the natural logarithm of the fraction of green patents over patent applications. The *Patent* is the natural logarithm of one plus patent counts weighted by the mean number of patents granted in the same year and technology class. In Panel B, *Round Amount* variable is measured using the natural logarithm of round amount disclosed and *Syndicate Size* is measured using the natural logarithm of one plus round number of investors. *SCAP* indicator equals one if a startup's state of location has adopted the SCAP, and zero otherwise. State-level controls include: *Unemployment*, *GDP growth*, and *Political Rep*. Deal-level controls include: *Distance*, *Age*, *Early Dummy*, and *Patent Before VC*. Appendix Table A1 presents specific variable definitions. Industry dummies are defined by three-digit SIC codes. All continuous variables are winsorized at the 1% level in both tails. *t*-statistics (clustered by state of location) are reported in parentheses. *10%, **5%, and ***1% significance level.

Panel A: Innovation

	$Green\ Patent$		$Green\ Patent/Patent$		$Patent$	
	(1)	(2)	(3)	(4)	(5)	(6)
$SCAP$	-0.001	-0.000	-0.000	-0.000	0.005	-0.005
	(-0.32)	(-0.16)	(-0.52)	(-0.38)	(0.39)	(-0.35)
$Green\ Startups$	0.172***	0.169***	0.038***	0.038***	0.613***	0.299***
	(16.04)	(16.19)	(10.74)	(10.98)	(10.97)	(7.02)
$SCAP \times Green\ Startups$	0.063***	0.063***	0.017***	0.017***	-0.183**	-0.164**
	(4.27)	(4.27)	(4.85)	(4.84)	(-2.07)	(-2.19)
Controls	No	Yes	No	Yes	No	Yes
Lead VC FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	75,735	75,735	75,735	75,735	75,735	75,735
Adjusted R^2	0.390	0.391	0.391	0.391	0.254	0.416

Panel B: VC Investment

	$Round\ Amount$		$Syndicate\ Size$	
	(1)	(2)	(3)	(4)
$SCAP$	0.015	-0.032	0.011	0.005
	(0.26)	(-0.61)	(0.57)	(0.28)
$Green\ Startups$	0.219***	-0.058	0.036***	-0.018
	(4.44)	(-1.03)	(3.43)	(-1.62)
$SCAP \times Green\ Startups$	0.110*	0.133**	0.011	0.017
	(1.90)	(2.38)	(0.48)	(0.68)
Controls	No	Yes	No	Yes
Lead VC FE	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Observations	54,974	54,974	75,735	75,735
Adjusted R^2	0.372	0.382	0.185	0.189

Table 6

The Effect of SCAP Adoptions on Brown Startups

This table shows results from staggered panel regressions related to the effect of SCAP adoptions on brown startups. In Panel A, *Green Patent* is measured using the natural logarithm of one plus green patent counts. The *Green Patent/Patent* is defined as the natural logarithm of the fraction of green patents over patent applications. The *Patent* is the natural logarithm of one plus patent counts weighted by the mean number of patents granted in the same year and technology class. In Panel B, *Round Amount* variable is measured using the natural logarithm of round amount disclosed and *Syndicate Size* is measured using the natural logarithm of one plus round number of investors. *SCAP* indicator equals one if a startup's state of location has adopted the SCAP, and zero otherwise. State-level controls include: *Unemployment*, *GDP growth*, and *Political Rep*. Deal-level controls include: *Distance*, *Age*, *Early Dummy*, and *Patent Before VC*. Appendix Table A1 presents specific variable definitions. Industry dummies are defined by three-digit SIC codes. All continuous variables are winsorized at the 1% level in both tails. *t*-statistics (clustered by state of location) are reported in parentheses. *10%, **5%, and ***1% significance level.

Panel A: Innovation

	$Green\ Patent$		$Green\ Patent/Patent$		$Patent$	
	(1)	(2)	(3)	(4)	(5)	(6)
$SCAP$	0.007***	0.006**	0.002***	0.001**	0.004	-0.011
	(2.92)	(2.53)	(2.76)	(2.28)	(0.31)	(-0.69)
$Brown\ Startups$	-0.010***	-0.014***	-0.002**	-0.003***	0.087**	0.004
	(-2.93)	(-5.01)	(-2.66)	(-3.92)	(2.18)	(0.21)
$SCAP \times Brown\ Startups$	-0.032*	-0.028*	-0.008	-0.007	-0.120	-0.060
	(-1.79)	(-1.75)	(-1.59)	(-1.52)	(-1.32)	(-1.21)
Controls	No	Yes	No	Yes	No	Yes
Lead VC FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	75,735	75,735	75,735	75,735	75,735	75,735
Adjusted R^2	0.223	0.241	0.256	0.267	0.206	0.407

Panel B: VC Investment

	$Round\ Amount$		$Syndicate\ Size$	
	(1)	(2)	(3)	(4)
$SCAP$	0.033	-0.019	0.013	0.007
	(0.58)	(-0.37)	(0.69)	(0.36)
$Brown\ Startups$	0.785***	0.740***	0.057**	0.047*
	(4.79)	(4.69)	(2.40)	(1.98)
$SCAP \times Brown\ Startups$	-1.012***	-0.880***	-0.111*	-0.100*
	(-4.21)	(-3.22)	(-1.81)	(-1.86)
Controls	No	Yes	No	Yes
Lead VC FE	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Observations	54,974	54,974	75,735	75,735
Adjusted R^2	0.372	0.383	0.185	0.189

Table 7

Experienced VCs

This table shows the results of VC investment made by experienced VCs after the SCAP adoption. *Green Patent* is measured using the natural logarithm of one plus green patent counts. The *Patent* is the natural logarithm of one plus patent counts weighted by the mean number of patents granted in the same year and technology class. *Round Amount* variable is measured using the natural logarithm of round amount disclosed and *Syndicate Size* is measured using the natural logarithm of one plus round number of investors. The experienced VC is defined as the VCs with the number of IPO exits of companies above the average of the total sample. State-level controls include: *Unemployment*, *GDP growth*, and *Political Rep*. State-level controls include: *Distance*, *Age*, E*arly Dummy* and *Patent Before VC*. Appendix Table A1 presents specific variable definitions. Industry dummies are defined by three-digit SIC codes. All continuous variables are winsorized at the 1% level in both tails. *t*-statistics (clustered by state of location) are reported in parentheses. *10%, **5%, and ***1% significance level.

Panel A: All Deals Funded by Experienced VCs (# of IPO exits)

	Green Patent		*Patent*		*Round Amount*		*Syndicate Size*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$SCAP$	0.006*	0.006*	0.002	-0.009	-0.038	-0.081	-0.006	-0.011
	(1.92)	(1.91)	(0.13)	(-0.57)	(-0.78)	(-1.59)	(-0.31)	(-0.57)
Exp_VC	-0.002	-0.001	-0.015**	-0.001	-0.040	-0.021	0.001	0.004
	(-1.40)	(-0.81)	(-2.16)	(-0.24)	(-1.06)	(-0.55)	(0.07)	(0.49)
$SCAP \times Exp\_VC$	0.001	0.000	0.004	-0.006	0.123**	0.105**	0.035***	0.032***
	(0.21)	(0.08)	(0.36)	(-1.20)	(2.60)	(2.19)	(5.48)	(5.01)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Lead VC FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	75,735	75,735	75,735	75,735	54,974	54,974	54,974	54,974
Adjusted R^2	0.222	0.241	0.206	0.407	0.371	0.382	0.185	0.190

Table 7 (Continued)

Panel B: Green and Brown Startups Funded by Experienced VCs (# of IPO exits)

	Green Startups				Brown Startups			
	Green Patent (1)	*Patent* (2)	*Round Amount* (3)	*Syndicate Size* (4)	*Green Patent* (5)	*Patent* (6)	*Round Amount* (7)	*Syndicate Size* (8)
$SCAP$	-0.000	0.005	-0.096*	-0.014	0.006*	-0.009	-0.079	-0.010
	(-0.15)	(0.32)	(-1.89)	(-0.75)	(1.90)	(-0.55)	(-1.55)	(-0.56)
Exp_VC	-0.001	-0.004	-0.016	0.002	-0.001	-0.001	-0.023	0.003
	(-0.72)	(-0.62)	(-0.41)	(0.34)	(-0.85)	(-0.17)	(-0.61)	(0.47)
$SCAP \times Exp\_VC$	0.000	-0.019***	0.116**	0.038***	0.001	-0.006	0.110**	0.033***
	(0.08)	(-3.36)	(2.24)	(4.94)	(0.16)	(-1.30)	(2.36)	(5.14)
$Green\ Startups$	0.159***	0.268***	-0.029	-0.028				
	(11.14)	(6.34)	(-0.37)	(-1.48)				
$SCAP \times Green\ Startups$	0.071***	-0.252***	0.207	0.059**				
	(4.13)	(-3.94)	(1.57)	(2.08)				
$Exp\_VC \times Green\ Startups$	0.023*	0.067*	-0.066	0.022				
	(1.70)	(1.85)	(-0.71)	(0.80)				
$SCAP \times Exp\_VC$	-0.018	0.164***	-0.131	-0.086				
$\times Green\ Startups$	(-0.59)	(3.60)	(-0.53)	(-1.23)				
$Brown\ Startups$					-0.017***	0.032	0.669***	0.048
					(-3.23)	(0.96)	(4.50)	(1.48)
$SCAP \times Brown\ Startups$					0.012	-0.109*	-0.209	-0.087
					(1.28)	(-1.73)	(-0.77)	(-0.60)
$Exp\_VC \times Brown\ Startups$					0.007	-0.060	0.170	-0.001
					(0.81)	(-1.07)	(0.41)	(-0.02)
$SCAP \times Exp\_VC$					-0.057**	0.090	-0.965*	-0.028
$\times Brown\ Startups$					(-2.41)	(0.88)	(-1.73)	(-0.16)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lead VC FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	75,735	75,735	54,974	75,735	75,735	75,735	54,974	75,735
Adjusted R^2	0.391	0.417	0.382	0.190	0.241	0.407	0.383	0.190

Table 8

The Effect of SCAP Adoptions on Early Rounds

This table shows results from staggered panel regressions related to the effect of SCAP adoptions on startups at early rounds. In Panel A, *Green Patent* is measured using the natural logarithm of one plus green patent counts. The *Green Patent/Patent* is defined as the natural logarithm of the fraction of green patents over patent applications. The *Patent* is the natural logarithm of one plus patent counts weighted by the mean number of patents granted in the same year and technology class. In Panel B, *Round Amount* variable is measured using the natural logarithm of round amount disclosed and *Syndicate Size* is measured using the natural logarithm of one plus round number of investors. *SCAP* indicator equals one if a startup's state of location has adopted the SCAP, and zero otherwise. State-level controls include: *Unemployment*, *GDP growth*, and *Political Rep*. Deal-level controls include: *Distance*, *Age*, *Early Dummy*, and *Patent Before VC*. Appendix Table A1 presents specific variable definitions. Industry dummies are defined by three-digit SIC codes. All continuous variables are winsorized at the 1% level in both tails. *t*-statistics (clustered by state of location) are reported in parentheses. *10%, **5%, and ***1% significance level.

Panel A: Innovation

	$Green\ Patent$		$Green\ Patent/Patent$		$Patent$	
	(1)	(2)	(3)	(4)	(5)	(6)
$SCAP$	0.008***	0.006**	0.002***	0.001**	0.005	-0.027
	(3.20)	(2.48)	(2.91)	(2.23)	(0.36)	(-1.65)
$Early\ Rounds$	-0.002**	-0.001	-0.000	-0.000	-0.075***	-0.049***
	(-2.42)	(-1.46)	(-1.39)	(-1.46)	(-5.65)	(-3.57)
$SCAP \times Early\ Dummy$	-0.004**	-0.000	-0.001	-0.000	0.011	0.073***
	(-2.10)	(-0.10)	(-1.52)	(-0.14)	(1.42)	(5.20)
Controls	No	Yes	No	Yes	No	Yes
Lead VC FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	75,735	75,735	75,735	75,735	75,735	75,735
Adjusted R^2	0.223	0.241	0.256	0.267	0.210	0.408

Panel B: VC Investment

	$Round\ Amount$		$Syndicate\ Size$	
	(1)	(2)	(3)	(4)
$SCAP$	0.050	-0.003	-0.004	-0.012
	(0.83)	(-0.06)	(-0.21)	(-0.61)
$Early\ Rounds$	0.001	-0.119***	-0.047***	-0.074***
	(0.05)	(-8.28)	(-3.38)	(-5.08)
$SCAP \times Early\ Dummy$	-0.085**	-0.067*	0.080***	0.089***
	(-2.26)	(-1.88)	(5.16)	(5.42)
Controls	No	Yes	No	Yes
Lead VC FE	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Observations	54,974	54,974	75,735	75,735
Adjusted R^2	0.371	0.383	0.186	0.191

Table 9

The Effect of SCAP Adoptions on Energy Industries

This table shows results from staggered panel regressions related to the effect of SCAP adoptions on startups with energy industries. In Panel A, *Green Patent* is measured using the natural logarithm of one plus green patent counts. The *Green Patent/Patent* is defined as the natural logarithm of the fraction of green patents over patent applications. The *Patent* is the natural logarithm of one plus patent counts weighted by the mean number of patents granted in the same year and technology class. In Panel B, *Round Amount* variable is measured using the natural logarithm of round amount disclosed and *Syndicate Size* is measured using the natural logarithm of one plus round number of investors. *SCAP* indicator equals one if a startup's state of location has adopted the SCAP, and zero otherwise. State-level controls include: *Unemployment*, *GDP growth*, and *Political Rep*. Deal-level controls include: *Distance*, *Age*, *Early Dummy*, and *Patent Before VC*. Appendix Table A1 presents specific variable definitions. Industry dummies are defined by three-digit SIC codes. All continuous variables are winsorized at the 1% level in both tails. *t*-statistics (clustered by state of location) are reported in parentheses. *10%, **5%, and ***1% significance level.

Panel A: Innovation

	$Green\ Patent$		$Green\ Patent/Patent$		$Patent$	
	(1)	(2)	(3)	(4)	(5)	(6)
$SCAP$	0.002	0.002	0.001	0.001	-0.014	-0.020
	(1.02)	(0.86)	(0.91)	(0.61)	(-0.91)	(-1.20)
$Energy\ Industry$	0.032**	0.033**	0.012**	0.012**	0.022	0.029
	(2.08)	(2.42)	(2.36)	(2.64)	(0.41)	(1.38)
$SCAP \times Energy\ Industry$	0.084**	0.075**	0.026**	0.024**	0.165	0.002
	(2.62)	(2.47)	(2.51)	(2.37)	(1.55)	(0.03)
Controls	No	Yes	No	Yes	No	Yes
Lead VC FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	78,166	78,166	78,166	78,166	78,166	78,166
Adjusted R^2	0.088	0.121	0.101	0.123	0.127	0.377

Panel B: VC Investment

	$Round\ Amount$		$Syndicate\ Size$	
	(1)	(2)	(3)	(4)
$SCAP$	0.040	-0.011	-0.004	-0.008
	(0.92)	(-0.25)	(-0.25)	(-0.45)
$Energy\ Industry$	0.047	0.039	-0.020	-0.016
	(0.50)	(0.36)	(-1.42)	(-0.98)
$SCAP \times Energy\ Industry$	0.177*	0.084	0.025	0.007
	(1.84)	(0.85)	(1.41)	(0.35)
Controls	No	Yes	No	Yes
Lead VC FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Observations	57,018	57,018	78,166	78,166
Adjusted R^2	0.353	0.364	0.177	0.183

Table 10

The Effect of SCAP on Exit Performance of Startups

This table shows the effect of SCAP on the performance of startups. Panel A shows the effect of SCAP on the total sample. Panel B shows the effect of SCAP for green startups while Panel C shows the results when the green startups are funded by experienced VCs. Panel D shows the effect of SCAP for brown startups while Panel E shows the results when the brown startups are funded by experienced VCs. The dependent variable is an indicator equals to one for last round year before a startup had either a successful exit, IPO, or acquisition, and zero otherwise. I exclude startups from the sample once they had any of the events. SCAP indicator equals one if a startup's state of location has adopted the SCAP, and zero otherwise. State-level controls include: *Unemployment*, *GDP growth*, and *Political Rep*. State-level controls include: *Distance*, *Age*, E*arly Dummy* and *Patent Before VC*. Appendix Table A1 presents specific variable definitions. Industry dummies are defined by three-digit SIC codes. All continuous variables are winsorized at the 1% level in both tails. *t*-statistics (clustered by state of location) are reported in parentheses. *10%, **5%, and ***1% significance level.

Panel A: All deals

	Success	*IPO*	*M&A*	*M&A Public*	*M&A Private*
	(1)	(2)	(3)	(4)	(5)
SCAP	-0.004	-0.000	-0.004	-0.024**	-0.014
	(-0.44)	(-0.12)	(-0.54)	(-2.08)	(-1.38)
Controls	Yes	Yes	Yes	Yes	Yes
Lead VC FE	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Observations	72,371	72,371	72,371	72,371	72,371
Adjusted R^2	0.039	0.083	0.028	0.149	0.162

Panel B: Green Startups

	$Success$ (1)	IPO (2)	$M\&A$ (3)	$M\&A\ Public$ (4)	$M\&A\ Private$ (5)
$SCAP$	-0.003	0.000	-0.004	-0.025**	-0.015
	(-0.42)	(0.03)	(-0.61)	(-2.20)	(-1.53)
$SCAP \times Green\ Startups$	-0.004	-0.011*	0.005	0.028	0.022
	(-0.57)	(-2.00)	(0.75)	(1.53)	(1.33)
Controls	Yes	Yes	Yes	Yes	Yes
Lead VC FE	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Observations	72,371	72,371	72,371	72,371	72,371
Adjusted R^2	0.039	0.083	0.028	0.150	0.162

Panel C: Green Startups funded by experienced VC

	$Success$ (1)	IPO (2)	$M\&A$ (3)	$M\&A\ Public$ (4)	$M\&A\ Private$ (5)
$SCAP$	-0.010	-0.003	-0.007	-0.029**	-0.009
	(-1.24)	(-0.69)	(-0.98)	(-2.27)	(-0.79)
$SCAP \times Green\ Startups \times Exp\_VC$	0.032**	0.017**	0.020	-0.108***	0.036
	(2.27)	(2.46)	(1.46)	(-2.69)	(1.65)
Controls	Yes	Yes	Yes	Yes	Yes
Lead VC FE	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Observations	72,371	72,371	72,371	72,371	72,371
Adjusted R^2	0.039	0.083	0.028	0.150	0.162

Panel D: Brown Startups

	$Success$ (1)	IPO (2)	$M\&A$ (3)	$M\&A\ Public$ (4)	$M\&A\ Private$ (5)
$SCAP$	-0.003	-0.000	-0.004	-0.023**	-0.014
	(-0.37)	(-0.03)	(-0.52)	(-2.05)	(-1.37)
$SCAP\ \times Brown\ Startups$	-0.154***	-0.102***	-0.048	-0.054	-0.030
	(-4.45)	(-3.44)	(-1.28)	(-1.05)	(-1.18)
Controls	Yes	Yes	Yes	Yes	Yes
Lead VC FE	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Observations	72,371	72,371	72,371	72,371	72,371
Adjusted R^2	0.039	0.083	0.028	0.150	0.162

Panel E: Brown Startups funded by experienced VC

	$Success$ (1)	IPO (2)	$M\&A$ (3)	$M\&A\ Public$ (4)	$M\&A\ Private$ (5)
$SCAP$	-0.010	-0.004	-0.007	-0.024*	-0.009
	(-1.35)	(-0.91)	(-0.98)	(-1.82)	(-0.77)
$SCAP\ \times Brown\ Startups\ \times Exp\_VC$	-0.072	0.013	-0.083	-0.008	0.051
	(-0.91)	(0.23)	(-0.78)	(-0.07)	(0.89)
Controls	Yes	Yes	Yes	Yes	Yes
Lead VC FE	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Observations	72,371	72,371	72,371	72,371	72,371
Adjusted R^2	0.039	0.083	0.028	0.150	0.162

Table 11

Timing of SCAP Adoptions on Main Dependent Variables

This table shows results from staggered panel regressions of main dependent variables on a SCAP timing indicator variable. The SCAP timing indicator variables, *Year Before3*, *Year Before2*, *Year Before1*, *Year 0*, *Year 1*, *Year 2*, *and Year 3 and After*, indicate the year relative to each respective state's adoption of the SCAP. State-level controls include: *Unemployment*, *GDP growth*, and *Political Rep*. Deal-level controls include: *Distance*, *Age*, *Early Dummy* and *Patent Before VC*. Appendix Table A1 presents specific variable definitions. Industry dummies are defined by three-digit SIC codes. All continuous variables are winsorized at the 1% level in both tails. *t*-statistics (clustered by state of location) are reported in parentheses. *10%, **5%, and ***1% significance level.

	$Green\ Patent$	$Green\ Patent\ /Patent$	$Round\ Amount$
	(1)	(2)	(3)
$Year\ Before3\ \times Green\ Startup$	0.013	-0.002	-0.074
	(0.22)	(-0.16)	(-0.58)
$Year\ Before2\ \times Green\ Startup$	0.002	-0.001	-0.187
	(0.11)	(-0.12)	(-0.90)
$Year\ Before1\ \times Green\ Startup$	-0.003	0.000	-0.005
	(-0.08)	(0.05)	(-0.03)
$Year0 \times Green\ Startup$	0.053**	0.011*	0.083
	(2.60)	(1.87)	(0.97)
$Year1 \times Green\ Startup$	0.040*	0.006	-0.126
	(2.00)	(0.97)	(-0.65)
$Year2\ \times Green\ Startup$	0.018	0.004	0.230**
	(1.10)	(0.60)	(2.18)
$Year3\ and\ After \times Green\ Startup$	0.075**	0.021***	0.202***
	(2.47)	(3.13)	(2.98)
Controls	Yes	Yes	Yes
Lead VC FE	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes
State FE	Yes	Yes	Yes
Observations	78,226	78,226	56,943
Adjusted R^2	0.391	0.391	0.375

Table 12

Robustness Checks

This table shows results from different robustness checks on the effect of SCAP adoptions on dependent variables. In Panel A, I follow Gormley and Matsa (2014) and rearrange the original staggered panel dataset into dataset with cohorts of treated and control startups. The window period of stacked approach using the alternative cohort dataset is three years before and after each SCAP enactment for each state. In Panel B, I use fixed state- and deal-level controls by using each of control variables' first round year observations per startup as their fixed values. State-level controls include: *Unemployment*, *GDP growth*, and *Political Rep*. Deal-level controls include: *Distance*, *Age*, *Early Dummy* and *Patent Before VC*. Appendix Table A1 presents specific variable definitions. Industry dummies are defined by three-digit SIC codes. All continuous variables are winsorized at the 1% level in both tails. *t*-statistics (clustered by state of location) are reported in parentheses. *10%, **5%, and ***1% significance level.

Panel A: Stacked Approach

	$Green\ Patent$	$Green\ Patent\ /Patent$	$Round\ Amount$
	(1)	(2)	(3)
$SCAP \times Green\ Startup$	0.047**	0.013***	0.132*
	(2.44)	(2.98)	(1.84)
Controls	Yes	Yes	Yes
Lead VC FE	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes
State FE	Yes	Yes	Yes
Observations	175,908	175,908	132,479
Adjusted R^2	0.418	0.417	0.411

Panel B: Fixed Controls with Staggered Setting

	$Green\ Patent$	$Green\ Patent\ /Patent$	$Round\ Amount$
	(1)	(2)	(3)
$SCAP \times Green\ Startup$	0.063***	0.017***	0.131**
	(4.31)	(4.89)	(2.34)
Controls	Yes	Yes	Yes
Lead VC FE	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes
State FE	Yes	Yes	Yes
Observations	75,731	75,731	54,969
Adjusted R^2	0.391	0.391	0.382

Table A1

Variable Definitions

Table A1 provides the definition and data source for the main variables used in this study.

Dependent variables:	Description
$Green\ Patent$	Natural logarithm of one plus green patent counts. *Source*: USPTO PatentView Dataset and Haščič and Migotto (2015).
$Green\ Patent/Patent$	Natural logarithm of the fraction of green patents over patent applications. *Source*: USPTO PatentView Dataset.
$Patent$	Natural logarithm of one plus patent counts weighted by the mean number of patents granted in the same year and technology class defined by the United States Patent Classification. *Source*: USPTO PatentView Dataset and Fich, Harford, and Tran (2021).
$Round\ Amount$	Natural logarithm of round amount disclosed. *Source*: VentureXpert.
$Syndicate\ Size$	Natural logarithm of one plus round number of investors. *Source*: VentureXpert.

Independent variables:	Description
$SCAP$	An indicator variable equals to one if a state adopted the State Climate Adaptation Plan (SCAP) where startup company is located, and equals to zero otherwise.
$Green\ Startups$	An indicator variable equals to one if a startup is identified to have green patent applications at least three years before raising first VC investment, and equals to zero otherwise. *Source*: VentureXpert.
$Brown\ Startups$	An indicator variable equals to one if a startup has a environmental violation record history during the VC investment horizon, and equals to zero otherwise. *Source*: VentureXpert and Violation Tracker Dataset.
Exp_VC	An indicator variable equals to one if a round is financed by experienced VCs defined as the VCs with the number of IPO exits of companies above the average of the total sample equals to zero otherwise. *Source*: VentureXpert and Sørensen (2007) and Kwon (2022).
$Energy\ Industry$	An indicator variable equals to one if a startup's SIC code is between 1200-1399, or 2900-2999, or 4900-4949, or 2800-2829, or 2840-2899, and equals to zero otherwise. *Source*: VentureXpert.
$Unemployment$	The unemployment rate in a startup company's state of location. *Source*: U.S. Bureau of Labor Statistics Local Area Unemployment Statistics Series.
$GDP\ Growth$	State's GDP growth rate over the fiscal year. *Source*: U.S. Bureau of Economics Analysis.

$Political\ Rep$	The percent of a startup company's state of location's representatives in the U.S. House of Representations who belong to the Democratic Party, in a given year. *Source*: U.S. House of Representative's website.
$Distance$	Geodetic distance in miles between startup company and VC based on zipcode information. *Source*: Gu, Huang, Mao, and Tian (2022).
Age	Natural logarithm of one plus (years between current round year and the year the startup company received its first investment + 1). *Source*: Gu, Huang, Mao, and Tian (2022).
$Early\ Dummy$	An indicator variable equals to one if a round state level is defined as "Startup/seed" or "Early stage", and equals to zero otherwise. *Source*: Gu, Huang, Mao, and Tian (2022).