

# CHAPTER 2

## THE EFFECT OF US CLIMATE POLICY ON FINANCIAL MARKETS: AN EVENT STUDY OF THE INFLATION REDUCTION ACT

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### ABSTRACT

*The Inflation Reduction Act of 2022 (IRA) represents the largest climate policy action ever undertaken in the United States. Its legislative path was marked by two abrupt shifts as the likelihood of climate policy action fell to near zero and then rose to near certainty. The authors investigate equity price reactions to these two events, which represent major realizations of climate policy transition risk. Our results highlight the heterogeneous nature of climate policy risk exposure. The authors find sizable reactions that differ by industry as well as across firm-level measures of greenness such as environmental scores and emission intensities. While the financial market response to the IRA was economically significant, it did not lead to instability or financial stress, suggesting that transition risks posed by climate policies even as ambitious as the IRA may be manageable.*

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## 1. INTRODUCTION

The IRA is widely considered to be the most ambitious climate policy action in US history. Over the next decade and beyond, a broad array of new tax credits and direct government expenditures will provide substantial financial support for clean technologies and industries. Additionally, the IRA will offer strong direct incentives for US households and firms to invest in the equipment and capital needed to reduce their carbon emissions. [Bistline et al. \(2023b\)](#) estimate that the cumulative budgetary effect of the climate-related parts of the IRA could be on the order of \$1 trillion over the next 10 years.<sup>1</sup> The economic changes induced by the IRA incentives are also expected to result in significant reductions to US greenhouse gas emissions ([Bistline et al., 2023a](#)). However, such projections of the economic and climate consequences of the IRA are generally silent about any financial implications. This is true even though the financial sector is integral to supplying the requisite capital for decarbonization and determining climate policy outcomes. The forward-looking responses of financial markets will also be evident much sooner than the economic and emissions effects and can thus provide a useful early reading on policy transmission and success. In this chapter, we document the financial market responses to the IRA and provide a new climate finance perspective on this major climate policy action.

One particularly important issue for climate finance is transition risk. The substantial investment required for the transformation to a low-carbon economy will rely heavily on financial markets and institutions (e.g., [Battiston et al., 2021](#)).<sup>2</sup> However, the uncertain pace and consequences of decarbonization have become a major policy concern in recent years ([Van der Ploeg & Rezai, 2020](#)). If investor expectations were to adjust precipitously to new climate policies, the resulting adverse revaluations of carbon-dependent assets – potentially resulting in stranded assets – could have severe implications for financial solvency and stability along the lines of what former Bank of England governor Mark Carney termed a “climate Minsky moment” ([Carney, 2016](#)). To better quantify the potential risks to banks and other financial institutions from such abrupt shifts in business prospects and asset prices, central banks and financial supervisory authorities are developing climate scenario analyses ([Acharya et al., 2023](#)). Clearly, the pricing of transition risks in financial markets has become a first-order policy issue. The passage of the IRA – the culmination of decades of attempts to obtain significant US legislation addressing climate change – represents a major realization of climate policy transition risk.

By investigating the stock market responses to this climate policy realization across firms and industries, we can illuminate the consequences of transition

risk. Our study addresses several key questions: Did this legislation materially affect stock prices in a way consistent with the specific climate policy measures? Did stocks of “green” firms – characterized by comparably low CO<sub>2</sub> emissions or low environmental/emissions scores – benefit from the IRA, despite the fact that the legislation did not include any carbon taxation? If there is a differential firm-level stock market response, which measures of greenness can capture this heterogeneity?

To answer these questions, we use event-study methods to examine equity price movements following key news events around the introduction of the IRA. Event studies are particularly revealing when relevant new information becomes public via discrete, definitive announcements.<sup>3</sup> The legislative genesis of the IRA in 2022 included two such unambiguous shifts that whipsawed the prospects for climate-related legislation. The first, which we term a “brown event,” occurred when news reports surfaced late on July 14 of the withdrawal of any support for new climate spending by Senator Joe Manchin of West Virginia – the pivotal vote required for getting legislation through the Senate. The likelihood of Senate passage of climate legislation plummeted and the probability of any near-term sizable policy action fell to almost zero. The second event, a “green event,” took place in the early evening of July 27, when news broke that Senator Manchin had reached a surprise agreement with Democratic leaders on new legislation that unveiled the IRA and made it nearly certain that significant climate policy would ultimately become law. Section 2 explains in more detail the provisions of the IRA and the timeline of events preceding its passage.

We carry out several complementary event-study exercises to investigate equity market responses to this climate legislation. In Section 3, we examine the returns of green and brown industries around the IRA announcements. We first employ several commonly used energy equity indices such as the S&P Global Clean Energy and S&P 500 Integrated Oil & Gas funds. Clean energy indices had sizable negative abnormal returns after the brown event on July 14 but then rebounded strongly after the July 27 IRA debut, but fossil fuel industry indices showed a reverse pattern. We also use Fama-French industry portfolios to provide insight into what sectoral shifts investors expected. Industries that stand to benefit from the provisions in the IRA for greater green product demand or subsidized production costs exhibited a strong positive response to the green announcement on July 27 while, in contrast, the oil and coal industry lost significant market value after that event.

In Section 4, we conduct a more granular analysis at the level of individual firms. The publicly listed firms in our sample are differentiated using measures of greenness based on their actual carbon emissions data as well as emissions scores and broader Environmental scores (or *E* scores) calculated by a provider of firm-level environmental characteristics. The heterogeneous stock market responses across these measures of greenness are statistically and economically significant and support their use in identifying climate policy exposure. Specifically, the brown event lowered the stock market values of green firms – those with relatively low emission intensities and superior *E* and emissions scores – and boosted the values of brown firms. By contrast, with the announcement that made this climate legislation a near-certainty, green firms benefited and brown firms did not.

Taken together, these event-study results document substantial and rapid financial asset price reactions to climate policy news. In response to these realizations of climate policy transition risk, green and brown stocks displayed sizable movements in opposite directions. From a theoretical perspective, positive news about the passage of the IRA lifted expected profitability for green firms and disadvantaged brown firms through both demand and cost channels.<sup>4</sup> The IRA subsidies for purchases of low-carbon products should lead to a policy-induced strengthening of customer demand for green goods and services, boosting green firm stocks as their business prospects were improved (a demand channel as in [Pástor et al., 2021](#)). Other financial incentives in the IRA include clean energy production and investment tax credits and subsidies, lowering production costs and raising profits (a cost channel). Through these channels, news about the IRA appear to have impacted expected future dividends and, ultimately, stock prices.<sup>5</sup>

Section 5 shows implications for calibrating climate policy transition risk using industry-level measures of risk exposure. To better understand the risks of climate change and the transition to a low-carbon economy, financial supervisors are developing climate scenario analyses and stress tests to identify potential vulnerabilities in the financial system and assess bank solvency (e.g., [Financial Stability Board, 2022](#); [NGFS, 2022a](#)). For many climate-related risk assessments, potential losses have been calculated based on sectoral or industry classifications, in part due to limited firm-level data availability. In Section 5, we investigate whether measures of industry-level greenness can account for the cross-industry variation in the equity price responses to the climate policy news. Such metrics have been used, for example, for assessing the exposure of commercial banks to different climate policy scenarios (e.g., [Jung et al., 2023](#)). Industry-level greenness appears to be a poor predictor of an industry's responses to the climate policy announcements we study in this chapter. This finding suggests that there is a need for a more granular firm- and asset-level accounting of transition risks – much like earlier work has called for with regard to physical risk ([Bressan et al., 2022](#)).

A central contribution of our chapter is to characterize the asset price responses to a given change in climate policies. We find that declines in brown firm stock prices to the IRA policy action do not appear outsized or disorderly even though this climate policy transition realization was very large by historical comparison. Therefore, the transition risks of financial sector bankruptcies, dislocations, and crises to future climate policies may be manageable. Of course, it may be that other climate policy actions could have more dramatic financial consequences, given that the prevalence of stranded assets may depend on the specific type of climate policy implemented; e.g., taxes versus subsidies ([Rozenberg et al., 2020](#)). However, the IRA events that we consider are extraordinary not only in terms of their large fiscal magnitude but also because the policy announcements were made during narrowly circumscribed event windows. It is difficult to envisage other climate policy realizations that could serve as a more definitive event study for assessing climate transition risk. Given that the IRA climate policy action

caused manageable financial market responses of brown firms and disadvantaged industries, our evidence suggests limited risk for a climate Minsky moment.

Our chapter contributes to a quickly growing literature on the pricing of climate risks in financial markets, and specifically on the pricing of transition risks in green and brown stocks; see [Bolton and Kacperczyk \(2021\)](#), [Pástor et al. \(2022\)](#), and [Bauer et al. \(2022\)](#), among many others. Most prior work on the effects of climate policy on financial markets has studied events with news about *possible future* climate action and shifts in perceived transition risks, often with mixed results. [Ramelli et al. \(2021\)](#) investigate the stock market reaction to the 2016 and 2020 US Presidential elections, finding better stock market performance of carbon-intensive firms in response to the Trump election but also higher stock returns for firms with higher climate responsibility around *both* the Trump and Biden election wins. [Monasterolo and De Angelis \(2020\)](#) document shifts in the risk characteristics of green and brown stock indices before and after the announcement of the 2015 Paris Agreement, but they find no appreciable penalty on the returns or valuations of high-carbon assets and firms. Other related empirical work considers larger and more heterogeneous sets of climate policy news. [Barnett \(2023\)](#) identifies a number of climate policy events and shows that industries with a larger exposure to changes in oil prices exhibit a more negative stock market response to events that increase the likelihood of future climate policy action. [Ardia et al. \(2022\)](#) show that unexpected increases in a news-based index of climate change concerns benefit green stocks over brown stocks. [Cassidy \(2023\)](#) constructs a dataset of climate policy announcements and documents that brown stocks perform better than green stocks around events with a large amount of climate policy news. Other studies of the effects of climate policies on financial performance more broadly include [Kumar and Purnanandam \(2022\)](#), [Bartram et al. \(2022\)](#), and [Jung et al. \(2021\)](#).

Only few other studies examine clearly identified events with major news about immediate climate policy action, i.e., realizations of transition risk. [Ochoa et al. \(2022\)](#) study the effects of an unexpected carbon tax increase in Germany and find a heterogeneous stock market response based on emission intensity but not based on *E* scores, in contrast to our findings. [Carattini and Sen \(2019\)](#) document which stocks benefited from news that two carbon tax initiatives in Washington State were rejected by voters. [Ivanov et al. \(2023\)](#) study the passage of California's cap-and-trade legislation and the failed version at the federal level (the Waxman-Markey bill) and document more constrained bank lending to high-emission firms. [Hengge et al. \(2023\)](#) study carbon policy news related to the European Union Emission Trading System (EU-ETS). They examine events with exogenous changes in the price of emission permits following [Känzig \(2023\)](#) and show that a surprise increase in the carbon price leads to negative abnormal returns of brown stocks compared with green stocks, measured using emission intensities. Our chapter provides novel evidence on the financial market response to realizations of transition risk, using the stock market response to news about the IRA – the most important climate policy in US history.

## 2. THE INFLATION REDUCTION ACT

To set the stage for the empirical analysis, we provide a description of the timeline of events leading up to passage of the IRA and then summarize the key climate policy ingredients of this legislation.

[Table 2.1](#) highlights some of the key events in the legislative history of the IRA. The IRA resulted from negotiations in the Senate to rework the Build Back Better Act, which was an expansive package of climate change, health care, tax reform, and social safety net proposals. While the Build Back Better Act passed the House despite unanimous Republican congressional opposition, it faced an evenly divided Senate and would need every Democratic vote for passage. Senator Joe Manchin became the key holdout, which resulted in months of challenging negotiations and swings of sentiment regarding passage. On the evening of July 14 – after US equity markets<sup>6</sup> had closed – press reports surfaced that Senator Manchin had decided to oppose any further attempts to pass the Build Back Better Act and, in particular, had rejected any further climate legislation. One such report, [Romm and Stein \(2022\)](#), noted

Sen. Joe Manchin III (D-W.Va.) told Democratic leaders Thursday he would not support an economic package this month that contains new spending on climate change or new tax increases targeting wealthy individuals and corporations, marking a massive setback for party lawmakers who had hoped to advance a central element of their agenda before the midterm elections this fall.

However, two weeks later on July 27, Senator Manchin and Senate Majority Leader Charles Schumer announced that they had reached a new agreement to pass climate legislation, and they unveiled the complete text of the “Inflation Reduction Act of 2022.”<sup>7</sup> This announcement was also made after equity markets closed and was generally viewed as essentially guaranteeing passage of climate legislation. Indeed, the IRA sped through the Senate and House within two weeks and was signed into law a few days later.

**Table 2.1.** Timeline of Key Legislative Events for Inflation Reduction Act (IRA).

Date	Time	Event
Nov 19, 2021, Fri.	9:49 am	House passes Build Back Better climate legislation
Dec 19, 2021, Sun.	9:12 am	Manchin announces decision to vote against Build Back Better
Jul 14, 2022, Thu.	9:29 pm	Press reports Manchin will not support new climate spending
Jul 27, 2022, Wed.	5:03 pm	Manchin and Schumer announce new climate legislation: IRA
Aug 03, 2022, Wed.	3:31 pm	CBO/JCT publishes cost estimates of IRA
Aug 07, 2022, Sun.	2:45 pm	Senate passes IRA
Aug 12, 2022, Fri.	5:42 pm	House passes IRA
Aug 16, 2022, Tue.		President Biden signs the IRA into law

*Notes:* A timeline for major legislative events during passage of the IRA, which was a smaller, climate-focused version of the earlier Build Back Better Act. Event times (in ET) reflect initial news accounts according to Dow Jones Newswires, which is a financial news source used by investors worldwide.

The dramatic demise and rebirth of climate legislation represented by these July events – with the probability of climate policy action first falling to near zero and then jumping to close to one – are ideal for assessing the impact of the IRA on financial markets.<sup>8</sup> The other events in [Table 2.1](#) are arguably of much less interest for our purposes. The two events that preceded July 2022 pertained to the more expansive Build Back Better legislation and were part of yearlong intermittent negotiations with shifting legislative priorities that included health care, education, immigration, and tax reform. Accordingly, the extent and timing of any climate news content of these earlier events is much less clear. There were also three notable IRA events after July 2022 that included the release of cost estimates and actual IRA passage by the Senate and House. However, once Senators Manchin and Schumer had reached agreement, the August 2022 events were widely anticipated, and, according to contemporaneous press accounts, any residual uncertainty was effectively resolved before the actual votes were recorded in Congress. With climate concerns front and center for the July 2022 events and with the information arrival so clearly delineated, our analysis focuses on these dates to give the cleanest read on climate policy news.

In terms of legislative initiatives to limit climate change, the IRA provides funding for clean energy through a mix of tax incentives, grants, and loan guarantees.<sup>9</sup> It supports investments in clean electricity and transmission, carbon capture and storage, green hydrogen, and electric transportation and energy infrastructure. There are home energy rebates to help make homes more energy efficient and new tax credits to induce consumers to buy new and used electric vehicles. The IRA also introduces a fee on methane emissions from some companies in the oil and gas industry. Relative to past initiatives, the cost of the climate actions in the IRA is enormous – accrued both by expanding existing programs and introducing new ones. The Congressional Budget Office (CBO) and Joint Committee on Taxation (JCT) estimated that US federal budgetary costs through 2031 would be \$271 billion in climate-related tax credits and \$121 billion for direct expenditures ([Bistline et al., 2023b](#)). However, as stressed by [Bistline et al. \(2023b\)](#), many of the tax credits are uncapped, so their take-up and cost depend on corporate investment decisions and household consumption decisions. Based on a detailed energy systems modeling of the US economy, [Bistline et al. \(2023b\)](#) project the budgetary cost of the climate-related provisions to be several times larger than the CBO/JCT estimate – perhaps as high as \$1 trillion.

In terms of climate policy effectiveness, the IRA is estimated to significantly reduce carbon emissions, with projected reductions by 2030 of around 37% below 2005 levels ([Bistline et al., 2023a](#)).<sup>10</sup> This would seem to put the United States within reach of its 50% reduction target by 2030 under the Paris Agreement. To calibrate the magnitude of the IRA policy action, it is possible in theory to provide a rough estimate of the equivalent carbon price that would be needed to achieve the same emissions reduction. That is, a non-carbon price climate policy can be translated into an emissions-equivalent shadow carbon price, as described in [Hänsel et al. \(2022\)](#). [Bistline et al. \(2023b\)](#) estimate that the power sector policies, which account for about 70% of the IRA emissions reductions, may have similar emissions reductions to a US carbon tax of around \$12 to \$15 per ton of

carbon dioxide (CO<sub>2</sub>). Scaled up, this suggests that the total IRA would represent an approximate equivalent shadow carbon price of roughly on the order of \$20 per ton of CO<sub>2</sub>. By this measure, the IRA clearly represents a sizable climate policy initiative with significant effects comparable to those contemplated in the usual climate scenario analyses associated with central bank climate stress tests (NGFS, 2022a).

By using an emissions-equivalent shadow carbon price that summarizes various climate policy actions such as subsidies, taxes, and regulation (e.g., Hänsel et al., 2022; NGFS, 2022a), it is possible to provide a broad-brush account of the two key climate policy events. With the election of President Biden and Democratic majorities in both houses of Congress in 2020, there were three broad plausible paths for US climate policy: (1) further minimal incremental action, which would continue a more than decade-long trend of little progress on national climate policy; (2) a break from the past in the form of a moderately significant climate policy initiative; or (3) a very ambitious, wide-ranging policy action along the lines of a “Green New Deal” or the Build Back Better climate legislation. These three potential paths could be roughly approximated in terms of the future shadow carbon price path as (1) no change to the path, (2) a level shift upward in the path of about \$20, and (3) a level shift upward of \$50 or more. Before July 2022, there was a sizable transition risk associated with the uncertainty around which path would be taken. The July 14 event appeared to adopt the first option with no policy action. However, the IRA announced on July 27 locked in the middle path and represented a substantial climate policy transition realization.

Before turning to the empirical analysis, it is helpful to outline how these climate policy events might be expected to affect the stock market from a conceptual asset pricing perspective. A company’s equity price depends on its expected stream of future profits and dividends and on the discount rate used to calculate their (risk-adjusted) present value. The legislative events in July 2022 likely affected stock prices predominantly by changing expected dividends (as in Ochoa et al., 2022). The shifts in the expected path for the shadow carbon price directly impacted the expected profitability of green and brown firms. Higher carbon price paths translate into higher profits for green firms, which will face less competition from carbon-dependent competitors, and lower profits for brown firms. For example, a higher carbon price will raise the production costs and lower sales and revenues of firms that are more dependent on fossil fuels in their operations. Meanwhile, lower carbon price paths benefit brown firms more than green firms. After the July 14 brown event – which established a low expected shadow carbon price path – the expected profits of brown firms would likely rise, and those of green firms would fall. Conversely, the jump in the future carbon price trajectory following the July 27 green event would push up expected profits of green firms and depress those of brown firms. Furthermore, these shifts in the expected paths for profits would have corresponding differential effects on the prices of green and brown stocks.

Considering the specifics of the IRA, there are both supply- and demand-side subsidies that favor green firms. On the supply side, the IRA includes production and investment tax credits for clean energy, which can boost green firm profits by lowering costs. The effects on stock prices might be best understood through the

lens of a *cost channel*: Firms that benefit from such subsidies see their marginal cost decline and their profits, dividends, and stock prices rise. The IRA also contains demand-side subsidies to businesses and consumers to increase demand for green products. Via this *demand channel*, profits and dividends of green firms are boosted as well, again raising their stock prices.<sup>11</sup> Brown firms, which are relatively disadvantaged by the production and demand subsidies, would see their profits and dividends – and thus stock prices – decline. Therefore, we anticipate that the two sharp movements in the mean shadow carbon price path will have effects on profitability and equity prices that vary with the overall greenness of a firm, which, following a growing carbon finance literature, can be measured by the firm's CO<sub>2</sub> emissions or environmental score.

Another potential channel through which a change in climate policy could affect stock prices is via the cost of capital. An increase in transition uncertainty would raise the expected returns of firms that are exposed to this type of risk and thus lower their stock prices.<sup>12</sup> The signing of the 2015 Paris Agreement and, more generally, increasing concerns about climate change, raise the likelihood of future climate policy action and therefore transition risk – particularly for carbon-dependent firms. However, unlike many previous analyses of climate-related events and risks (e.g., Barnett, 2023; Jung et al., 2021; Ramelli et al., 2021), we do not interpret our event study results as operating primarily through *changes* in climate policy transition uncertainty and risk. Although some IRA implementation details are still being worked out, we view the passage of the IRA as a *realization* of transition risk, because it implements specific new climate policies.

Finally, there are, of course, complications resulting from the specific non-carbon price nature of the US climate legislation. In contrast to a broad, uniform carbon tax, the effects on cost and demand of the IRA subsidies will depend on their particular specification, the relevant market structure and segmentation, and the incidence across firms and industries. For example, subsidies in support of clean electricity may benefit utility firms and energy companies that are in industries with relatively high overall emissions footprints. As a result, the stock market effects of the IRA may depend not only on emissions/greenness of individual firms, but also on whether their industries are specifically favored and subsidized by the IRA – regardless of the greenness of that industry. This is a point that we will return to in Section 5.

### 3. CLIMATE POLICY RESPONSES AT AN INDUSTRY LEVEL

The first part of our analysis focuses on the response of different sectors and industries to the IRA announcements. We consider both stock market indices commonly used to represent the green and brown energy sectors, and then turn to industry portfolios using methods from empirical asset pricing. The goal of this industry-level analysis is to provide some indication of financial market participants' views about whether the IRA represents meaningful climate legislation that will be sustained going forward.

We investigate the returns of about a dozen stock market indices that are classified either as clean or green energy funds or as fossil energy funds. Our selection of indices is informed in part by [Monasterolo and De Angelis \(2020\)](#), who studied the reaction of various equity market indices to the 2015 announcement of the Paris Agreement.<sup>13</sup> [Table 2.2](#) shows event-study results for our 11 selected indices, including six green and five brown indices. We use daily index returns based on end-of-day prices from Bloomberg, and calculate abnormal returns as the differences between raw returns and predicted returns from an estimated market model, following common practice in empirical asset pricing ([MacKinlay, 1997](#)). To estimate the market model, we regress daily returns of each index on the return of the CRSP value-weighted stock market index, a proxy for the market portfolio, from January 2016 to May 2022 to avoid overlap with the event days.<sup>14</sup> For each event, we report one-day and three-day returns, with the latter calculated by cumulating daily abnormal returns. As noted above, the events took place in the evenings after trading hours on July 14 and July 27, 2022. The event windows therefore start when the stock market closed on those dates and end at market close on the next day (for one-day returns) or three days later (for three-day returns).<sup>15</sup> In addition to the abnormal returns for each individual index, we also report returns for a green factor and a brown factor,

**Table 2.2.** Abnormal Returns of Green and Brown Equity Indices.

	Brown Event (July 14)		Green Event (July 27)	
	1 day	3 days	1 day	3 days
<i>Green indices</i>				
Nasdaq Clean Edge Green Energy	-3.4**	-0.9	6.9***	7.5***
Wilderhill Clean Energy	-2.6*	-0.8	6.3***	5.6**
S&P Global Clean Energy	-3.4***	-1.4	6.5***	7.2***
World Renewable Energy (Renixx)	-4.0**	-2.6	7.3***	7.7***
ISE Global Wind Energy	-0.5	0.6	3.3***	3.9**
MAC Global Solar Energy	-4.1**	-2.6	6.2***	6.9**
<i>Brown indices</i>				
S&P 500 Integrated Oil & Gas	-0.3	2.5	-0.3	2.6
FTSE Local USA Oil & Gas & Coal	-0.1	2.4	-1.6	-2.5
FTSE All World Oil & Gas & Coal	0.3	3.3	-0.4	1.0
Dow Jones Select Oil Expl. & Prod.	-0.3	3.1	-1.6	-2.6
Dynamic Energy Expl. & Prod. Intellindex	-0.3	3.7	-1.1	-1.8
<i>Factors</i>				
Green Factor	-2.1**	-0.5	4.3***	2.6***
Brown Factor	-0.1	1.0	-0.6	-0.2
Green-Minus-Brown	-2.1*	-1.5	4.9***	2.8**

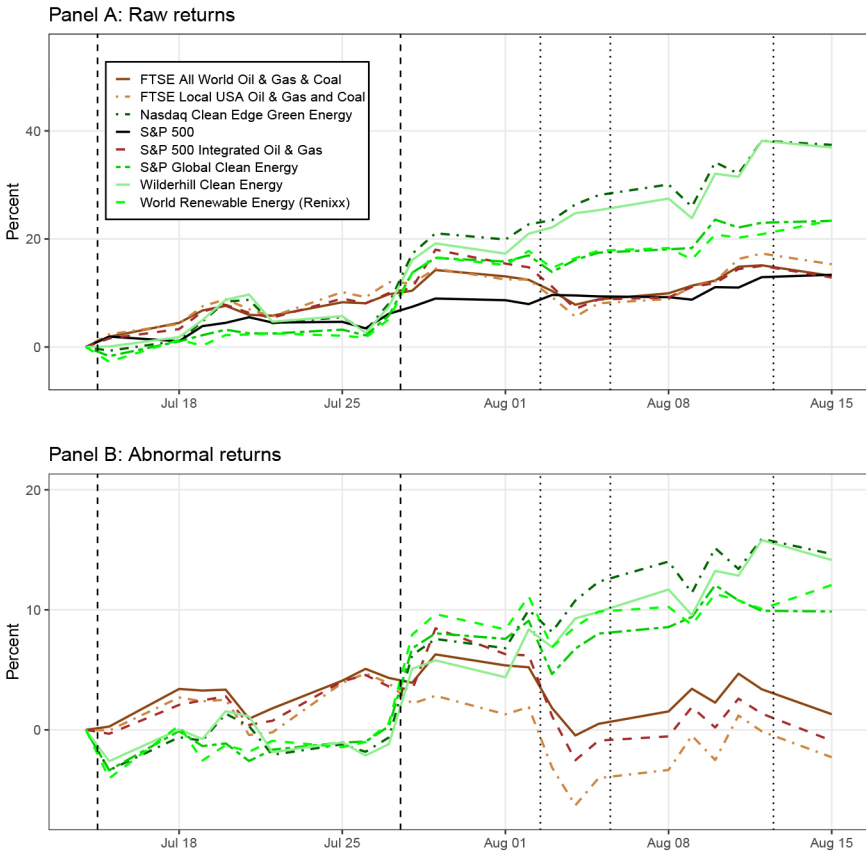
*Notes:* Abnormal returns around key IRA events. Expected returns are estimated with a market model using daily value-weighted CRSP market returns from January 2016 to May 2022. Statistical significance levels are obtained from regressions of abnormal returns on event dummies; \*\*\*, \*\*, and \* denote significance at the 1%, 5%, and 10% level, respectively.

which are weighted averages of the green and brown index returns based on their first principal components. All abnormal event returns and their statistical significance levels are obtained from regressions of the abnormal index returns on dummies for the two IRA events.

Table 2.2 shows these abnormal one-day and three-day returns around the two key IRA events on July 14 and July 27. The two events had substantially different effects on green and brown indices. The direction of the differences is intuitive, and their magnitudes are sizable. After the July 14 media reports that lowered the probability that any climate policy action would pass the Senate, green indices performed worse than brown indices, both for one-day and three-day abnormal returns. For one-day returns, the green factor fell by 2.1% while the brown factor was little changed. The relative outperformance of brown indices justifies the “brown event” label. The pattern is reversed and even more stark for the July 27 “green event,” when news of Senator Manchin’s support for the IRA assured its passage. For the one-day window, most green indices had significantly positive abnormal returns, and the green factor was at +4.3%. The brown factor has a slightly negative abnormal return of  $-0.6\%$ . The differential green-minus-brown return was significantly positive for both the one-day and three-day windows around the green event, but the green outperformance was larger and more strongly statistically significant for the one-day event.

To provide further insight on broad market moves around the policy events, Fig. 2.1 plots the cumulative returns for eight market indices from market close on July 14 to market close on August 15. These cumulative returns illustrate the persistence of the equity index reactions to climate legislation during the crucial month when climate policy was declared dead, and the IRA was announced and later signed by President Biden. The July 14 and July 27 events are indicated with vertical dashed lines.<sup>16</sup> The clean-energy and fossil-fuel-energy stock indices are shown as green and brown lines, respectively.<sup>17</sup> For the cumulative raw returns shown in Panel A, the green indices underperformed the brown ones during the two weeks following the July 14 announcement, ending about 6% lower on July 26. Similarly, the outperformance of green indices on the day after the July 27 announcement also persisted. The performance differences in green versus brown stocks are even more pronounced for the abnormal returns shown in Panel B. During the month, the gains in the green indices following the green event significantly outweighed their losses after the brown event, resulting in a cumulative outperformance ranging from 8 to 24 percentage points.

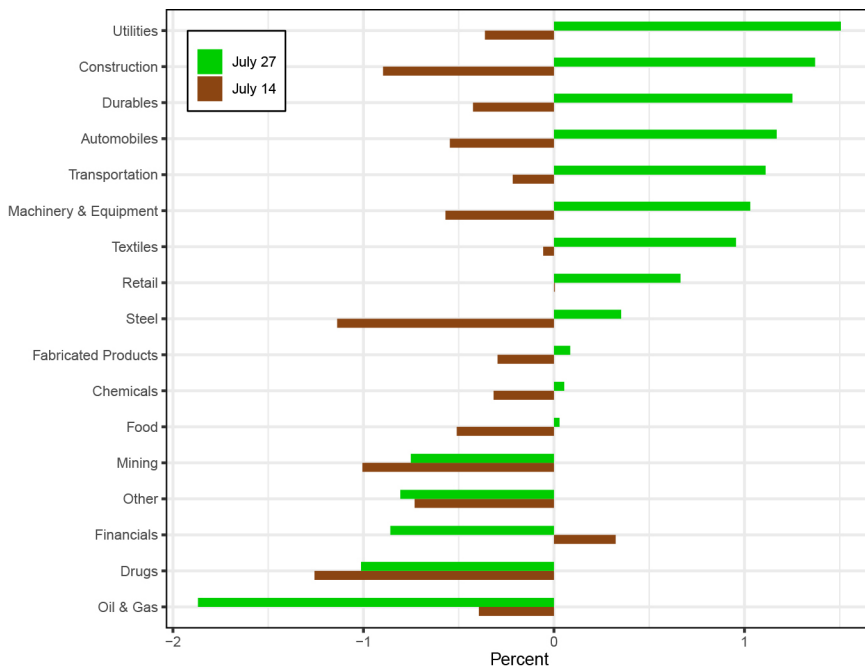
This index-level industry analysis yields a consistent picture of the financial performance of energy-related equity holdings. Indeed, the response of equity markets to major news about the likelihood of the passage of the IRA suggests that markets expected clean/renewable energy companies to benefit and oil/gas/coal firms to be disadvantaged by its policies. Differences between green and brown industry equity indices were far less apparent following the passage of the IRA in the House and Senate later in August 2022. The small impact of these two widely anticipated events is confirmed by event-study results in Appendix Table A2.1, which contains results for the other IRA-related events listed in Table 2.1. Reflecting the smaller, more diffuse releases of releases on these dates described



*Fig. 2.1.* Performance of Green and Brown Indices After Climate Policy Events. Daily cumulative returns for green and brown indices from market close on July 14 to August 15. Panel A (B) shows raw (abnormal) returns—see notes for Table 2.2. The brown and green events on July 14 and July 27, respectively, are denoted by vertical dashed lines. Three later events—described in Table 2.1—are denoted by vertical dotted lines. Each vertical line denotes the start of the event window, so the immediate observation to the right of each line shows the market response.

above, the green and brown abnormal event-returns are not dissimilar. Evidently, the two events with the largest effects on stock market indices were the news announcements on July 14 and 27 – the focus of our chapter.

We now examine the heterogeneous response of equity returns on these two dates using the 17 Fama-French industry portfolios. We use daily, equal-weighted portfolio returns, which are available on Ken French’s website and are constructed using four-digit Standard Industrial Classification (SIC) codes.<sup>18</sup> For each of the 17 industry portfolios, we calculate abnormal returns as for the index returns and report the one-day abnormal returns across industries. The resulting abnormal portfolio returns for the 17 Fama-French industries for the brown event on July 14



**Fig. 2.2.** Abnormal Industry Returns Around Green and Brown Events. Daily abnormal returns for 17 Fama-French industry portfolios (equal-weighted). Abnormal returns are calculated using the market model, estimated with daily returns and the CRSP equal-weighted market index return over the period from January 2016 to May 2022. Brown bars show returns using closing prices from July 14 to July 15 (brown event), and green bars show the returns from July 27 to July 28 (green event).

and the green event on July 27 are shown in Fig. 2.2. (Raw event returns are plotted in Appendix Fig. A2.1.) The brown event led to industry-level responses that are quite mixed and less clear-cut. But the green event produced industry winners and losers generally in line with what would be expected based on the IRA legislation.

In response to the green event, the best-performing industries were likely to benefit substantially from IRA subsidies and related measures. The utilities industry, which showed the most positive response, contains electric services and natural gas transmission/distribution/services. It stands to gain from the additional demand for electricity, which is given a significant boost by the IRA, as well from tax credits for renewable (biogas) natural gas and construction of renewable electricity plants more generally. The construction industry includes some favored clean energy companies and contractors that focus on solar installations and power generation and will be helped by the tax incentives for energy-efficient home improvements. Tax credits for electric vehicles and charging infrastructure will help the automobile and transportation industries (for an in-depth analysis,

see [Slowik et al., 2023](#)). The machinery and equipment industry includes electrical equipment/machinery/distribution/components and batteries, which will play an integral part in the green transition.

At the other end, the oil & gas and mining industries stand to lose substantially from the IRA legislation and the intended decarbonization of the US economy. Consequently, stocks in these industries exhibited large negative abnormal returns around the green event. Two other industries performed poorly around this event but due to measures in the IRA unrelated to climate change. The drug industry is expected to be adversely impacted by the IRA changes to Medicare that try to lower prescription drug prices. And financial institutions are likely to be particularly affected by the 15% minimum corporate tax on large corporations, as many large banks and insurance companies pay little or no federal taxes.<sup>19</sup>

The cross-industry heterogeneity in the equity market response conforms quite well with the incidence of the subsidies and credits contained in the IRA. The effects can be understood through the lens of the model of [Pástor et al. \(2021\)](#) as working via the customer channel, as well as the cost channel defined in Section 2 whereby production subsidies lower costs and increase profits and stock returns. But it is important to note that the IRA did not necessarily benefit green industries and hurt brown industries, as commonly defined. For example, two industries with generally high levels of emissions – oil & gas and utilities – had entirely opposite responses to the green event, according to [Fig. 2.2](#). In Section 5, we will revisit the question of whether the observed cross-industry heterogeneity in the equity response is related to emissions or other measures of industry exposure to carbon policy.

Overall, the response of both indices returns as well as portfolio returns to IRA announcements shows that market participants quickly differentiated between expected winners and losers among various industries. Differences in abnormal returns were sizable, on the order of several percentage points, after news that the IRA passage had become a near certainty.

#### 4. CLIMATE POLICY RESPONSES OF INDIVIDUAL FIRMS

So far, we have established that the two climate policy events had substantial impacts on broad equity valuations – especially for the clean and fossil fuel energy sectors, which appeared particularly sensitive to the news about climate policy. Here, we examine the effects of these events on individual firms. The extent to which individual companies face the prospect of greater or lesser profits resulting from the policy initiatives should be reflected in changes in their equity prices. Specifically, firms will perform better if they are well-positioned to benefit – in relative terms – from clean-economy production and consumer subsidies, or more generally, from a higher (implicit) price of carbon.

Earlier research – such as [Hengge et al. \(2023\)](#), [Bauer et al. \(2022\)](#), [Barnett \(2023\)](#), and many others – identify green and brown firms by using firm-level measures of environmental characteristics such as firm-level CO<sub>2</sub> emissions.

Using such firm-level measures of greenness ( $G_i$ ), including environmental scores and emissions, we investigate the equity responses to climate policy news with the following regression:

$$r_i = \alpha + \beta G_i + \delta X_i + \gamma_s + \varepsilon_i. \quad (1)$$

This specification regresses the equity returns of individual firms ( $r_i$ ) on greenness ( $G_i$ ), a vector of firm-level controls ( $X_i$ ), and industry fixed effects ( $\gamma_s$ ) for the green and brown event days separately. We focus our attention on estimates of the coefficient  $\beta$ , which captures the role of greenness for the stock market response of individual firms to climate policy news.

The requisite firm-level accounting, equity return, and environmental data are from Refinitiv.<sup>20</sup> We use all available US stocks after imposing some commonly used filters. Initially, our raw data set consists of the 3,601 US firms. We filter out firms without emissions scores for the year 2021, reducing the number of firms to 3,165. Following common practice in the empirical asset pricing literature, we apply a variety of standard filters to avoid unreliable returns data, which reduces our sample to 2,537 stocks.<sup>21</sup> Some firms released their earnings data during our event windows, which can lead to large price movements unrelated to the IRA news and thus create noise for our estimates. To mitigate this problem, we exclude firms with an earnings announcement on the event day or the following day. As a result of this additional restriction, our regression samples contain 2,520 firms for the July 14 event and 2,122 firms for the July 27 event. Given the occurrence of both IRA announcements in July 2022, we use firms' 2021 environmental and accounting data in order to best match the information set that investors likely had available when trading in response to the policy news.

For individual firms, our analysis employs several different measures of carbon dependence or greenness. Two of these are proprietary estimated measures.<sup>22</sup> The first is an "emissions score" that aggregates various firm-level metrics of how effective and committed a company is to reducing its emissions. This measure depends heavily on the estimated emissions data but also, for example, on assessments of the quality of a firm's "environmental management systems." The second measure is a broader environmental ( $E$ ) score, which combines almost 70 metrics in three categories: emissions, innovation, and resource use. Note that the emissions score is one of the three components of the  $E$  score. Importantly, in the calculation of both of these scores, each underlying indicator is evaluated relative to peer companies in the same industry. That is, firms are categorized among 60 different industries, and green firms – those with high emissions scores or  $E$  scores – perform well within their own industry.

Finally, we also employ a very tangible, narrow measure of greenness: a firm's CO<sub>2</sub> emissions. This metric is widely used in economic research to measure a firm's sensitivity to climate risk and climate policy news. Similar to [Ilhan et al. \(2021\)](#), [Ramelli et al. \(2021\)](#), and many others, we use emission intensity, defined as the ratio of a firm's emissions to its market capitalization, which accounts for the effect on emission levels of firm size. In calculating emission intensity, it is also useful to differentiate between emissions as reported by firms and estimated

emissions (Bauer et al., 2022). Many firms – even those in an ESG database – do not report emissions. For such firms, ESG data vendors provide estimates of emission levels that are largely based on a firm’s sales or scale. These estimates have measurement error, and some have argued that using such imputed instead of reported emissions can lead to bias in some empirical analyses (Aswani et al., 2023), although event studies have not been implicated. Accordingly, our analysis using emission intensity is limited to firms with disclosed/reported emissions, which reduces our sample size by about two-thirds but arguably increases the reliability of the results.<sup>23</sup> However, in unreported analysis, we obtained very similar results for the much larger sample of firms available using emission intensity calculated with estimated emissions. In addition, our other two greenness metrics – *E* scores and emissions scores – incorporate the estimated emission levels, and we use the full sample of available firms for these.

The firm-level characteristics we control for include size (log total assets), market leverage (earnings before interest and taxes divided by interest expenses), revenue growth (annual growth rate in total revenues), and profitability (return on assets). Additionally, we follow Ramelli et al. (2021) and Wagner et al. (2018) and include a measure of cash effective tax rate (ETR), given that the tax burden of a firm can be an important determinant of its exposure to policy changes.<sup>24</sup> For the emission intensity measure of greenness, we also include the standard industry fixed effects using 17 Fama-French industries based on their SIC codes. As noted above, industry effects are already accounted for with *E* and emissions scores, which are constructed relative to peer companies in the same industry. In any case, omitting industry fixed effects completely or including them everywhere did not significantly change our results reported below.

Table 2.3 reports summary statistics for our firm-level data. The emissions and *E* scores range from 0 to 1 (as we divide the raw scores by 100). High scores indicate good environmental and emissions performance – i.e., low-carbon firms – but the median firm gets a relatively low score of around 0.2. These scores also display substantial dispersion across firms but little skewness. Emission intensity, which is available for fewer firms, ranges from 0 to 3.7 (kilotons of CO<sub>2</sub> per million USD market cap), with higher values indicating higher-carbon firms. As others have noted (Bauer et al., 2022; Bolton & Kacperczyk, 2021), there is a large degree of skewness in emission intensity. A small number of firms have very high emission intensities, so the mean firm has an intensity about 20 times as large as the median firm (0.2 vs 0.01). This effect is mitigated for *E* and emissions scores by their within-industry construction. The bottom panel characterizes daily returns around the two IRA events. These returns display little skewness but substantial dispersion across firms.

Table 2.4 provides estimation results for equation (1) for raw event returns, and Appendix Table A2.2 reports results for abnormal returns, which differ minimally from those for raw returns. The results in the first three columns of Table 2.4 pertain to the brown event returns on July 14–15. They show that firms with high *E* and emissions scores or low emission intensities had a significantly worse daily stock market performance around this event. This is consistent with a deterioration in the outlook for future profits of green firms by the diminished prospects

**Table 2.3.** Summary Statistics of Firm-Level Data.

	Mean	SD	Min	q25	Median	q75	Max	Obs.
<i>Environmental performance</i>								
E score	0.28	0.28	0.00	0.01	0.19	0.50	0.98	2,537
Emissions score	0.31	0.32	0.00	0.00	0.21	0.58	1.00	2,537
Emission intensity	0.20	0.58	0.00	0.00	0.01	0.08	3.70	900
<i>Firm-level controls</i>								
Size	21.70	1.84	17.40	20.44	21.61	22.87	26.37	2,528
Leverage	0.15	0.56	-2.20	0.01	0.09	0.24	3.51	2,133
Rev. growth	0.34	1.13	-1.00	0.04	0.14	0.30	10.39	2,428
Profitability	-0.01	0.18	-1.02	-0.02	0.02	0.07	0.37	2,503
ETR	0.11	0.31	-1.73	0.00	0.15	0.23	1.23	2,537
<i>Daily returns</i>								
Brown event (July 14), raw	1.92	2.60	-44.74	0.86	1.94	3.05	24.35	2,520
Brown event (July 14), abn.	-0.18	2.60	-47.54	-1.06	-0.11	0.91	22.39	2,520
Green event (July 27), raw	1.04	2.99	-26.61	-0.31	0.96	2.33	29.97	2,122
Green event (July 27), abn.	-0.25	2.97	-27.87	-1.60	-0.31	1.07	27.87	2,122

*Notes:* Summary statistics for firm-level environmental measures, controls, and accounting variables, and event returns. Environmental measures are described in the text. Size is the log of total assets in millions USD, market leverage is EBIT divided by interest expenses, revenue growth is annual growth in total sales, profitability is return on assets, ETR is the cash effective tax rate (total income taxes paid divided by pretax income). Returns are from market close of July 14 (27) to market close of July 15 (28), and abnormal (abn.) returns are the residuals from an estimated market model.

for comprehensive climate policy. By contrast, the differential stock market responses of green and brown firms to the green event on July 27–28 have the opposite sign. The estimated  $\beta$ s for the *E* and emissions scores are positive, while the coefficient on emission intensity is negative. These responses are also stronger and statistically more significant than for the earlier event. With the astonishing news of near-certain passage of comprehensive climate policy in the form of the IRA, green firms exhibited a substantially better stock market performance than brown ones. Specifically, in terms of *E* scores, a greener firm at the upper 75 percentile (with an *E* score of 0.58) had almost a full percentage point higher daily equity return after July 27 than a browner firm at the lower 25 percentile (with an *E* score of 0.01).

Overall, our results using *E* and emissions scores are completely consistent with those using emission intensity. All three metrics show that high-carbon firms were expected to have better prospects in the absence of climate policy and that low-carbon firms performed better when the IRA climate policy was announced. This consistency is notable because the environmental scores calculated by ESG data providers are based on relatively subjective collections of indicators using proprietary methodologies. As such, at the firm level, the information in these metrics can differ substantially across providers (Berg et al., 2022; Ehlers et al., 2022).

**Table 2.4.** Event Return Regressions.

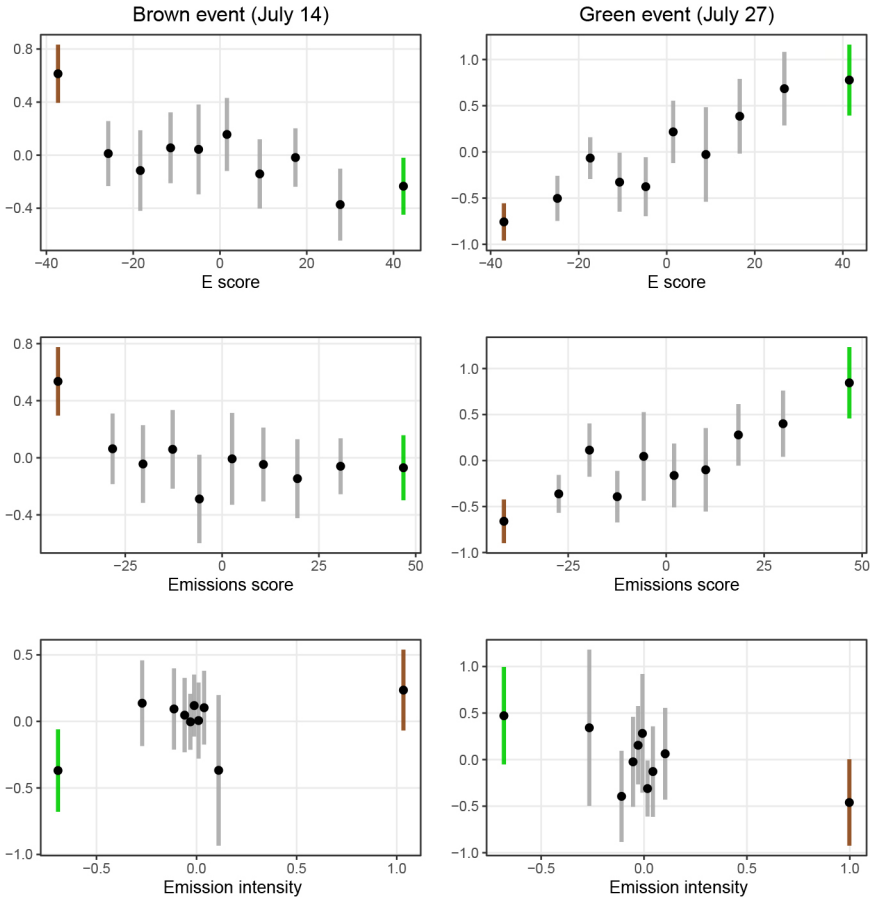
	Brown Event (July 14)			Green Event (July 27)		
	(1)	(2)	(3)	(4)	(5)	(6)
E score	-0.77*** (0.19)			1.98*** (0.27)		
Emissions score		-0.44** (0.17)			1.47*** (0.24)	
Emission intensity			0.31** (0.15)			-0.43** (0.21)
Size	0.16*** (0.03)	0.13*** (0.04)	0.05 (0.06)	-0.15*** (0.05)	-0.13*** (0.05)	-0.21*** (0.07)
Market leverage	0.30*** (0.10)	0.30*** (0.10)	0.37 (0.25)	0.02 (0.11)	0.03 (0.11)	-0.02 (0.33)
Revenue growth	0.15* (0.08)	0.15** (0.08)	-0.20 (0.21)	-0.04 (0.07)	-0.05 (0.07)	0.28* (0.16)
Profitability	0.01 (0.58)	-0.04 (0.58)	0.89 (2.24)	0.45 (0.87)	0.50 (0.87)	-3.94 (4.20)
ETR	0.12 (0.19)	0.13 (0.18)	-0.01 (0.16)	-0.04 (0.17)	-0.04 (0.17)	-0.38 (0.31)
ETR missing dummy	-1.21*** (0.43)	-1.20*** (0.43)	-0.32 (0.72)	-0.73 (0.46)	-0.77* (0.46)	-1.32** (0.52)
Constant	-1.23 (0.75)	-0.85 (0.77)		3.94*** (1.04)	3.60*** (1.06)	
Observations	2,043	2,043	824	1,693	1,693	669
R <sup>2</sup>	0.04	0.03	0.10	0.04	0.03	0.12
Industry fixed effects	No	No	Yes	No	No	Yes

*Notes:* Regression results for event returns. The dependent variable is the one-day raw return from market close on July 14 to July 15 (the brown event) in the first three columns, and the return from July 27 to 28 (the green event) in the last three columns. The key regressors are the environmental pillar score (E score), the emission category score, and emission intensity, calculated as the reported level of scope 1 + 2 emissions divided by market cap (at the end of 2021). Controls include size, market leverage, revenue growth, profitability, and ETR, which are described in the text and the notes to Table 2.3. The third and sixth columns include industry fixed effects using the 17 Fama-French industries. Clustered standard errors (by industry) are reported in parentheses. \*\*\*, \*\*, and \* denote significance at the 1%, 5%, and 10% level, respectively.

Similarly, we find a modest connection between  $E$  and emissions scores and the direct measure of emission intensity:  $E$  and emissions scores have a correlation of only  $-0.11$  and  $-0.08$ , respectively, with emission intensity. In light of the apparent noise in distinguishing green and brown firms, the consistency of our results points to the strength of the underlying effect of the climate policy news that we identify.<sup>25</sup>

To more finely judge the economic significance of the firm-level results, Fig. 2.3 displays the cross-section of firm-level returns using portfolio sorts. We first orthogonalize event returns and greenness measures with respect to our regression control variables (size, market leverage, revenue growth, profitability, and ETR – as well as industry fixed effects for emission intensity). Then, a univariate regression of the orthogonalized event return on the orthogonalized greenness

measure would recover exactly the coefficient of interest reported in Table 2.4 (according to the Frisch-Waugh-Lovell theorem). We form decile portfolios and plot mean portfolio returns against greenness (similar to a bin scatter plot of returns on greenness). The resulting Fig. 2.3 shows the cross-sectional relationship between event returns and our three measures of greenness. The left-hand column illustrates brown event returns and shows clear negative relationships between returns and  $E$ /emissions scores and a positive relationship between returns and emission intensity. These correlations are completely consistent with



**Fig. 2.3.** Event Returns of Decile Portfolio. The dots measure event returns of decile portfolios formed using  $E$  scores (top row), emissions scores (middle row) or emission intensities (bottom row), for either the brown event on July 14 (left column) or the green event on July 27 (right column). Returns and greenness measures are orthogonalized with respect to the control variables in Table 2.4 (size, market leverage, revenue growth, profitability, and ETR). Vertical bars indicate 90% confidence intervals with greenest (brownest) deciles denoted by green (brown).

the associated coefficient estimates in [Table 2.4](#) but allow a finely sliced reading of the firm-level results. For example, much of the response is driven by the greenest and brownest deciles of firms. These extremes are denoted by green and brown colored confidence intervals. For the brown event, the greenest firms had returns that were around 3/4 percentage point lower than brownest firms for *all* of the carbon metrics. For the green event shown in the right-hand panels, the reverse correlations between returns and greenness metrics are evident, with the high-carbon firms performing much worse across all three metrics. The announcement of the new IRA climate policy clearly led to a quantitatively significant green outperformance. Specifically, after the IRA announcement, the returns of green firms were 1.5 percentage points higher than those of brown ones using *E* and emissions scores and almost 1 percentage point higher using emission intensity. Furthermore, given the considerable lack of overlap of the green and brown confidence intervals in all of the panels of [Fig. 2.3](#), the statistical significance of our results across both events is confirmed.

Our analysis provides clear and consistent evidence of the stock market impact of the two climate policy events. When negotiations for further US climate policy action publicly collapsed on July 14, investors bid up shares of brown, carbon-dependent firms while green, low-emissions firms lost value. Conversely, unveiling the IRA climate policy package benefited green stocks and hurt brown stocks. These results hold up whether environmental performance is measured using scores from ESG providers or actual emissions disclosed by the stock market companies. Again, these results are consistent with, for example, the asset pricing model of [Pástor et al. \(2021\)](#) in which green stocks can benefit from a policy-induced greater demand for goods and services of greener providers. In addition, clean-energy investment subsidies and similar policies appeared likely to reduce costs for green firms.

## 5. INDUSTRY GREENNESS AS A MEASURE OF TRANSITION RISK

So far, we have shown that surprising realizations of US climate policy had substantial effects on equity prices and that these effects differed significantly across firms. Such estimates of policy sensitivities are critical to a rapidly growing literature on the potential adverse implications of climate policy changes for the financial system. Specifically, central banks and financial supervisors are investigating the exposure and resilience of financial institutions to the transition risks posed by imperfectly anticipated efforts to facilitate and force a shift to a low-carbon economy ([Acharya et al., 2023](#); [NGFS, 2022a](#)).

Central banks and supervisors are particularly interested in financial transition risk assessments of commercial banks, including how loans and other bank assets are revalued under a range of climate policy scenarios ([Jung et al., 2023](#)). The various climate scenarios differ in terms of the scope and pace of the policy-induced economic transformations taken to lower carbon emissions. The associated decarbonization risks include possible declines in asset prices, income,

and profitability, and these risks are most material for companies with business models that rely on high carbon emissions, but firm-level emission metrics and data are only available for a subset of firms. Given the inadequate coverage of the available firm-level data, it is difficult to estimate such potential transition-related losses at a granular level. Thus, for many climate-related risk assessments, potential losses have been calculated based on sectoral or industry classifications, which are available for all of a financial institution's loans and assets. For example, [Jung et al. \(2023\)](#) examine the exposure of commercial banks to different climate policy scenarios by employing estimates of the effects of different carbon taxes on the output and profits of various industries as estimated from the general equilibrium models of [Jorgenson et al. \(2018\)](#), [Goulder and Hafstead \(2017\)](#), and [NGFS \(2022b\)](#). In effect, banks' exposures to climate policy shifts depend on the industry composition of their loan portfolio and the estimated industry-level effects of the climate policies that drive decarbonization. Similarly, [Choi et al. \(2020\)](#) identify high-emission firms based on their industry classification.

The climate policy events that we identified can provide a useful case study to assess the appropriateness of using industry classifications to account for climate transition risk. Specifically, we consider whether industry-level greenness metrics can account for the cross-industry variation of the equity price response to climate policy news. This analysis employs three different measures of industry-level greenness. The first two are constructed directly from our firm-level data, which we aggregate up to the 17 Fama-French industries. Industry-level emissions are the sum of all disclosed scope 1 and scope 2 emissions (in tons of CO<sub>2</sub> equivalents) of the firms in each industry. For these industry-level greenness metrics, we use total industry emissions and emission intensity, which divides total emissions by industry market cap (in million USD at the end of 2021).

Our final measure of industry-level greenness is based on the transition risk exposure for each industry as proxied by estimates of the differing loss in output in each sector that would be caused by a carbon tax. [Jung et al. \(2023\)](#) use such carbon tax sensitivities in their study of the transition risk exposures of US banks. Like them, we use the [Jorgenson et al. \(2018\)](#) estimates of carbon tax sensitivities, which are based on an intertemporal general equilibrium model calibrated to US industries.<sup>26</sup> [Jorgenson et al. \(2018\)](#) use the Intertemporal General Equilibrium Model industry classification. We assign the firms in each of the 60 Refinitiv industries to one of the IGEM industries, which results in 29 IGEM industries for our sample.

To calculate industry-level event returns, we aggregate firm-level abnormal returns – constructed as explained in Section 3 – into equal-weighted industry portfolios. [Table 2.5](#) relates the industry-level event returns to the three measures of industry greenness. Note that, for all three measures, high values indicate brown industries with high transition risk. Thus, if these measures accurately captured the transition risk of the IRA policies, then we would expect to see positive coefficients in the regressions for the brown event (first three columns), and negative coefficients for the green event (last three columns). Instead, the coefficients on the emissions level variable have the wrong sign in both regressions, although they are not statistically significant. For emission intensity, the coefficients have the expected sign only for the brown event, but that is marginally statistically

**Table 2.5.** Event Returns and Industry-Level Green Metrics.

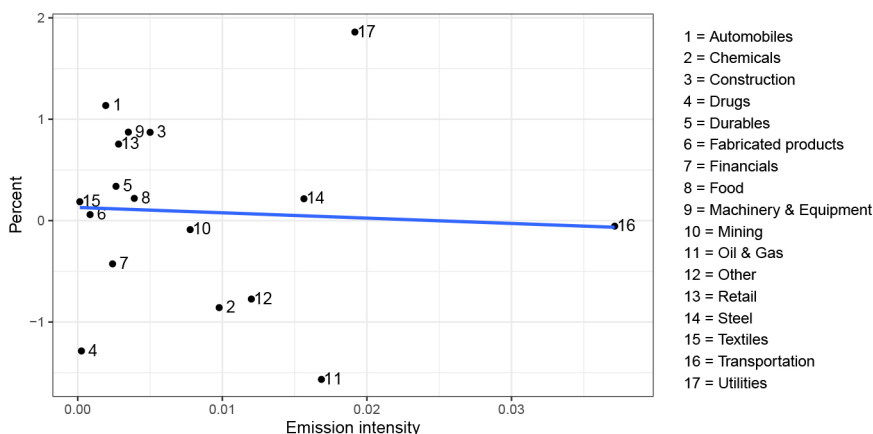
	Brown Event (July 14)			Green Event (July 27)		
	(1)	(2)	(3)	(4)	(5)	(6)
Emissions	-0.17 (0.31)			1.05 (2.56)		
Emission intensity		8.96* (4.64)			-5.26 (19.38)	
Carbon tax sensitivity			-1.31 (3.29)			-7.06 (8.83)
Constant	-0.38*** (0.12)	-0.49*** (0.14)	-0.05 (0.14)	-0.02 (0.23)	0.13 (0.22)	0.22 (0.21)
Observations	17	17	29	17	17	29
R <sup>2</sup>	0.004	0.067	0.004	0.024	0.003	0.047

*Notes:* Regressions of abnormal returns on emissions, emissions intensity, and a measure of industry sensitivity to carbon taxes. Emissions and emission intensity are aggregated to 17 Fama-French industries from firm-level data. Carbon tax sensitivity is from Jorgenson et al. (2018), the industry output sensitivity to the introduction of a \$25 tax per ton of CO<sub>2</sub> with a 1% growth rate. \*\*\*, \*\*, and \* denote significance at the 1%, 5%, and 10% level, respectively.

significant (at the 10-percent level). Finally, the coefficients on the carbon tax sensitivity variable only have the expected sign for the green event, but again, neither is statistically significant.

To illustrate the weak relationships between greenness measures and returns, Fig. 2.4 provides the underlying scatter plot corresponding to column 5 in Table 2.5. The emission intensities of the 17 industries are measured on the horizontal axis, and the equity responses of firms in those industries are measured on the vertical axis.<sup>27</sup> The regression line is effectively flat indicating a very poor fit and weak predictive ability. Two industries illustrate the difficulty of using measures of greenness at an industry level: oil & gas and utilities have similar emission intensities, but they had diametrically opposed IRA equity price responses because clean power subsidies supported the utility sector.

Overall, the measured greenness of industries appears to be essentially unrelated to the equity response to the climate policy announcements. By contrast, the within-industry heterogeneity documented in Section 4 was significantly correlated with firm-level greenness. One important implication of the poor performance of the industry-level greenness measures is that, based on the climate policy transition realizations that we examined, they are likely a weak foundation for capturing and assessing transition risk. We believe that our event study considers some of the cleanest, most clearly demarcated US climate policy announcements in terms of timing. Of course, the announced policy shifts were much more complicated than the simple carbon tax changes envisioned in many climate stress tests and model simulations. However, policy complexity seems unavoidable and practical, real-world stress testing should take this into account.<sup>28</sup>



*Fig. 2.4.* IRA Announcement: Industry Abnormal Returns and Emission Intensity. Emission intensity and abnormal returns from July 27 to July 28 (green event) for the 17 Fama-French industries. Firm-level data are aggregated to the industry level. Abnormal returns are calculated from raw returns using a market model estimated with daily value-weighted CRSP market returns from January 2016 to May 2022. Emission intensity is constructed as the total emissions (scopes 1 and 2) divided by market cap. The best-fitting regression is shown as the blue line.

## 6. CONCLUSION

Our event study used the econometric identification of clearly delineated policy news to investigate how financial markets value firms' climate-related prospects. We show that the equity market responses to announcements of climate policy actions were quick, substantial, and distinctly heterogeneous with wide variation across firms and industries. Green stocks – equities of firms with lower carbon emission intensities and better environmental and emissions scores – benefited from news that the IRA would become law, while brown stocks – those of more carbon-intensive and more polluting firms – lost value. This heterogeneity of stock price responses is both statistically and quantitatively significant. We find equity movements in the opposite direction – with brown stocks outperforming green stocks – for the earlier event when the prospects for climate action shifted to negligible. These heterogeneities – particularly the increased investor demand for the stocks of low-carbon firms – are in line with the IRA's goal of fostering a transition away from fossil fuels. These results also appear consistent with several mechanisms that lead to different expected profits for green and brown firms. In particular, the heterogeneities likely reflect the varying effects of IRA tax credits and subsidies on green and brown product demand, revenues, and investment and production costs.

We also provide a cautionary note regarding the use of industry or sectoral measures of greenness for financial risk assessments and climate scenario analyses. Industries likely to benefit from the new policies – in particular, the utilities,

construction, and automobile/transportation sectors – saw their stocks appreciate. However, across all industries, there was little correlation between industry-level greenness and stock market response. This finding suggests that a more granular, firm-level level approach may often be necessary to reliably capture exposure to transition risk.

Our examination of the reactions of equity prices to two major climate policy transition realizations can help policymakers, regulators, and investors better understand such transition risks and the likely financial effects of new climate policies. The results of our event study have some reassuring implications for financial transition risk assessments. The highly ambitious IRA climate policy legislation was a significant climate policy transition realization that could have increased the likelihood of stranded assets. Nevertheless, it did not result in any dramatic or disorderly repricing akin to a “climate Minsky moment.” That is, the most consequential climate policy action ever in US history did not lead to firm-level equity price responses that were overwhelming or destabilizing. Of course, there are caveats to this conclusion. The impact effects on equity prices may not persist. Financial investors may have naively or sensibly underreacted to the IRA, perhaps downplaying the open-ended tax cuts, or even putting sizable odds on a future policy rollback. Alternatively, other types of climate policies – such as a precipitous and largely unexpected carbon pricing scheme – could have different implications and potentially lead to financial stress and instabilities. But given the significant scope and clear-cut timing of the climate policy news during the passage of the IRA, it is difficult to envisage another set of events that would serve as a more definitive realization for assessing climate transition risk.

## NOTES

1. Many of the IRA tax credits are open-ended without fixed budgets, so the fiscal impact depends on usage and the amount claimed. The official IRA budget score by the Joint Committee on Taxation was under \$400 billion, but that likely underestimates likely participation and tax credit take-up.

2. There are three broad roles that financial markets will play in the green transition (Giglio et al., 2021): allocating funds to sustainable investment, informing climate-related economic and policy decisions, and managing climate risks. As an example, information from financial markets can help pin down the long-run social discount rate used in determining the social cost of carbon (Bauer & Rudebusch, 2023).

3. See MacKinlay (1997) for a review of event-study methods. In macroeconomics, a large literature has employed event studies to examine the financial market effects of monetary policy announcements (e.g., Bauer & Rudebusch, 2014; Bauer & Swanson, 2023; Gürkaynak et al., 2005; Kuttner, 2001).

4. As noted by Bistline et al. (2023b), the economic incidence of IRA tax credits and other provisions – that is, whether they will be captured by producers or consumers – is relevant for assessing the effects of the IRA.

5. The passage of the IRA could also have shifted the cost of capital and risk premia, by changing perceptions of future climate risks, but such shifts are much less clear.

6. The New York Stock Exchange is usually open from Monday through Friday from 9:30 a.m. to 4:00 p.m.

7. As described in Romm et al. (2022): “Sen. Joe Manchin III (D-W.Va.) on Wednesday reached a deal with Democratic leaders on a spending package that aims to lower

health-care costs, combat climate change and reduce the federal deficit, [...] Under the deal, Schumer secured Manchin's support for roughly \$433 billion in new spending, most of which is focused on climate change and clean energy production. It is the largest such investment in US history, and a marked departure from Manchin's position only days earlier."

8. Further supporting press accounts are included in Appendix A. It is difficult to augment these narratives with prediction market probabilities. There was a tiny New Zealand prediction market that did record bets on whether the US Senate would pass a budget "reconciliation" bill by September 2, 2022 (see <https://www.predictit.org>). While the reconciliation process was used to pass the IRA, the crucial issue for our event study is whether climate policy would be included in this reconciliation bill, and the prediction market is silent on this key question.

9. Besides curtailing climate change, the IRA has two other goals: restraining health-care costs and reducing the federal budget deficit. The first of these is notably aided by allowing Medicare to begin negotiating the price of select prescription drugs. Federal deficit reduction is largely achieved via a new 15% minimum tax on corporations with earnings of at least \$1 billion a year.

10. Baseline projections without the IRA had reductions by 2030 of about 28% below 2005.

11. This demand channel is similar to the *customer channel* of Pástor et al. (2021) where firms benefit from additional demand in accordance with their greenness.

12. Effects on the cost of capital could also result from a shift in investor preferences for green investments, perhaps from a bandwagon effect in which IRA news increases investor interest in green assets, according to the *investor channel* of Pástor et al. (2021). While it is conceivable that new climate legislation could raise public awareness in a way that drives investors toward green investments – lowering expected returns and raising prices of green stocks – evidence of such a shift is not apparent.

13. We omit one index that was labeled green in Monasterolo and De Angelis (2020), the STOXX Global ESG Environmental Leaders index. They find that this index is just as well correlated with the brown oil and gas funds. Most tellingly, this index is heavily weighted toward bank stocks, which fared poorly with the announcement of the IRA. We also omit a European oil and gas index listed as a brown index in Monasterolo and De Angelis (2020).

14. For stock market event studies with daily data, the market model captures abnormal movements in stock returns fairly well and adding additional factors is generally found to be unnecessary (e.g., Brown & Warner, 1985; MacKinlay, 1997). Consistent with this prevailing view, we also calculated abnormal returns using the Fama-French three-factor model and found very similar results.

15. We obtained similar results using just the overnight close-to-open returns but judged that a slightly longer window better captured the market pricing of news during business hours.

16. Again, the news on these days was released after markets had closed, so these news releases are shown as occurring between the market close quotes on these event days and the subsequent days.

17. The fossil-fuel stock declines on August 3 and 4 partly reflected a plunge in benchmark crude oil prices, which were down about 6% over those two days on concerns about rising oil supplies and a deteriorating economic outlook. Oil prices posted much smaller movements around the July 14 and 27 events – up 1.8% and down 1.0%, respectively.

18. See [https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data\\_Library/det\\_17\\_ind\\_port.html](https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/det_17_ind_port.html) (accessed 04/13/2023) for data and details on the industry definitions and return calculations. The use of value-weighted portfolios leads to qualitatively similar results. Our focus for the rest of this chapter is on daily returns, which is a common solution to the tradeoff faced in the choice of window length in event studies: longer windows allow for delayed reactions or reversion of the effects, but they also include more noise as other news unrelated to the events affect stock returns.

19. For example, among the 19 Fortune 100 companies that the Center for American Progress identified in a recent report as paying an effective federal tax rate below 10%, four belong to the financial sector (Koronowski et al., 2022).

20. Refinitiv – now rebranded as LSEG Data & Analytics – provides accounting data from the Worldscope database, stock market returns from Datastream, and environmental data from the ESG database.

21. Specifically, we filter out stocks that are not common equity, primary equity quotations, or listed in NYSE, AMEX, or NASDAQ. We also remove securities with prices lower than \$1 during our estimation and event windows, and securities whose name fields indicate non-common equity affiliation (see, e.g., Bauer et al., 2022; Griffin et al., 2010; Ince & Porter, 2006).

22. Refinitiv offers a large ESG database that covers about 85% of the global market cap and draws on more than 630 different ESG metrics. For details about the proprietary methodology, see [https://www.refinitiv.com/content/dam/marketing/en\\_us/documents/methodology/refinitiv-esg-scores-methodology.pdf](https://www.refinitiv.com/content/dam/marketing/en_us/documents/methodology/refinitiv-esg-scores-methodology.pdf) (accessed 03/16/2023).

23. Specifically, we use each firm's reported total 2021 scopes 1 and 2 emissions (in kilotons of CO<sub>2</sub> equivalents) relative to its market capitalization (in million USD at the end of 2021). We do not include scope 3 emissions because they are hard to monitor and attribute.

24. ETR is missing for a fairly large number of firms, and like Ramelli et al. (2021) we replace the missing values with zero and add an indicator variable identifying missing observations.

25. As noted earlier, Ramelli et al. (2021) find conflicting results for the stock market response to the Trump election depending on whether *E* scores and emission variables were used, but for that event, the timing of any news about the prospects for climate action was less clear-cut.

26. Specifically, we employ the estimated output sensitivities to an introduction of a \$25 tax per metric ton of CO<sub>2</sub> equivalents, with a 1% tax growth rate.

27. There are small differences in industry returns between Figs. 2.2 and 2.4. The former are estimated using all registered firms, and the latter are estimated using only our ESG firm-level dataset. However, the same conclusion is obtained with either measure: on average across all industries, returns and greenness appear uncorrelated.

28. The United States may be especially prone to policy complexity, given the politicization of views on climate change (see, e.g., DiLeo et al., 2023).

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## APPENDIX 1. SUPPLEMENTAL PRESS COVERAGE OF CLIMATE POLICY EVENTS

### A1.1. PRESS REPORTS FOR JULY 14, 2022 BROWN EVENT

#### **Joe Manchin Won't Support Climate, Tax Measures in Economic Package**

*Wall Street Journal, July 14, 2022, 11:48 pm ET*

Sen. Joe Manchin (D., W.Va.), the pivotal vote in Democrats' efforts to pass a bill aimed at fighting climate change, told Senate Majority Leader Chuck Schumer that he wouldn't support an economic package that raises taxes or includes climate provisions, according to people familiar with the matter. Instead, Mr. Manchin told Mr. Schumer on Thursday that he would only support a bill that includes provisions aimed at lowering the price of prescription drugs and a two-year extension of Affordable Care Act subsidies, according to one of the people.

[https://www.wsj.com/articles/joe-manchin-wont-support-bill-that-includes-climate-and-tax-measures-11657848978?page=2&mod=article\\_inline](https://www.wsj.com/articles/joe-manchin-wont-support-bill-that-includes-climate-and-tax-measures-11657848978?page=2&mod=article_inline) (accessed 11/09/2023)

#### **How Joe Manchin Doomed the Democrats' Climate Plan**

*The New York Times, July 15, 2022*

Senator Joe Manchin III of West Virginia, who took more campaign cash from the oil and gas industry than any other senator, and who became a millionaire from his family coal business, independently blew up the Democratic Party's legislative plans to fight climate change. [...] Privately, Senate Democratic staff members seethed and sobbed on Thursday night, after more than a year of working nights and weekends to scale back, water down, trim and tailor the climate legislation to Mr. Manchin's exact specifications, only to have it *rejected inches from the finish line*. [...] Mr. Manchin's refusal to support the climate legislation, along with steadfast Republican opposition, *effectively dooms the chances* that Congress will pass any new law to tackle global warming for the foreseeable future [...].

<https://www.nytimes.com/2022/07/15/climate/manchin-climate-change-democrats.html> (accessed 11/09/2023)

#### **Manchin Pulls Plug on Climate and Tax Talks, Shrinking Domestic Plan**

*The New York Times, July 14, 2022*

Senator Joe Manchin III, Democrat of West Virginia, pulled the plug on Thursday on negotiations to salvage key pieces of President Biden's agenda, informing his party's leaders that he would not support funding for climate or energy programs or raising taxes on wealthy Americans and corporations. [...] The decision by Mr. Manchin [...] *dealt a devastating blow* to his party's efforts to enact a broad social safety net, climate and tax package.

<https://www.nytimes.com/2022/07/14/us/politics/manchin-climate-taxes.html> (accessed 11/09/2023)

## **A1.2. PRESS REPORTS FOR JULY 27, 2022 GREEN EVENT**

### **Joe Manchin Reaches Deal with Chuck Schumer on Energy, Healthcare, Tax Package**

*Wall Street Journal, July 28, 2022, 10:28 am ET*

Sen. Joe Manchin (D., W.Va.) agreed to back a package aimed at lowering carbon emissions and curbing healthcare costs while raising corporate taxes, marking a *stunning revival* of core pieces of President Biden's economic and climate agenda that the West Virginia Democrat had *seemingly killed* earlier this month. The deal, negotiated privately between Messrs. Manchin and Senate Majority Leader Chuck Schumer (D., N.Y.) since the start of last week, would raise roughly \$739 billion [...]

<https://www.wsj.com/articles/joe-manchin-reaches-deal-with-chuck-schumer-on-energy-healthcare-package-11658957299> (accessed 11/09/2023)

### **Surprise Deal Would Be Most Ambitious Climate Action Undertaken by US**

*The New York Times, July 28, 2022*

Senate Majority Leader Charles Schumer (D-N.Y.) and centrist Sen. Joe Manchin (D-W.Va.) on Wednesday said they had struck a climate, health and tax package deal [...] The new package is a fraction of the more than \$3 trillion deal once envisioned by liberal Democrats, but it still could give the party a big win ahead of midterm elections [...].

<https://www.nytimes.com/2022/07/28/climate/climate-change-deal-manchin.html> (accessed 11/09/2023)

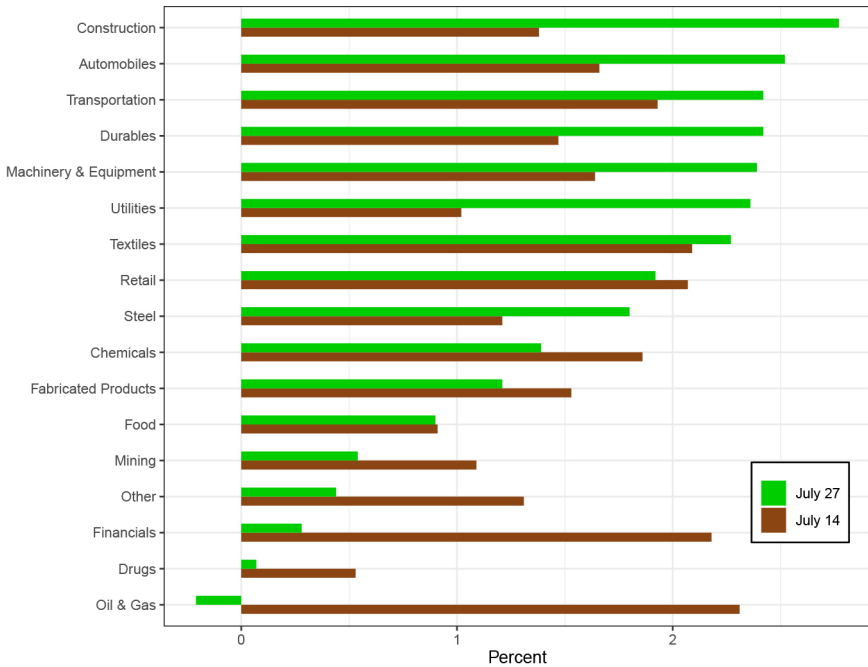
### **Manchin, Schumer announce slimmed-down deal on climate, taxes, health**

*The Hill, July 27, 2022, 5:38 pm ET*

The \$369 billion climate and tax package forged in a surprise deal by Senate Democrats would be the most ambitious action ever taken by the United States to try to stop the planet from catastrophically overheating. The agreement, which Senate Democrats announced late Wednesday and hope to pass as early as next week, shocked even some who had been involved in the sputtering negotiations over climate legislation during the past year. The announcement of a deal, after many activists had given up hope, almost instantly reset the role of the United States in the global effort to fight climate change. And it was delivered by Senator Joe Manchin III of West Virginia, the holdout Democrat who had been reviled by environmentalists and some of his own colleagues after he said this month that he could not support a climate bill due to inflation concerns.

<https://thehill.com/homenews/senate/3576965-manchin-schumer-announce-slimmed-down-670-billion-deal/> (accessed 11/09/2023)

## APPENDIX 2. ADDITIONAL EMPIRICAL ANALYSIS



*Fig. A2.1.* Returns of 17 Fama-French Industry Portfolios Around Green and Brown Events. Daily returns for 17 Fama-French industry portfolios (equal-weighted). Brown bars show returns using closing prices from July 14 to July 15 (brown event), and green bars show the returns from July 27 to July 28 (green event).

**Table A2.1.** Abnormal Returns of Green and Brown Equity Indices with Alternative Events.

	CBO/JCT (Aug 03)		Senate (Aug 07)		House (Aug 12)	
	1 Day	3 Days	1 Day	3 Days	1 Day	3 Days
<i>Green indices</i>						
Nasdaq Clean Edge Green Energy	-1.7	2.1	1.5	2.5	-1.1	-5.2**
Wilderhill Clean Energy	-1.4	1.3	1.7	3.1	-1.4	-6.3**
S&P Global Clean Energy	-4.1***	-1.0	0.5	3.7	-0.1	-1.2
World Renewable Energy (Renixx)	-3.8**	-1.2	0.4	1.3	1.8	-0.7
ISE Global Wind Energy	-2.0**	-0.3	0.9	2.2	0.1	1.1
MAC Global Solar Energy	-4.6***	-0.8	0.8	3.8	-0.2	-2.2
<i>Brown indices</i>						
S&P 500 Integrated Oil & Gas	-4.8***	-6.7***	0.3	1.1	-2.2	-1.5
FTSE Local USA Oil & Gas & Coal	-4.9***	-5.8*	0.7	1.6	-2.2	0.0
FTSE All World Oil & Gas & Coal	-3.2**	-4.5*	1.0	1.8	-2.0	-1.0
Dow Jones Select Oil Expl. & Prod.	-5.0**	-5.8*	0.4	1.1	-2.6	-0.3
Dynamic Energy Expl. & Prod.	-5.5***	-7.0*	-0.1	1.1	-2.9	-0.5
<i>Intellindex</i>						
<i>Factors</i>						
Green Factor	-2.1**	0.0	0.7	1.1	-0.1	-0.9
Brown Factor	-2.7***	-2.0**	0.3	0.5	-1.4	-0.3
Green-Minus-Brown	0.6	2.1*	0.4	0.7	1.3	-0.7

*Notes:* Abnormal returns around other IRA-related events. Expected returns are estimated with a market model using daily value-weighted CRSP market returns from January 2016 to May 2022. Statistical significance levels are obtained from regressions of abnormal returns on event dummies; \*\*\*, \*\*, and \* denote significance at the 1%, 5%, and 10% level, respectively.

**Table A2.2.** Event-Study Regressions: Abnormal Returns.

	14 July 2022			27 July 2022		
	(1)	(2)	(3)	(4)	(5)	(6)
E score	-0.86*** (0.19)			1.93*** (0.27)		
Emissions score		-0.54*** (0.17)			1.41*** (0.24)	
Emission intensity			0.31** (0.14)			-0.42** (0.21)
Size	0.15*** (0.03)	0.13*** (0.03)	0.07* (0.04)	-0.16*** (0.05)	-0.13*** (0.05)	-0.19** (0.09)
Market leverage	0.37*** (0.10)	0.36*** (0.10)	0.43* (0.25)	0.06 (0.11)	0.06 (0.11)	0.02 (0.33)
Revenue growth	0.10 (0.08)	0.11 (0.08)	-0.38*** (0.14)	-0.07 (0.07)	-0.08 (0.07)	0.17 (0.14)
Profitability	0.61 (0.60)	0.56 (0.60)	2.17 (2.21)	0.79 (0.88)	0.84 (0.88)	-3.22 (4.22)
ETR	0.31* (0.18)	0.31* (0.18)	0.12 (0.13)	0.08 (0.16)	0.08 (0.17)	-0.27 (0.32)
ETR missing dummy	-1.19*** (0.44)	-1.18*** (0.44)	-0.16 (0.70)	-0.72 (0.45)	-0.76* (0.45)	-1.21** (0.52)
Constant	-3.26*** (0.73)	-2.93*** (0.75)		2.77*** (1.03)	2.39** (1.06)	
Observations	2,043	2,043	824	1,693	1,693	669
R <sup>2</sup>	0.05	0.04	0.09	0.04	0.03	0.12
Fixed Effects	NO	NO	YES	NO	NO	YES

*Notes:* The figure shows the industry fixed-effects regression of one-day abnormal returns on environmental pillar score (E score), emissions score, and emission intensity. Emission intensity is constructed as total emissions (scopes 1 and 2) divided by market cap. Controls include size, market leverage, revenue growth, profitability, and ETR. Fixed effects account for the Fama-French 17 industries. Clustered standard errors are reported in parentheses. \*\*\*, \*\*, and \* denote significance at the 1%, 5%, and 10% level, respectively.