The impact of corporate net-zero commitments on stock performance.

by

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Abstract

“Sustainability” has become a common buzzword in investing, and it is likely to become even more prevalent as corporations respond to climate change. In this thesis, I explore the impacts of corporate net-zero commitments on stock performance. A net-zero commitment communicates a company’s intention to emit no more carbon emissions than are removed from the atmosphere. I use two complementary methods to assess the commitments’ effects on stock returns. First, using Fama-MacBeth regressions, I found that portfolios of stocks of companies with net-zero commitments on average earn lower annualized excess returns by about 3%, relative to those without such commitments. Second, using difference analysis and event-study methods, I find that stock prices and returns decline for five weeks after announcing a net-zero commitment. These results are consistent with three non-mutually exclusive hypotheses. One is that the net-zero commitment is costly, thus decreasing the firm’s value. Second, commitments could mitigate climate-related risk, meaning investors no longer require compensation for climate-related risk. Third, it is possible that investors who value sustainability are willing to accept lower returns on the stocks of companies that have made net-zero commitments.

Acknowledgments

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1. Introduction

While the prioritization of sustainability in financial markets has become increasingly relevant in the past decade, the Covid-19 pandemic accelerated the market-wide obsession with ESG investing.1 Furthermore, the outbreak exposed the relevance and urgency of climate change, encouraging investors and businesses alike to rethink their sustainability practices. Larry Fink, CEO and chairman of Blackrock, highlights investors’ shift toward environmental considerations, citing, “The pandemic has presented such an existential crisis– such a stark reminder of our fragility– that it has driven us to confront the global threat of climate change more forcefully and to consider how, like the pandemic, it will alter our lives.”2 Corporate net-zero commitments are one of the most popular present-day methods that firms use to insulate themselves from the risks associated with climate change, while also confronting the reality of Fink’s message.

Financial regulation is beginning to engage with sustainable finance through proposing new policies and supervision. On March 21, 2022, the Securities and Exchange Commission (SEC) approved a monumental proposal to require all publicly traded companies to disclose greenhouse gas emissions and climate change risks. If passed, this proposal marks the first time firms are mandated to disclose carbon risks and report in a standardized fashion. SEC chair Gary Gensler believes the proposal would provide “consistent, comparable information” for investors and initiate the private sector to confront the economic risks associated with climate change. Further, the proposal would obligate companies with public sustainability pledges, such as a net-

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1 ESG stands for Environmental, Social, and Governance. ESG investing refers to the prioritization of these principles when making investment decisions.
2 Blackrock is one of the world’s top investment management firms. CEO Larry Fink released this statement in his widely regarded 2021 Letter to CEOs.
zero commitment, to explain how they plan to reach their goal and release relevant emissions data.

Emissions reporting proposals such as the SEC’s stem from the United Nations’ Paris Climate Agreement and its goal to reduce the international carbon footprint. The Paris Climate Agreement (COP21), set in 2015, is an international treaty striving to limit global warming temperature increases below 1.5-2 °C compared to pre-industrial levels. At the latest, this goal requires an ambitious timeline of achieving international net-zero emissions by 2050 or 2060. However, as the popularity of net-zero commitments increases, it is vital to consider the financial and economic implications resulting from these commitments. Previous literature establishes that carbon emissions affect corporate returns and stock performance due to climate-risk exposure, but minimal research exists on the role of net-zero commitments.

1.1 Climate versus Market Risk

It is important to distinguish between climate and market risk because I refer to both types of risk throughout my research. First, I will address the concept of climate risk. In financial markets, climate risk takes on physical and transitional forms. Physical risk refers to the tangible effects of climate change on the environment, such as rising sea levels, severe weather events, and increasing temperatures. If such events cause physical damage to a firm, this is reflected in a lower stock price. For example, if sea levels rise and submerge Exxon’s refineries on the Gulf Coast, we will see the firm’s value drop and stock price fall. Net-zero commitments typically do not mitigate a firm’s physical exposure to climate change.

Next, the transitional risk stems from the impacts of potential climate policy and regulation in the shift toward a low-carbon world. For example, if the government takes actions
to disincentivize fossil fuel consumption by implementing a carbon tax, one would expect high-emission companies’ stock prices to tank. There are two main ways that transitional carbon risk impacts corporate performance. First, emissions are tied to fossil-fuel sources and thus are affected by energy and commodity price risks. Second, firms with high emissions levels have greater exposure to carbon pricing risk and other climate change-oriented policies. Further, fossil-fuel-dependent firms are more vulnerable to technology risks because of their limited reliance on newer, greener energy sources (Bolton & Kacperczyk, 2020). In summary, significant risk is associated with disproportionately high emissions levels, leaving heavily carbon-dependent companies more susceptible to impending regulatory measures and input costs.

Climate change exposes companies to unexpected climate catastrophes and potential regulation. Both the physical and transitional forms of climate risk can reduce firm value, but I focus predominantly on the intangible transitional risks in this paper. My research asks if corporations with net-zero commitments tend to earn higher or lower returns when controlling for market risk. Market risk relates to the covariance between a stock’s return and the market return. Further, beta is a measure of market risk and the strength of a stock’s co-movements with the market. Market risk and beta are further explained in Section 4.1.

1.2 Impacts of Net-Zero Impacts on Stock Performance

There exist multiple channels in which corporate net-zero commitments can affect stock price and returns. I will lay out four main hypotheses that I examine in this paper. The theories behind the impact of net-zero commitments on stock performance are the following: (1) the
“Green is Costly” Hypothesis, (2) the Risk Mitigation Hypothesis, (3) the “Feel Good” Hypothesis, and (4) the “Cheap Talk” Hypothesis.

First, we consider the “Green is Costly” (GC) Hypothesis. When firms commit to net-zero emissions, they must pay a real cost, either now or in the future. The cost results from the obligation to be a “good citizen” and address sustainability concerns. But, ultimately, the commitment has no material effect on the firm’s exposure to climate risk. Paying the price of going green without changing risk exposure will unambiguously reduce the present value of future profits, and in turn, the stock price will fall. If the net-zero commitment came as a surprise to investors and markets priced the news immediately, then the stock price would fall on the day of the announcement. Going forward, the returns would be given by the Capital Asset Pricing Model (CAPM), as further described in Section 4.1. But, if markets took time to figure out the announcement, the stock price would fall gradually as investors digested the news, resulting in a period of negative excess returns.

Next, we think about the “Risk Mitigation” (RM) Hypothesis. Here, we assume the net-zero commitment actually reduces the probability that a firm experiences loss of value due to climate catastrophe. Examples of such climate catastrophes are rising sea levels, carbon taxes, and severe weather, among others. While these climate catastrophes considered are both physical and transitional threats, it is most likely that the net-zero commitment insulates a company from some degree of transitional risk exposure, such as a carbon tax.

First, I will lay out the influence of possible future climate events on a firm’s present value. For example, there exists a firm with profits of $100 this year and consider the potential that a flood next year would lower profits. The profits for the following year are $100 with a 50% probability of no flood and $50 with a 50% chance of a flood. If we assume a discount rate
of zero, then the present value of the future profits is $100 + 0.5 * $100 + 0.5 * $50 = $175. But, expecting the firm continues operating into future years and the flood threat persists, then investors will require an excess return relative to the market in each sequential period. The excess return compensates investors for the potential that the price falls in the future due to the catastrophe. Under this scenario, investors would see a long period of positive excess returns, followed by substantial negative excess returns if the catastrophe materialized. Of course, there is a chance that the catastrophe never transpires.

But, now suppose that firms are able to pay some cost today to reduce the catastrophe probability to zero. If we assume it costs $20 today to eliminate the potential catastrophe, then the firm’s profits, net of the net-zero cost, would be $180. Further, investors would no longer require the excess returns in sequential periods to compensate for the catastrophe risk. Therefore, the catastrophe risk goes to zero in the future and we would see excess returns proportional to the market returns.

For example, if Occidental Petroleum commits to net-zero today, they remain just as exposed to the physical effects of climate change. But, now the firm does not have to worry about potential carbon taxes. Before the commitment, perhaps investors demanded a higher return due to the company’s susceptibility to impending carbon taxes. After the net-zero announcement, we expect the stock’s price to first rise; from then on, investors no longer require the premium to account for the potential carbon tax, leading to lower excess returns.

It is also important to consider the synergies between the GC and RM Hypotheses. In the RM Hypothesis, the net-zero commitment increases the present value of firm profits while reducing transitional climate risk exposure. But, the net-zero commitment could actually decrease the present value of profits, due to the costs of going green. In this situation, a firm is
paying to reduce climate risk exposure, meaning the stock price will fall and risk-adjusted excess returns become zero.

The final two hypotheses both rely on the assumption that net-zero commitments are costless and have no impact on climate risk exposure. The “Feel Good” (FG) Hypothesis assumes investors “feel good” about investing in sustainable companies and are willing to accept a lower rate of return when holding a green firm. Consequently, the firm will see negative excess returns relative to the overall market. If a specific firm, such as a financial institution, does not have to worry about the physical impacts of climate change or potential carbon regulation, the firm can still see the impacts of a net-zero commitment on excess returns. In this situation, a commitment could decrease excess returns, controlling for the market risk; investors are willing to take lower excess returns because they are supporting a green, climate-conscious firm. Finally, it would be remiss to disregard the “Cheap Talk” (CT) Hypothesis. Such a hypothesis says that net-zero commitments have no impact, and both the markets and investors realize there is no effect on stock price or market returns.

This analysis only considers the impact of commitments to net-zero emissions instead of strictly looking at corporations that have achieved net-zero. Since the stock market is forward-looking, investors will price in the impacts of such commitments to emissions reductions. Further, this paper does not distinguish between net-zero and carbon neutrality. By definition, net-zero implies reducing emissions to the lowest levels possible, then offsetting the rest. However, carbon neutrality does not require reducing emissions to the lowest levels; instead, carbon neutrality means that all emissions are offset. The paper assumes that investors will price net-zero emissions and carbon neutrality similarly.
1.3 Implications and Importance of Results

While ESG trends suggest corporations are increasing their consideration of environmental impacts, the underlying financial implications and potential economic outcomes of this sustainability focus are often overlooked. Do reductions in corporate carbon emissions promote sustainable economic growth? In financial markets, the transitional climate risk results from the potential impacts of climate policy, such as a carbon tax. As a result, this suggests that the growing emphasis on sustainability would increase the climate risk associated with high-emissions companies and those lacking emission reduction strategies. If climate-conscious firms tend to have better economic performance than less sustainable firms, then policies that discourage emissions will have minimal negative impacts on the environmentally-conscious corporations. Further, the economy-wide abatement costs would be low for these firms.

When discussing the implications of this research, we must also consider the motivations behind a firm’s commitment to net-zero emissions. Some firms are more concerned with climate change than others and have greater impetus to mitigate their climate risk exposure. For example, consider ExxonMobil’s refineries on the Gulf Coast and their susceptibility to rising sea levels. If the future collapse of the Arctic Sea Shelf raises sea levels and submerges Exxon’s refineries, then Exxon will experience a catastrophic reduction in the value of the firm’s assets. Although a net-zero commitment does not shield Exxon from physical catastrophe, the company has incentives to commit to net-zero and reduce exposure to global warming effects.

As a result, firms less vulnerable to climate risk may not commit to net-zero. Instead, these companies will reap the societal benefits from other, more susceptible firms pursuing actions to minimize the threats of climate change. This is the “free-rider problem,” where non-commitment firms are experiencing a positive externality from net-zero firms. Ultimately, when
deciding whether or not to target net-zero emissions, we assume firms often take the least costly option and assess the individual gains to be made from the commitment.

At the most basic level, research on the financial performance of companies with net-zero commitments is a question of returns: what is the expected return to a net-zero commitment? Further, do corporate net-zero commitments improve stock returns and decrease transitional carbon risk? If the resultsreveal positive implications for going net-zero, then this suggests that future economic growth lies in the trend of sustainability and reducing carbon emissions.

Sustainability in financial markets is a large-scale, international movement with rapidly growing relevance across macroeconomics. However, macroeconomics considers the structure and performance of the aggregate economy, meaning that the research inherently lags behind contemporary trends. Therefore, as the economy prioritizes net-zero commitments, investors are shifting market-wide trends towards corporate emissions reductions.

2. Literature Review

The goals of the Paris Climate Agreement heighten the financial risk associated with the transition towards a low-carbon economy and encourage companies to respond to the impending changes. Before the 2008-2009 Global Financial Crisis, financial markets viewed carbon emissions as a form of externality to pass on to consumers and supply chain partners. At that point, markets priced the risk through carbon taxes (Bolton and Kacperzyk, 2020). The process of emissions valuation has since changed drastically, with investors now taking more active consideration of corporate sustainability.

The growing emphasis on carbon emissions suggests that resources and attention will continue trending towards the concept of net-zero commitments. To understand the importance
of carbon risk and capital markets, we must recognize how pertinent carbon emissions are in the broader economy. In 2009, a collaboration between the Investor Responsibility Research Center and Trucost priced the cost of carbon as a function of company revenue. On average, S&P 500 firms emitted 382 tons of carbon for every $1 million in revenue generated. The researchers suggest a price of $28.24 for each ton of CO2 emitted, resulting in emission costs of over $92.8 billion. These costs account for 1.08% of a company's revenue and 5.5% of EBITDA\(^3\) in 2007. Substantial portions of company earnings are designated for carbon-intensive processes and this fee will only grow in the coming years, indicating the lower costs for companies that transition away from heavy fossil fuel dependency.

To comprehend the implications of net-zero commitments, we will explore existing literature on carbon emissions and financial markets. First, we examine how the transition to a low-carbon economy exists as a material risk for investors and firms. Second, we focus on the relationship between carbon emissions, stock market returns, and "carbon beta." "Carbon beta" is an extension of the standard market beta and refers to a firm's carbon risk. Finally, we consider an event-study analysis looking at the impact of carbon shocks on the stock market. The carbon shock analysis provides a model framework for an event-study analysis that I later perform.

2.1 Pricing Carbon Transition Risk

Developing literature has gravitated toward pricing carbon transition risk. Bolton et al. (2020) examine how the transition to a low-carbon economy poses risks for investors; the paper identifies the determinants for pricing transition risk. As previously discussed in Section 1.1, Bolton et al. define carbon risk as both a physical risk due to climate change and a transitional

\[^3\] EBITDA stands for earnings before interest, taxes, depreciation, and amortization.
risk in pursuit of a low-carbon environment. Bolton et al. only consider transitional risk in their paper.

The model sets up risk as a function of carbon emissions in the short and long run, the degree of market integration, and uncertainties about change due to technology, beliefs, and policies. Further, they use two different measures of carbon emissions: (1) the firm level of emissions and (2) the percent changes in firm-level emissions. Emissions level conveys historical emissions trends and communicates information about long-term risk; meanwhile, the percent changes in emissions suggest short-term transition risk and likely trends for future emission levels. Net-zero commitments similarly indicate the distinction between long and short-run trends because such a commitment demonstrates the long-run sustainability intentions and the short-term transitional risks in pursuit of the target.

Bolton et al. use a pooled data regression model with average monthly stock returns as the dependent variable and carbon risk as the independent variable. They create an estimation of carbon risk and use firm-level characteristics as control variables. The results show three main findings with specific relevance to net-zero commitments. First, long-term risks are unrelated to economic development, energy mix, or social environment but depend on domestic policy implementation. The long-run risks associated with policies emphasize the importance of net-zero commitments as a durable solution. Companies with higher carbon dependency have greater exposure to policy risk. Next, such policy risk is not as relevant in the short term; instead, technological and social environments dictate near-term risks. Ultimately, these distinctions between short and long-term risk contextualize the temporal relevance of specific emissions determinants and when stock markets price them.
The last salient finding of the paper is the importance of investor awareness in dictating the carbon premium. Bolton et al. use the COP21 as a shock to investor awareness, analyzing the carbon premium before and after COP21. The carbon premium increases post-COP21, primarily for long-term risk, indicating that climate-related events can shift investor attitudes around beliefs, policies, and technology.

2.2 Investors and Carbon Risk

A more recent paper by Bolton and Kacperzyk (2021) expands on carbon transition risk and analyzes how stock markets price carbon risk. The research focuses on the connections between emission levels and alpha, where alpha measures how much an investment has returned compared to the market. Bolton et al. identify a carbon premium, suggesting that investors demand additional alpha proportional to carbon exposure. The Fama-MacBeth model is used to estimate investment returns. In my analysis, I also use the Fama-MacBeth regression, and the specifications of the model are explained in Section 4 Methodology.

Bolton et al. quantify a carbon premium based on how firm-level stock returns vary with carbon emissions. As mentioned in Section 1.1, the intuition behind the model is that carbon emissions affect stock returns in two ways. First, emissions are tied to fossil-fuel energy use and are affected by energy prices. Second, firms with disproportionately high carbon emissions are more vulnerable to carbon pricing risk and other climate policies. Similarly, high-emissions corporations are exposed to technology risks because of their limited reliance on cleaner energy sources.
Bolton et al. use a cross-sectional analysis to quantify the impact of emissions on US-stock returns:

\[ RET_{i,t} = a_0 + a_1 \log( TOT \text{ Emissions})_{i,t} + a_2 \text{ Controls}_{i,t-1} + \mu_t + \epsilon_{i,t}. \]

\( RET_{i,t} \) is the stock return of company \( i \) in a given time \( t \). \( \text{Controls}_{i,t-1} \) is a vector containing identifying factors for company \( i \), such as market capitalization, book value, book leverage, and market beta over one year. The portfolio return series uses Ken French portfolios. Bolton et al. later include industry effects in the regression and find the model's predictive power increases anywhere between 70% and 280% compared to the model without industry controls.

Ultimately, greater returns are associated with higher emissions through the carbon premium. The research finds that the carbon premium relates to emissions level but not intensity. Intensity refers to the level of emissions associated with a given unit of output; there exist no benefits to lowering emissions intensity. The insignificance of intensity is most likely because climate regulation targets emission levels and not the intensity. Also, increasing output would lower intensity, thus changing intensity without altering emission levels. The prioritization of emissions level over intensity is crucial in net-zero commitments because such commitments focus on reducing emissions levels.

In a deeper analysis of carbon risk and performance, Görgen et al. (2019) generate each firm-level market beta and the individual "carbon beta" to quantify the carbon risk for a given firm. It is important to note that a significant focus of their paper is "carbon beta," which is different from the standard market beta that I use in my later analysis. The "carbon beta" refers to how companies respond to the returns of a low-carbon portfolio. My analysis looks at the company's response to the market returns overall.
Görgen et al. classify companies as either "brown" (high-carbon emissions) or "green" (low-carbon emissions) to develop a "Brown-Minus-Green" portfolio (BMG). The portfolio is long in brown firms and short in green firms. They assume all companies have exposure to carbon risk, but brown companies will become greener over time. Also, green firms' equity prices will respond positively to rapid and unexpected regulatory changes pushing for a low-carbon economy. "Brown-Green-Scores" (BGS) are calculated for firms using three indicators: value chain, public perception, and adaptability. The value chain encompasses production, technology, supply chains, and current emissions, among other factors. Next, public perception is how stakeholders interpret a company's emissions and carbon policy. Finally, adaptability is how prepared a firm is for changes concerning carbon price and potential regulation.

Using the BGS values, the analysis finds the expected returns of the BMG. Each firm was allocated into one of six portfolios based on size and BGS. The value-weighted average monthly returns of four portfolios are used to calculate the BMG:

\[ BMG_t = 0.5(SH_t + BH_t) - 0.5(SL_t + BL_t) \]

\( BMG_t \) is the return in month \( t \) of the self-financing portfolio long in brown firms and short in green firms. The four portfolios used in the calculation are as follows: \( SH_t \) is “small/high BGS,” \( BH_t \) is “big/high BGS,” \( SL_t \) is “small/low BGS,” and \( BL_t \) is “big/low BGS.” Overall, this creates a global carbon risk mimicking portfolio, which they use in a time-series regression to explain a firm’s excess returns and calculate the carbon beta. “Brown” firms have positive beta values due to their heightened market sensitivity to carbon risk, and “green” firms have negative beta values for the opposite reason.

The Görgen et al. framework differs from my methodology discussed below in Section 3.1 because they regress firm-level excess returns on an intercept, beta, and "carbon beta,"
creating a two-factor model. Instead, my framework uses a single-factor model with excess returns regressed on an intercept and beta. By distinguishing between the traditional market beta and "carbon beta," the Görgen et al. methodology is valuable in separating carbon risk from generalized financial risk and identifying underlying variables influencing the carbon beta value.

2.3 Carbon Shocks to the Market

Finally, Zeckhauser et al. (2019) look at how stock prices move in response to salient events surrounding US policy on climate change. The paper considers two "shocks" to the US attitude towards climate change. First, Donald Trump's 2016 election of Scott Pruitt, a prominent climate skeptic, to head the Environmental Protection Agency (EPA) caused a downward shift in US climate change policy expectations. Next, the election of President Biden in 2020 dramatically pushed up expectations on climate policy. Biden ran for president with the clear intention to re-enter the United States in the Paris Climate Agreement and improve the country's broader climate agenda. These two contrasting events allow Zeckhauser et al. to capitalize on the opposite US stock price reactions and interpret market responses to climate policy.

The analysis uses Russell 3000 firms from 2016 to 2020. Zeckhauser et al. calculate the excess returns for each firm using the Capital Asset Pricing Model, further explained in Section 4. CAPM-adjusted returns serve as the primary dependent variable in the analysis. After Trump's election of Pruitt, the results show that carbon-intensive firms saw boosted returns and rewards from the loosening policy expectations. However, firms with climate-responsible strategies, such as a net-zero commitment, also experience boosted returns. "Boomerang" expectations for climate policy explain this counterintuitive result because long-term investors viewed Trump's loosening policy as only a transitory shift. Next, after Biden's election in 2020, climate-
responsible firms saw a significant increase in excess returns, and carbon-intensive firms did not experience such gains.

The paper's use of carbon policy "shocks" sets up a framework that I later adapt in my event-study analysis of firm returns before and after net-zero announcements. Further, the work shows that corporate sustainability and strategy impact firm value; long-term investors see increased benefits associated with environmentally-conscious firms. Similarly, rewards for sustainable investing appear to depend on long-run climate regulation expectations. By committing to net-zero, firms prepare for the transition to a low-carbon economy and tightened climate policy in the long run.

3. Data

In my analysis, I use S&P 500 companies and record the stock price data on a weekly basis. The data cover the 2012 to 2021 time period. I also record the company’s sector, net-zero commitment status, and, if applicable, the date of the net-zero announcement. Sector classification is based on the Global Industry Classification Standard (GICS). Sector-level considerations are essential because, on average, different sectors have varying carbon intensity and dependence levels.

Due to data limitations around stock price and corporate sustainability, I manually compiled my dataset. Financial information on corporate sustainability is often privatized, expensive, and inaccessible. The weekly stock price is individually pulled for all the companies included in the S&P 500. Next, I systematically researched each company to see whether they had a net-zero commitment. Searches on publicly available sources of the following formats were done to acquire information on commitment status: “[firm name] net zero carbon,” “[firm
name] carbon neutral," and “[firm name] net zero emissions." There is no universal compilation of corporate net-zero commitments, and the intensive data collection process is similar to the approaches of related published literature. After I obtain the commitment status, I also record the commitment date. Due to this manual process, slight discrepancies in commitment status and date could exist.

The S&P 500 weekly index serves as the proxy for overall market performance. One note for consideration is that the analysis does not distinguish between companies that have achieved net-zero and those that have only committed to achieving net-zero at a later date. The stock market is forward-looking, and thus investors will similarly price how companies are insulating themselves from carbon risk. Research out of the Yale School of Management and Yale Center for Business and the Environment provides an informative breakdown of revenue and emissions levels for all S&P 100 companies that is shown in Figure 7.1 in the Appendix. The figure provides context for which big-name companies are the best-in-class, meaning high revenue and low emissions and the firms that are the worst-in-class carbon offenders.

The companies researched in the analysis are the S&P 500 companies as of January 1, 2022. Thus, some companies have not been in the S&P 500 throughout the entire 2012 to 2021 time period. In addition, 15 stocks are excluded from the analysis due to inadequate price information, leaving 485 companies in total. The S&P 500, as a compilation of the largest, most established corporations, were chosen for this analysis because they provide informative, recent, and publicly available data on financial performance. Also, these companies are required to adhere to financial reporting standards. While not all companies publish sustainability information, these large, international companies are often the most likely to release corporate net-zero commitments and sustainability intentions. Out of the 485 companies, 232 have net-zero
commitments, leaving 253 companies without a commitment. **Table 3.1.1** provides a summary of net-zero commitments across sectors.

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<th>Total</th>
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### 4. Methodology

#### 4.1 Capital Asset Pricing Model (CAPM)

The analysis uses the Capital Asset Pricing Model to calculate each company’s sensitivity to the market movements and predict excess returns. *Market risk* is the strength of a stock price’s co-movement with the market average. Beta measures the stock price’s volatility compared to
market movements. For example, a beta of two implies that if the market goes up by 1%, we predict the stock price to go up by 2%, assuming the risk-free rate is 0%. Similarly, a beta of one means that the stock tends to move in tandem with the market. A higher beta value, meaning greater than one, suggests there exist factors affecting the price that do not impact other stocks. On the contrary, low beta stocks have movements of smaller amplitudes than market averages and reduce market risk exposure for investors. We must note that beta only accounts for a stock’s sensitivity to systematic risk, which is the risk that affects the market as a whole. Also, market risk is separate from climate risk, which I define in Section 1.1.

Overall, the CAPM determines a theoretically appropriate required rate of return for a stock based on its covariance with the market and assuming investors demand a premium for such market risks. Further, the CAPM’s outcome variable, excess return, is the additional return that an asset receives over the market. An excess return of 5% indicates that an asset outperformed the market by 5% after accounting for the stock’s volatility. In the case of net-zero commitments, we predict that investors demand a carbon premium for non-commitment companies. The CAPM is a single factor model, but in the discussion of Görgen et al. in Section 2.2, we saw that this simplified model could be extended into a two-factor model.

The CAPM is as follows,

$$E[r_{jt}] = r_f + (r_m - r_f)\beta_{jm}$$

\(r_{jt}\) is the return on stock \(j\) at time \(t\), \(r_{mt}\) is the return on the market index \(m\) at time \(t\), and \(r_f\) is the risk-free rate \(f\) at time \(t\). Typically, the US 10-year bond yield is the proxy for the risk-free rate. The S&P 500 index is used for the average market return in this analysis. Putting this together, the market premium, \(r_m - r_f\), is the excess return of the market over the risk-free rate. Finally, \(E[r_{jt}]\) is the excess return of a stock. The CAPM predicts that excess returns
depend positively and linearly on beta. I estimate the parameters of the CAPM through a two-step process.

In my analysis, the CAPM serves as a framework for examining stock returns, market risk, and assessing the financial performance of S&P 500 companies. The CAPM simplifies market and investor behaviors down to the conjecture that markets are competitive and investors demand returns proportional to the financial risks assumed. As a result, the CAPM isolates market risk.

For the following analysis, first, the firm-level beta values are estimated by calculating the covariance in movement between a given stock price and the S&P 500 market index. Beta values are analyzed across net-zero commitment status. Also, a firm’s industry must be considered in the beta analysis because industries are often associated with commonly accepted beta ranges. For example, firms in the consumer staple industry typically have beta values of less than one because consumers rely on these products, regardless of financial conditions and market performance. After the beta calculations, I next estimate excess returns. This framework allows us to see whether companies with net-zero commitments earn excess returns, either positive or negative, relative to the market.

While literature exists on carbon emission levels and company performance, there is virtually no research on the specific topic of net-zero commitments. In terms of carbon risk and stock markets, Bolton and Kacperczyk (2020) examine the effect of carbon emissions on US stock returns. Ultimately, the paper finds that firms with higher carbon emissions earn higher returns, suggesting that investors demand a carbon premium for increased exposure to carbon risk. The carbon premium is not present in data prior to the 1990s, showing the economy’s growing sustainability focus with time. Further, Bolton et al.’s event study analysis reveals that
the carbon premium increased substantially after the induction of the Paris Climate Agreement in 2015. The Paris Climate Agreement serves as a shock to investor awareness on emissions and leads to higher marketplace risk for more carbon-intensive firms.

While Bolton et al. demonstrate this correlation between market returns and carbon emissions, the University of Oxford and Arabesque Partners (2020) find that setting emissions reduction targets improves operational and stock performance, lowers the cost of capital for companies, and leads to more positive corporate behavior, among other beneficial outcomes. These results reveal some of the potential financial incentives for companies to transition to net-zero. Similarly, Matsumara et al. (2014) discover that while markets penalize corporations for their carbon emissions, voluntarily disclosing carbon dependency can mitigate the magnitude of an emissions penalty from the markets. In summary, the existing literature suggests positive benefits result from increasing transparency and regulation around emission levels. In this analysis, it is possible that net-zero commitments signal to investors and the market that a given company prioritizes sustainability and minimizing carbon risk, all while preparing for the transition to a low-carbon economy.

### 4.2 Beta Calculations

Each company’s weekly rate of return, which is the percent change in stock price, is calculated along with the weekly market returns of the S&P 500 index. To estimate beta, I run a time-series regression of the company’s stock return over time $t$ on a constant and the market returns. The process is summarized below in Equation (2).

$$r_{jt} = \alpha_j + \beta_{jm}r_{mt} + \epsilon_{jt}$$  \hspace{1cm} (2)
$r_{jt}$ is the stock return of company $j$ in period $t$, $r_{mt}$ is the market return $m$ in period $t$, and $\beta_{jm}$ is the estimated beta value of company $j$. The beta coefficient measures the stock’s covariance with market movements. An example of the beta calculation can be seen below in Figure 4.2.1, where Microsoft’s returns are plotted as a function of the S&P 500 returns. Table 4.2.1 shows the regression results. The coefficient on the S&P 500 variable implies that Microsoft has a beta of 0.975. The beta estimation process is carried out for all companies, and a summary of the findings are discussed in section 5. Results and Discussion. As previously mentioned, the beta estimations serve as an intermediary step to then calculate the excess returns of a given company.

Figure 4.2.1: Microsoft Returns as a Function of S&P 500 Returns
Table 4.2.1: Regression of Microsoft Returns on S&P 500 Returns  

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Microsoft Returns</th>
</tr>
</thead>
<tbody>
<tr>
<td>S&amp;P 500 Returns</td>
<td>0.975***</td>
</tr>
<tr>
<td></td>
<td>(0.0564)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.00225**</td>
</tr>
<tr>
<td></td>
<td>(0.00103)</td>
</tr>
<tr>
<td>Observations</td>
<td>514</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.453</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses  
*** p<0.01, ** p<0.05, * p<0.1

4.3 Fama-MacBeth Analysis

Next, I perform the Fama-MacBeth regression, which is used to estimate the parameters for the CAPM. The Fama-MacBeth estimates the beta and risk premium that could influence the asset price. Essentially, this is a way of seeing if the CAPM works. My use of the CAPM and Fama-MacBeth mirrors the analytical framework of Bolton et al. (2021) in their analysis of carbon intensity and stock performance. The Fama-MacBeth is a two-step process; step one estimates the betas, and step two relates the excess return to the stock’s beta. Following the beta calculations, I group companies into portfolios based on the ranked values of the estimated betas. Then, betas and excess returns are averaged and estimated on a portfolio basis. Compiling the beta-ranked portfolios minimizes the noise of individual stock returns and reduces the potential error of the model (Fama and MacBeth, 1973).

I generate 20 portfolios in total, where ten of the portfolios are “green” and ten of the portfolios are “dirty.” The “green” portfolios have only companies with net-zero commitments and the “dirty” portfolios consist of non-commitment companies. Portfolio one contains the
companies with the lowest beta values, up to portfolio ten with the highest beta values. The resulting portfolios are ten beta-ranked “green” portfolios and ten beta-ranked “dirty” portfolios. Then, the average beta is calculated on the portfolio level, delivering 20 averaged betas, with one for each portfolio. Also, excess returns for each period are averaged on the portfolio level. A summary of the portfolio statistics can be found in Table 7.2 in the Appendix.

Next, step two estimates the excess returns through a cross-sectional regression. For every period in the analysis, I regress portfolio returns on the beta, an indicator variable for net-zero commitment status, and a constant. The equation is as follows below,

\[ r_j = \alpha_0 + \alpha_1 \beta_j + \alpha_3 NetZero_j \]  

\( r_j \) are the returns of the portfolio in period \( t \), \( \beta_j \) is the portfolio’s average beta, and \( NetZero_j \) is an indicator variable that is equal to one for green portfolios, meaning the portfolio has only commitment companies.

It is important to note that the estimated betas from step one now become the regressors, meaning the previously estimated values serve as the independent variable and excess returns are the dependent variable. Also, at this point, I disregard individual companies and only look at the portfolio-level results. Therefore, each period has twenty observations. The regression output gives an estimated slope coefficient, a constant, and a net-zero coefficient for each period. The results estimate the excess returns attributed to beta and net-zero commitments. Ultimately, the analysis allows us to determine the impact of net-zero commitments on returns, controlling for co-movements with the market. As previously mentioned, Bolton et al. conclude that investors demand a carbon premium due to higher emission exposure, potentially suggesting that we would see net-zero companies having lower excess returns on average.
4.4 Threats to Empirical Strategy

There exist various threats to the identification strategy. The first and potentially most impactful threat is the concept of credibility and net-zero commitments. As defined by the “Race to Zero,” credible net-zero commitments have the following four components: (1) a pledge to reach net-zero emissions by 2050 and an interim target to hit by 2030, (2) a plan of short, medium, and long term goals released within the twelve months of committing, (3) taking immediate action, and (4) publishing reports to track progress on interim and long-term goals. As these commitments gain momentum in the corporate world, attention is directed towards understanding the commitment credibility and potential for greenwashing. Greenwashing is making a product or service appear more environmentally conscious than they are in actuality.

In February 2022, a report between the New Climate Institute and the Carbon Market Watch analyzed the legitimacy of emissions reduction strategies and corporate net-zero commitments. The report finds that many companies lag in their proposed emissions reduction plans, including 25 of the world’s most valuable companies. Together these 25 companies aggregated $2.3 trillion in revenues for 2020 and were responsible for 5% of global emissions in 2019, but their net-zero commitments indicated clear signs of greenwashing and illegitimate goals. Since there is currently no standard for reporting emissions and progress towards goals, it is difficult to assess the legitimacy of commitments and control for these discrepancies. While companies often intentionally greenwash their emissions performance, many others are completely unaware of how to reach sustainability targets and track progress, leading to ambiguity around reducing carbon footprints.

Furthermore, many net-zero commitments have been made in recent years, and 2021 was the most popular year for announcing such commitments. Given the high frequency of recent
commitments, this ultimately limits the amount of post-announcement data to examine potential impacts on stock performance. Perhaps the current popularity of net-zero commitments does not leave ample time to see the effects on the stock market. Similarly, the growing emphasis on net-zero in recent years may have increased the valuation of the net-zero commitments, meaning that companies with commitments made years ago could just be seeing the market impacts now.

Finally, we must consider the “best in class” effect. The S&P 500 are the top publicly traded companies in the US and represent the largest, most established companies globally. As a result, these companies are financially and physically equipped to make such commitments to carbon reduction and purchase carbon offsets. Ultimately, when looking at the companies committing to net-zero, we must acknowledge the types of companies and their varying financial abilities to reduce emissions.

5. Results and Discussion

5.1 Preliminary Results

First, we look at the resulting beta estimations to understand the implications of market risk and motivate our later use of the Fama-MacBeth regression. The beta estimations across sectors are shown in Figure 7.3 in the Appendix. We observe that consumer discretionary and energy have higher beta values on average, which falls in line with established sector trends for beta values. On the contrary, consumer staples and utilities have lower beta values. The sectors with the most net-zero commitments are utilities and communication services, where 70-80% of these companies have commitments. The sectors with the fewest net-zero commitments are real estate and healthcare, where only 34-42% of these companies have commitments. The full breakdown of commitment status across sectors is shown above in Table 4.1.1.
Next, Figure 5.1.1 shows the distribution of beta values for S&P 500 companies by commitment status. The mean beta value for net-zero companies is 1.069, whereas the mean beta value for non-commitment companies is 1.080. Also, a higher frequency of non-net-zero companies have beta values between 0.75 and 1.25 than companies with net-zero commitments. These results do not indicate any underlying trends about the impact of net-zero commitments on beta. Instead, the outcomes demonstrate the importance of controlling for market risk and motivate our later use of the Fama-MacBeth analysis.

**Figure 5.1.1: Beta Values for S&P 500 Companies by Commitment Status**

Finally, two preliminary regressions look at the correlation between net-zero commitments and beta. Equation (3) regresses beta on a constant and net-zero dummy.
\[ \beta_j = a_0 + a_1 \text{NetZero}_j \]  \hspace{1cm} (3)

Next, Equation (4) adds industry controls, where dummy variables account for all 11 sectors. A dummy variable for communication services is omitted, meaning that the resulting coefficients on the sectors are all relative to communication services.

\[ \beta_j = a_0 + a_1 \text{NetZero}_j + a_2 \text{Sector}_1 + a_3 \text{Sector}_2 + \ldots + a_{11} \text{Sector}_{10} \]  \hspace{1cm} (4)

The results from both equations are shown in Table 5.1.1 below.
The results from Equation (3), shown in the first column of Table 5.1.1, reveal that the coefficient on the net-zero dummy is not statistically significant and the model lacks any
predictive power. Similarly, Equation (4) exhibits an insignificant coefficient on the net-zero dummy variable but including industry controls improves the model’s predictive power.

In Equation (4), we choose communication services as the omitted sector variable because out of the 11 sectors in the model, it has an average beta closest to the market beta of 1.0. The average communication services beta is 1.02. In the regression results, the coefficients on consumer staples and utilities are negative and statistically significant. A net-zero commitment as a consumer staples or utilities firm, relative to the communication sector, is correlated with a much lower beta value than indicated in the simple regression. We expect these results given that both consumer staples and utilities are low-beta sectors. Similarly, health care has a statistically significant and negative coefficient. On the other hand, consumer discretionary and energy have positive and statistically significant coefficients, implying that a net-zero commitment in these sectors is correlated with higher beta values relative to the communications sector.

The results above are unsurprising, given the average trends for sector-level betas. While these relationships are only relative and do not indicate causation, the results from regression (3) and literature in the realm of emissions and stock returns suggest the importance of controlling for the sector when analyzing the impacts of net-zero commitments. Understanding the relationships between beta and net-zero commitments provides a foundation for interpreting the excess returns calculations in Section 5.2.

5.2 Fama-MacBeth Results

The Fama-MacBeth analysis runs a cross-sectional regression of the average excess returns of each portfolio in period \( t \) on beta, a constant, and a net-zero dummy variable, as shown in Equation (5).
\[ \text{returns}_t = a_0 + a_1 \beta + a_3 \text{NetZero} \quad (5) \]

I run three different versions of Equation (5), and the results are summarized below in Table 5.2.1. Regression 1 uses the average of total returns over 2012-2021, and regression 2 uses the average of total returns over 2016-2021. These regressions are run over all of the 20 portfolios, and both use the same beta values estimated from 2012-2021. Then, regression 3 uses a multi-period analysis to mimic the estimation method used by Fama and MacBeth. This approach uses the beta calculated over period 1, 2012-2016, as the regressor for the average total returns over period 2, 2017-2021. The coefficient on net-zero quantifies the additional annualized excess returns received by a portfolio due to having a net-zero commitment.
Table 5.2.1: Equation (5) Results

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1) 2012-2021 APR</th>
<th>(2) 2016-2021 APR</th>
<th>(3) 2016-2021 APR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta</td>
<td>0.309</td>
<td>0.373</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.264)</td>
<td>(2.127)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.021)</td>
<td>(1.242)</td>
<td>(1.238)</td>
</tr>
<tr>
<td>Period 1 beta (2012-2016)</td>
<td></td>
<td></td>
<td>0.666</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(2.222)</td>
</tr>
<tr>
<td>Constant</td>
<td>14.85***</td>
<td>14.06***</td>
<td>13.77***</td>
</tr>
<tr>
<td></td>
<td>(1.357)</td>
<td>(2.135)</td>
<td>(2.101)</td>
</tr>
<tr>
<td>Observations</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.380</td>
<td>0.284</td>
<td>0.288</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

APR refers to Average Portfolio Returns for a given period. Regression 3 uses a lagged beta value to predict portfolio returns in the next period.

All three versions of the regression in Table 5.2.1 deliver statistically significant net-zero coefficients and constants. Further, the net-zero coefficients are negative, predicting that committing to net-zero lowers the firm’s excess return. Using column 1 as the representative model, we estimate the annual impact of net-zero commitments to lower excess returns by 3.29% compared with non-commitment companies. Further, if a stock has an excess return of 14.85%, as implied by column 1, then a net-zero company would have an excess return of 11.56%. All three versions of the regression predict the excess returns of net-zero companies to be lower by anywhere between 3.2% to 3.29%.

The third regression, which uses a lagged beta to predict excess returns in the next period, follows the structure of Fama and MacBeth’s initial analysis. The rationale behind the method is that historical volatility can predict future excess returns. Fama and MacBeth used nine different six-year periods, whereas my analysis uses two periods of five years. Net-zero commitments
have only become relevant in the past ten years; therefore, extending our analysis to prior periods would be trivial.

While the standard error is fairly large on the beta coefficients, the magnitude is similar to the results of Fama and MacBeth. Fama (1965) and Blume (1970) suggest that the distribution of the common stock return is “thick-tailed” in comparison to the normal distribution, meaning the average returns more likely converge to a “non-normal symmetric distribution,” as opposed to a normal distribution (Fama, 619). In summary, the model assumes our results are normal, but our statistics do not follow the “t” distribution, and thus the correct critical values would be different. Also, the small size of the beta coefficient and lack of significance are not supportive of the CAPM. Our analysis sees the most significant error on the beta coefficient, but the variable of interest is the net-zero coefficient, which has smaller standard deviation. The three regressions in Table 5.2.1 attempt to find the method that minimizes the potential error; column 1 delivers the most promising results.

5.3 Difference Analysis

While the Fama-MacBeth analysis estimates returns across net-zero commitment status, the model does not consider when the companies commit to net-zero. In summary, the findings for the above regression estimate the excess returns even before the firm commits to net-zero. Although this method neglects the distinction between pre and post commitment, it still captures the discrepancies in returns across corporate sustainability intentions. Perhaps there are also unobserved firm characteristics that affect stock returns and make them more likely to commit. Therefore, these characteristics could be shared across net-zero companies.
I next perform a difference analysis to see how excess returns potentially change after a company’s net-zero announcement. The model predicts how investors price in the reduced transitional carbon risk and the acclimation towards a low-carbon economy at the firm level. Further, this analysis examines if the positive consequences of going net-zero, such as reducing fossil fuel dependency and emissions, outweigh the costs and uncertainties associated with the transition to net-zero.

The following difference model isolates the impact of excess returns due to net-zero commitments.

\[ y_{t} = \alpha_{t,1} + \alpha_{t,2}g_{i,t} + \beta_{t,1}y_{m,t} + \beta_{t,2}(g_{i,t} \cdot y_{m,t}) \]  

\( y_{t,i} \) is the average return of company \( i \) in period \( t \) and \( g_{i,t} \) is an indicator variable equal to zero before the net-zero commitment of company \( i \). Then, the indicator variable “turns on” post-commitment. \( \Delta t_{i,2} \) is the change in excess returns after the announcement, controlling for the co-movement with the market. Also, \( \beta_{t,2} \) allows for the possibility that beta is different after the announcement. The regression is carried out on 80 companies in the dataset that provide ample data before and after their respective commitments, delivering 80 \( \Delta t_{i,2} \) and \( \beta_{t,2} \) coefficients, with one for each company. Next, I average the 80 estimated \( \Delta t_{i,2} \) and \( \beta_{t,2} \) coefficients.

This method estimates the change in returns in the “post” announcement periods while controlling for the covariance with the market and time-invariant-firm-specific factors included in the \( \alpha_{t} \). Also, note that the change in excess returns is scaled to the annualized rate. The results are summarized below in Table 5.3.1.
Table 5.3.1: Changes in Excess Returns and Beta Post-Commitment

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>mean</th>
<th>sd</th>
<th>min</th>
<th>max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in beta</td>
<td>-0.0657</td>
<td>0.465</td>
<td>-1.197</td>
<td>1.479</td>
</tr>
<tr>
<td>Change in annualized excess returns</td>
<td>-3.966</td>
<td>27.90</td>
<td>-73.75</td>
<td>98.40</td>
</tr>
</tbody>
</table>

The difference approach for the event study was a natural model to isolate the effect. However, ultimately the results are not strong enough to determine significance. The model predicts that on average excess returns decrease by 3.966% post-announcement, with a large standard deviation for the change in excess returns.

While the overall results appear inconclusive, examining the outcomes by sector reveal potential trends. The sector-level breakdown of post-commitment excess returns is shown in Figure 5.3.1. Energy companies see the most significant outlying increases in excess returns post-commitment. Occidental Petroleum is the greatest outlier, with an increase in annualized excess returns of 98.40% after committing to net-zero. In November 2020, Occidental was the first major US oil company to target net-zero, and the commitment marked a significant shift in how US oil companies approached sustainability, explaining why the markets react so strongly. Even excluding Occidental from the analysis, the median change in excess returns for energy stocks post-commitment is still well above zero.
5.4 Event Study Analysis

Next, I perform an event-study method to look at the stock price reaction in the nine weeks following a company’s announcement to target net-zero emissions. I attempt to find underlying trends in prices and investor reactions due to news of the commitment. The equation is as follows below,

\[ x_{it} = \Delta S_{it} - \Delta S_{mt} \]  

\( \Delta S_{it} = S_{it} - S_{it-j} \) is the change in stock price \( i \) in the \( t^{th} \) week since committing to net-zero. \( \Delta S_{mt} \) is the change in the market index \( m \) over the same period. Subtracting market changes from the stock price allows us to ignore market movements. For each week, I calculate an \( x_{it} \), which is summed over the previous weeks to get the cumulative excess return in each week of the period.
For example, if the excess returns in the four weeks post-announcement were +1, +2, -1, +3, then the cumulative price response would be +1, +3, +2, +5. Finally, the price responses are normalized so that each firm starts at an $x_{it}$ of zero for week one. It is important to note that all firms are committing to net-zero at different points, and this analysis lines up the commitment announcements to all occur at time $t = 0$. I regress the firm-level excess returns on weekly indicator variables and a constant. The results are shown below in Figure 5.4.1.

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1) Excess Returns</th>
<th>(2) Excess Returns (Firm FE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.week</td>
<td>-0.546*</td>
<td>-0.546</td>
</tr>
<tr>
<td></td>
<td>(0.314)</td>
<td>(0.380)</td>
</tr>
<tr>
<td>2.week</td>
<td>-0.626</td>
<td>-0.626</td>
</tr>
<tr>
<td></td>
<td>(0.481)</td>
<td>(0.428)</td>
</tr>
<tr>
<td>3.week</td>
<td>-0.959</td>
<td>-0.959*</td>
</tr>
<tr>
<td></td>
<td>(0.657)</td>
<td>(0.548)</td>
</tr>
<tr>
<td>4.week</td>
<td>-1.062*</td>
<td>-1.062**</td>
</tr>
<tr>
<td></td>
<td>(0.603)</td>
<td>(0.511)</td>
</tr>
<tr>
<td>5.week</td>
<td>-1.843***</td>
<td>-1.843***</td>
</tr>
<tr>
<td></td>
<td>(0.679)</td>
<td>(0.592)</td>
</tr>
<tr>
<td>6.week</td>
<td>-0.684</td>
<td>-0.684</td>
</tr>
<tr>
<td></td>
<td>(0.423)</td>
<td>(0.538)</td>
</tr>
<tr>
<td>7.week</td>
<td>-0.292</td>
<td>-0.292</td>
</tr>
<tr>
<td></td>
<td>(0.501)</td>
<td>(0.566)</td>
</tr>
<tr>
<td>8.week</td>
<td>-0.127</td>
<td>-0.127</td>
</tr>
<tr>
<td></td>
<td>(0.441)</td>
<td>(0.543)</td>
</tr>
<tr>
<td>9.week</td>
<td>-0.330</td>
<td>-0.330</td>
</tr>
<tr>
<td></td>
<td>(0.290)</td>
<td>(0.487)</td>
</tr>
<tr>
<td>Constant</td>
<td>0</td>
<td>1.618**</td>
</tr>
<tr>
<td></td>
<td>(2.01e-08)</td>
<td>(0.648)</td>
</tr>
</tbody>
</table>

Observations  1,500  1,500
R-squared      0.008  0.333
Week FE        YES    YES
Firm FE        YES    YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Each \#.week refers to the number of weeks post-commitment. For example, 1.\textit{week} is the first-week post-announcement. Regression (1) includes time-fixed effects, and regression (2) includes both time and firm-fixed effects. The coefficients on weeks 3-5 in regression (2) are negative and statistically significant, indicating that firms, on average, are seeing increasingly negative returns over this period. The week five coefficient suggests that firms experience excess returns that are lower by 1.843\% five weeks after the commitment. Also, a scatterplot of returns as a function of the week is shown in Figure 7.4 in the Appendix.

Potentially, markets are slowly digesting the news over weeks three through five, and investors gradually price in the costs of going green, as proposed by the Green is Costly Hypothesis. Overall, I conclude that the weekly stock data are quite noisy, and thus estimates of post-announcement effects are unstable. Also, companies possibly have “green” reputations prior to the announcement. Therefore, these “sustainable” reputations, combined with the volatile stock returns, make it difficult to discern a market reaction unless it is substantial.

6. Conclusion

This thesis looks to predict the impact of net-zero commitments on the excess returns of the S&P 500 companies, controlling for market risk. In general, existing literature finds that higher emissions lead to a greater carbon premium demanded by investors. Since economic research on net-zero commitments is still in its early stages, I rely on previous work surrounding carbon emissions and financial performance to interpret the implications of net-zero commitments. While many corporations are making these commitments and portraying
“environmentally-friendly facades,” it is important to ask how environmental consideration actually mitigates climate risk and improves performance.

The preliminary results show different distributions of beta values for commitment and non-commitment firms. However, climate policy and potential carbon taxes are not frequent, dominant threats in the market, and there is likely no causation between having a net-zero commitment and reducing beta. But, the disparate distributions of beta values across commitment status show the need to control for market risk and motivate my use of the Fama-MacBeth analysis to estimate excess returns.

The Fama-MacBeth findings confirm the results of previous literature that carbon-conscious companies receive a lower risk-adjusted boost than more carbon-dependent companies. We find that S&P 500 companies with net-zero commitments earn a lower annualized excess return by about 3% compared to non-commitment firms. The lower excess returns earned by net-zero companies could be due to the following hypotheses. First, going green is perhaps costly, and markets take time to digest the announcement, resulting in a falling stock price and negative excess returns. Second, net-zero commitments could mitigate the risk of future climate catastrophe, and investors no longer require an additional market premium to compensate for the climate risk. Third, investors feel good about investing in sustainable companies and are willing to accept a lower rate of return when holding green stocks. In summary, net-zero commitments, if credible, can insulate investors from climate policy and the transition to a low-carbon economy.

I perform a difference analysis and an event study method to identify the post-commitment impact on returns. Both methods prove it is challenging to identify how the market reacts to net-zero announcements. The difference model suggests that firms see excess returns
about 4% lower than pre-commitment, but a large standard error inhibits a decisive conclusion that commitments lower returns. Also, the difference analysis indicates the importance of sector consideration because, for example, energy stocks have a significant increase in excess returns post-announcement.

The event study tracks normalized price reactions in the nine weeks following the announcement. The results reveal that excess returns are lower by around 1-1.8% in weeks three through five post-commitment. However, by week nine, an impact on stock price and returns is indiscernible. Potentially, investors gradually digest the commitment and price in the news over the five weeks following a firm’s announcement. Ultimately, stock market data are volatile, and corporate sustainability reputations often could be priced into the markets prior to net-zero announcements.

This thesis suggests the importance of continuing research in the area of net-zero commitments, especially as sustainability will remain a prominent feature in financial markets as the world adapts to climate risk. In my research, I find support for the Green is Costly, Risk Mitigation, and Feel Good Hypotheses. There lacks sufficient evidence for the Cheap Talk Hypothesis. As BlackRock’s Larry Fink argues in his 2021 letter: “There is no company whose business model won’t be profoundly affected by the transition to a net-zero economy.” Climate change is a long-term, substantial problem, and companies will need to decrease their carbon risk in both environmentally and economically efficient ways.
Figure 7.1: Revenue and Emissions Levels for S&P 100 Companies from Yale

Table 7.2: Beta-Ranked Portfolio Summary

<table>
<thead>
<tr>
<th>Portfolio</th>
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Figure 7.3: Mean Beta Values for S&P 500 Companies by Industry between 2012-2021
Figure 7.4: Price Reactions in the Nine Weeks Following Net-Zero Announcements
8. Works Cited


