



The effect of the Inflation Reduction Act on the European financial market

Tim Tuesfeld

Dissertation written under the supervision of Professor Jose
Garcia Revelo

Dissertation submitted in partial fulfilment of requirements for the
M.Sc. in International Finance, at the Universidade Católica
Portuguesa, 01.09.2024.

Abstract

This thesis analyzes the impact of the US Inflation Reduction Act (IRA) of 2022 on the European financial markets. The study employs an event study methodology to examine the abnormal returns of companies listed on the Euro Stoxx 600 index around key legislative events related to the IRA. The findings reveal significant variations in market reactions across different sectors, with the energy and healthcare sectors showing contrasting responses. The study highlights that firms with higher greenhouse gas emissions experienced significant negative abnormal returns, indicating increased investor concerns about regulatory costs. Additionally, the research explores the role of foreign sales. It demonstrates that companies with significant international exposure exhibited different abnormal returns depending on the phase of the legislative process. This thesis contributes to the climate finance literature by providing empirical evidence on how US climate policies can have significant effects on foreign markets, highlighting the importance of sector-specific and firm-specific factors.

Keywords: US Inflation Reduction Act (IRA) 2022, European financial markets, Event study methodology, Abnormal returns, Euro Stoxx 600, Greenhouse gas emissions, Climate finance, US climate policies, Climate risks

Title: The effect of the Inflation Reduction Act on the European financial market

Author: Tim Tuesfeld

Sumário

Este estudo investiga o impacto da Lei de Redução da Inflação dos EUA (IRA) de 2022 nos mercados financeiros europeus. Utilizando uma metodologia de estudo de eventos, a investigação analisa os retornos anormais das empresas cotadas no índice Euro Stoxx 600 em torno dos principais eventos legislativos relacionados com a IRA. Os resultados revelam variações significativas nas reacções do mercado em diferentes sectores, com os sectores de energia e de saúde a apresentarem respostas contrastantes durante as fases de anúncio e de implementação da IRA. O estudo salienta que as empresas com emissões de gases com efeito de estufa mais elevadas registaram retornos anormais notoriamente negativos, o que indica uma maior preocupação dos investidores com os custos regulamentares ao abrigo da nova legislação. Além disso, a investigação explora o papel das vendas no estrangeiro, concluindo que as empresas com uma exposição internacional substancial apresentaram rendibilidades anormais diferentes consoante a fase do processo legislativo. Esta tese contribui para a literatura sobre financiamento climático, fornecendo provas empíricas de como as políticas climáticas dos EUA podem ter efeitos substanciais nos mercados estrangeiros, enfatizando a importância de factores específicos do sector e da empresa na avaliação desses impactos.

Palavras-chave: Lei de Redução da Inflação dos EUA (IRA) 2022, mercados financeiros europeus, metodologia de estudo de eventos, retornos anormais, Euro Stoxx 600, emissões de gases de efeito estufa, finanças climáticas, políticas climáticas dos EUA, riscos climáticos

Título: O efeito da Lei de Redução da Inflação sobre o mercado financeiro europeu

Autor: Tim Tuesfeld

Acknowledgements

I would like to express my deepest gratitude to my supervisor, Professor Jose Garcia Revelo, for his invaluable insights and guidance throughout this journey. A special thanks to my friends Pascal and Luca for turning my last semester in Lisbon into one of the best times of my life. To all the new friends I met in Lisbon, thank you for making the past two years truly unforgettable. Finally, for my family, your support at every step I took has been my greatest strength. Thank you for always believing in me.

Contents

Abstract	I
Sumário	II
Acknowledgements	III
List of Figures	VI
List of Tables.....	VII
Glossary.....	VIII
1 Introduction	9
1. Literature review	11
1.1 Climate Finance.....	11
1.2 Climate risks.....	13
1.3 The effect of climate policies on financial markets	13
2 Inflation Reduction Act.....	15
2.1 The effect on the European Union	16
2.2 Legislative process and key events for the study	17
3 Hypothesis and Approach	19
4 Data	20
4.1 Explanatory Data Analysis for the cross-sectional regression.....	22
4.2 Explanatory Data Analysis of the variable foreign sales	25
5 Methodology	27
5.1 Event and Estimation Window.....	27
5.2 Abnormal Returns	27
5.3 Expected Returns.....	28
5.3.1 Mean-Adjusted Model.....	29
5.3.2 Market Model.....	29
5.4 Hypothesis testing	29
5.5 Test Statistics.....	31

5.5.1	Parametric Tests	31
5.5.2	Nonparametric Tests	33
5.6	Cross-sectional regression.....	34
5.6.1	Test statistics	36
6	Empirical Analysis	38
6.1	Overall impact on the EuroStoxx600	38
6.2	Event Study per sector – Brown Event	39
6.3	Event Study per sector – Green Event	40
6.4	Comparison of the CAAR on both events.....	41
6.5	Cross-sectional regression analysis.....	43
6.6	Cross-sectional regression analysis – Foreign Sales	44
7	Robustness.....	46
7.1	Robustness test of the regression analysis.....	48
7.2	Discussion of the robustness test.....	50
8	Summary of results.....	52
9	Limitations and avenues for future research	55
10	Conclusion.....	56
11	Appendix	57
12	Resources	64

List of Figures

Figure 1: Daily Returns of the Euro Stoxx 600 and key events of the IRA.....	21
Figure 2: Distribution of CAR - Brown Event.....	22
Figure 3: Correlation matrix – Brown Event	24
Figure 4: Correlation matrix – Green Event	24
Figure 5: Scatter plot of Foreign Sales and CAR – Brown Event	26
Figure 6: Scatter plot of Foreign Sales and CAR – Green Event.....	26
Figure 7: Development of AAR and CAAR for Event 6 and 7	39
Figure 8: Comparison of Industry CAAR – Green vs. Brown Event	42
Figure 9: Distribution of CAR Green Event	58

List of Tables

Table 1: Legislative process and key events of the Inflation Reduction Act	17
Table 2: Descriptive statistics for the MSCI Index	20
Table 3: Descriptive statistics for the equal weighted Euro Stoxx 600.....	20
Table 4: Composition of the Euro Stoxx 600.....	21
Table 5: Descriptive statistics for each sector	22
Table 6: Descriptive statistics of the Independent Variables – Brown Event.....	23
Table 7: Descriptive statistics of the foreign Sales variables at the brown and green event...	25
Table 8: Cumulative Average Abnormal Returns per Event	38
Table 9: Cumulative Average Abnormal Returns per sector – Brown Event.....	40
Table 10: Cumulative Average Abnormal Returns per Industry – Green Event	41
Table 11: Regression Analysis – Brown Event – Market Model.....	43
Table 12: Regression Analysis – Green Event – Market Model.....	44
Table 13: Regression Analysis: Foreign Sales and CAR.....	45
Table 14: CAAR per Industry – Mean Adjusted – Brown Event	46
Table 15: CAAR per Industry – Mean Adjusted – Green Event.....	47
Table 16: Regression Analysis – Brown Event – Mean Adjusted Model.....	49
Table 17: Regression Analysis – Green Event – Mean Adjusted Model.....	50
Table 18: Descriptive statistics for the control variables – Brown Event.....	57
Table 19: Descriptive statistics of the Independent Variables – Green Event	57
Table 20: Descriptive statistics of the Control Variables – Green Event.....	57
Table 21: AAR for the brown event – market model.....	59
Table 22: AAR for the green event – market model	60
Table 23: Regression Analysis: Green and Brown Event – Full Table - Market Model	61
Table 24: Regression Analysis: Foreign Sales and CAR – Full Table	62
Table 25: Regression Analysis: Green and Brown Event – Mean Adjusted Model	63

Glossary

AAR: Average Abnormal Returns

AR: Abnormal Returns

ASAR: Aggregated Standardized Abnormal Returns

CAAR: Cumulative Average Abnormal Returns

CAR: Cumulative Abnormal Returns

CBO: Congressional Budget Office

COP26: 26th United Nations Climate Change Conference of the Parties

EDA: Explanatory Data Analysis

EMH: Efficient Market Hypothesis

ESG: Environmental, Social, and Governance

EU: European Union

EU ETS: European Union Emissions Trading System

EV: Electric Vehicle

GHG: Greenhouse Gas

IRA: Inflation Reduction Act

IRS: Internal Revenue Service

MSCI: Morgan Stanley Capital International

OLS: Ordinary Least Squares

ROE: Return on Equity

SAR: Standard Abnormal Returns

SRI: Socially Responsible Investment

SST: Total Sum of Squares

US: United States

WTO: World Trade Organization

1 Introduction

Climate change is one of the most pressing challenges of our time, affecting not only the environment but also economic stability and growth. Recently, the observable impacts of climate change have become more visible. Therefore, governments and policymakers worldwide focus more on climate action. The Inflation Reduction Act (IRA) of 2022 is a significant climate policy introduced by the United States. It promotes the advancement of clean technology, renewable energy, accessible healthcare, and the protection of the environment. The IRA is projected to have a substantial impact on multiple sectors both domestically and internationally, with an estimated revenue of \$738 billion and expenditures of \$499 billion over the next ten years.

The policy focuses on substantial investment in green technology and clean energy. It announced \$369 billion over ten years to accelerate the transition to renewable energy sources and environmentally friendly practices. This includes production subsidies for manufacturers of sustainable technologies, tax credits for electric vehicle purchasers, and support for carbon-neutral electricity generation. While these measures are expected to drive the US towards a more sustainable future, their implications extend far beyond national borders, particularly impacting the European market.

The IRA's potential economic impact has attracted considerable public attention and debate in Europe. There are concerns about how the IRA's local content requirements and significant subsidies could challenge European companies, particularly in industries such as automotive and renewable energy. However, there is a lack of research that explores the impact the IRA has had on Europe's financial markets. This absence highlights the importance of this thesis to contribute cognitions to the topic.

The thesis focuses on the impact on companies that are characterized by a high level of greenhouse gas (GHG) emissions. It presents a new perspective on the field of climate finance by bridging the gap between climate policy implementation in the US and its impact on foreign financial markets, as previous research has mainly focused on the direct effects of climate policies within countries.

Therefore, this thesis investigates the following hypotheses:

1. The IRA's announcements will result in abnormal returns across various sectors. Sectors directly benefiting from the IRA, such as renewable energy, are expected to show significant positive abnormal returns. However, other sectors may show negative abnormal returns due to regulatory challenges and competitive disadvantages.
2. Following the IRA, companies with high GHG emissions will show abnormal returns. Firms with higher GHG emissions are likely to face increased regulatory costs. This might lead to significant negative abnormal returns as investors adjust their valuations based on the anticipated financial impact of the regulation.
3. Companies with substantial foreign sales might experience different abnormal returns compared to those primarily focusing on domestic sales. Firms with significant international exposure may be more affected by the IRA. This could result in negative abnormal returns, as their exposure to foreign revenue streams may be impacted by trade barriers.

The study applies the event study methodology to analyze the abnormal returns of companies listed on the Euro Stoxx 600. By examining the cumulative abnormal returns (CAR) and conducting a cross-sectional regression analysis, this research provides empirical evidence on how the IRA influences investor behavior and market dynamics.

The findings of this thesis have significant implications for policymakers, investors, and corporations. Understanding the IRA's international impact can improve policy coordination between the United States and Europe. It can guide investment strategies and companies in adapting to environmental policies. Given the increasing interconnectedness of global financial markets, it is crucial to understand how important (climate) regulatory policies in one economy can affect those of others.

In the subsequent sections, this thesis will present the theoretical framework of climate finance, review the relevant literature, outline the research methodology, present empirical findings, and discuss the broader implications of the study. This research aims to contribute to the growing body of literature on the economic impacts of climate policies and their global interconnections.

1. Literature review

Various studies from natural sciences have shed light on drivers of climate change (Andreae et al., 2005; Phillips et al., 2020), and thus helped to understand the scope and pace of the upcoming irreversible changes that societies will face (Nordhaus, 2019). This section will give an overview of the recent developments in the financial and climate related literature, the so-called field of climate finance.

1.1 Climate Finance

By conducting research about the relationship between climate change and economic dynamics, William Nordhaus's research during the 1970s laid the foundation for what has now emerged as climate finance (Nordhaus et al., 1973). The literature on climate finance examines how ecological developments affect financial markets.

GHG emissions have substantial financial implications that impact asset pricing, risk management, and investment decisions (Hong et al., 2020). While scientists predict that the impact of climate change will become more pronounced in the future, certain environmental and policy consequences are already observable at present. Many aspects of climate change are financial in nature, such as the pricing and hedging of risks stemming from climate change, the awareness and attitudes of investors toward these risks, and the effects of climate risks on investment decisions (Nordhaus, 1977; Venturini, 2022).

By implementing effective environmental risk management, a company can decrease its cost of capital, which reduces the perceived uncertainty linked to future cash flows. Therefore, investments in responsible practices contribute to the mitigation of financial risks, and companies can reduce their capital costs (Sharfman & Fernando, 2008). El Ghoul et al. (2011) highlight this and find that organizations with a better CSR rating typically have lower cost of equity. This shows that investments in improving responsible employee relations, environmental policies, and product strategies potentially contribute to reducing firms' cost of equity.

Renneboog et al. (2008) find that the expansion of Socially Responsible Investments (SRI) is substantial, mainly driven by the rising investor consciousness regarding ethical and environmental issues. However, the authors indicate that SRI funds demonstrate comparable performance to conventional funds, highlighting that Environmental, Social, and Governance (ESG) investments do not have a significant impact on financial returns. The investor

consciousness regarding ESG was underlined by Hong and Kacperczyk (2009) with the study on "sin stocks", which describes listed firms involved in industries like alcohol, tobacco, and gaming. The authors reveal that these firms often face investment aversion from pension funds due to social stigma. Thus, those stocks manage to yield higher returns, attributed to their undervaluation and less frequent institutional investments. Furthermore, companies that have greater carbon emissions can potentially earn greater returns, indicating the existence of a 'carbon premium' as investors seek higher returns for possible future expenses linked to high emissions (Bolton & Kacperczyk, 2021). Pástor et al. (2021) find that green equities tend to achieve better financial performance compared to brown stocks. The reason for this phenomenon is the increasing demand from investors, who are becoming progressively more worried about the environment and its related challenges. Nevertheless, this superior performance is not consistently attributed to elevated earnings projections but rather to investor sentiment.

Krüger (2015), investigates whether corporate social responsibility (CSR) can impact shareholder wealth. He finds that negative CSR events result in significantly negative abnormal returns, indicating that investors respond unfavorably to bad CSR activities. However, the response to positive CSR events is generally weak, suggesting that, while investors penalize environmentally unfriendly behavior, they do not highly reward positive CSR initiatives.

The literature indicates that climate change impacts bond markets, with green bonds generally carrying a small negative premium compared to traditional bonds, which results in slightly lower yields. This benefits issuers by reducing their cost of debt, while investors may experience marginally lower returns. (Zerbib, 2019). Issuing green bonds can enhance a company's reputation and appeal to investors, resulting in advantages for current shareholders such as increased institutional ownership and enhanced stock liquidity (Tang & Zhang, 2020). Dyck et al. (2019) suggest that institutional ownership appears to influence towards better corporate behavior through their investment choices of institutional investors.

Examining how the magnitude of carbon emissions impacts the firm values among constituents of the S&P 500, Matsumura et al. (2014) find a negative relationship between the quantity of carbon emissions and firm value, indicating that higher emissions are associated with lower firm value.

1.2 Climate risks

Numerous climate finance scholars propose managing climate risks within financial portfolios to be prepared for enactments of environmental policies that might impact asset valuations.

Climate risks are categorized into physical and transitional risks. Physical risks are related to climate and weather-related events impacting business operations, societal well-being, and supply chains. These risks include acute threats, such as floods, droughts, and wildfires, as well as chronic hazards like sea level rise (Reboredo & Ugolini, 2022). Transitional risks relate to transitioning to a low-carbon economy. They encompass several dimensions, including policy and regulatory risks, which involve financial implications from new environmental regulations. Within transition risks, we can further divide into technological risks that arise from a decreased demand for traditional services. Those risks are often driven by shifts in consumer preferences towards more sustainable alternatives (Curtin et al., 2019; Venturini, 2022).

Recent research highlights that climate risks are a relevant factor in investment decisions. For example, asset pricing models now incorporate long-run climate risks (Bansal et al., 2016). Furthermore, public perception and behavior influence market behavior. Abnormal temperature spikes and increased public engagement with climate issues lead to underperformance of brown stocks during warm periods (Choi et al., 2020). Research on carbon tail risks in the option market shows that high carbon intensity firms face greater costs for downside risk protection, especially during periods of heightened public attention to climate policy uncertainties (Ilhan et al., 2021). Engle et al. (2020) developed a strategy to hedge against climate risks. They propose a news-based climate risk metric to construct portfolios that mitigate the economic impact of climate-related news. The study by Krueger et al. (2020) underlines the awareness of institutional investors who prefer to engage with firms on climate issues over divesting, aiming to influence corporate behavior.

These studies illustrate the incorporation of climate concerns into asset pricing and investor behavior, emphasizing the financial sector's approaches in addressing climate change. This integration shows a transition towards more environmentally friendly and accountable investment strategies in the face of worldwide climate issues.

1.3 The effect of climate policies on financial markets

Environmental restrictions have emerged as a central focus in financial market analysis. This review consolidates some studies that examine the influence of environmental legislation on stock market activity and investor sentiment.

Birindelli et al. (2023) employed an event study to examine the impact of the COP26 conference on stock market reactions. Their analysis shows market responses that were influenced by the level of strictness in climate legislation. Companies located in jurisdictions with strict policies saw adverse reactions, while those in more tolerant regions saw favorable reactions. In a study conducted by Ramiah et al. (2013), 19 green policy announcements and their effect on Australian equities were analyzed. The study finds that the impact on abnormal returns varies across different industries. Additionally, the authors suggest that green policies may influence the long-term systematic risk of industries.

Ramiah et al. (2016) show that the UK market responds to nuclear policy pronouncements, suggesting that environmental policies have the potential to provide economic value but also raise the level of investment uncertainty. According to Pham et al. (2019), the Paris Climate Agreement had a negative impact on polluting businesses in Germany. Ramiah et al. (2015 a) emphasize significant market responses to the EU Emissions Trading System in France and varied responses to carbon taxes in Singapore.

Ramiah et al. (2015 b) find that high-polluting industries in the US had a decrease in stock returns after environmental policy announcements and the election of President Obama. This suggests that the market expected these sectors to face higher regulatory costs. In contrast, Pham et al. (2018) discovers substantial fluctuations in the market and unique responses from different sectors in response to Donald Trump's policy statements.

2 Inflation Reduction Act

The Inflation Reduction Act (IRA) of 2022 is a major piece of US legislation that deals with energy security, healthcare affordability, and environmental sustainability. According to the CBO (2022) the IRA is expected to generate \$738 billion in revenue and have \$499 billion in government expenses from 2023 to 2032. This would result in a deficit reduction of \$238 billion. The green technology incentives offered by the IRA amount to \$369 billion over the same time frame, predominantly based on tax exemptions.

The IRA is characterized by its energy and climate legislation, which allocates ~\$400 billion over the next ten years to a range of climate-oriented activities. This encompasses financial assistance for renewable energy and promotes environmentally friendly practices in many industries. For example, the legislation offers a \$7,500 tax credit to individuals who buy electric vehicles (EVs) that fulfill local content requirements. Furthermore, the IRA provides production subsidies to manufacturers of sustainable technologies, including batteries, wind turbines, solar components, and essential materials such as aluminum and cobalt. These subsidies cover up to 30% of the production costs. Additionally, the IRA offers a 30% tax credit for investments in "qualifying advanced energy projects" (Kleimann et al., 2023).

In addition, the IRA actively supports the production of carbon-neutral electricity and clean fuels, including hydrogen and renewable natural gas. Producers gain advantages from receiving subsidies for production and tax credits for investments. Explicit assistance is provided to rural and residential clean energy efforts. The healthcare provision extends the subsidies provided by the Affordable Care Act (ACA), a significant healthcare reform law enacted in 2010 aimed at expanding access to health insurance, reducing healthcare costs, and improving healthcare quality. The subsidies under the ACA have been extended until 2025, and the provision also empowers Medicare to engage in negotiations for prescription prices, thereby decreasing expenses for the government (CBO, 2022).

The policy mandates a 15% minimum corporate tax rate for companies that generate profits above \$1 billion. In addition, the legislation implements a 1% tax on stock buybacks and imposes a limit on the amount of interest that multinational firms can deduct. Moreover, the IRA strengthens the Internal Revenue Service (IRS) to promote compliance and guarantee that corporations and high-income individuals pay a higher share of taxes (Kleimann et al., 2023).

2.1 The effect on the European Union

As previously stated, the IRA aims to boost the domestic economy by providing significant financial incentives within the climate technology space. This regulation presents both problems and opportunities for Europe's industries, especially within the fields of automotive and renewable energy.

Some of the trading partners of the US criticize the IRA's local content regulations and subsidies. Local content requirements are a violation of the World Trade Organization's (WTO) norms since they require the use of components that must be sourced domestically. For example, French President Emmanuel Macron has publicly called for EU policies: "We need a Buy European Act like the Americans, we need to reserve [our subsidies] for our European manufacturers." (Clea, 2022). The aim of these programs is to bolster the manufacturing sector in the US and diminish the dependence on overseas suppliers. European car manufacturers may face difficulties if their vehicles fail to meet the IRA's local content requirements. This would result in the loss of consumer tax credits and less competitive products. The implementation of the local content rule could disrupt global supply chains (Kleimann et al., 2023).

The IRA provides subsidies to support the use of clean technologies and boost economic growth in the United States. Monetary support changes the competitive landscape by providing subsidies to companies that qualify under the Act. Subsidies can lead to an inefficient allocation of resources and thus disrupt supply and demand within industries (Sakano et al., 1997). This, in turn, could result in the promotion of inefficient technologies and companies through subsidies. Therefore, renewable energy providers may be required to engage in innovation to maintain competitiveness, considering the subsidies and tax incentives provided by the United States. To remain competitive in a global market that prioritizes sustainability, European firms must accelerate their progress in clean technologies. The EU must strategically adapt to uphold its position as a leader in green innovation and sustainable development (CITI, 2023; Kleimann et al., 2023).

It is widely discussed what the IRA's impact on the green transition outside the US will be. It may initially be negative due to changes in the supply chain. However, in the long run, the reduction in clean tech costs caused by the IRA could outweigh these initial negative impacts. New regulation and implementation of new green procurement standards, the deployment of renewable energy sources, and the integration of banking and financial markets could aid the

EU in enhancing its structural competitiveness (Kleimann et al., 2023; Rueda-Cantuche et al., 2024).

2.2 Legislative process and key events for the study

Table 1 illustrates the year-long legislative journey of the IRA in 2022 in a divided congress. Initially, part of President Biden's Build Back Better initiative, the policy faced opposition from moderate Democrats like Senator Joe Manchin who was concerned about spending and inflation.

Table 1: Legislative process and key events of the Inflation Reduction Act¹

Event Nr.	Date	Event	Green/ Brown
1	31.03.2021 [Wed.]	President Biden introduces the American Jobs Plan, setting the stage for what would become the Build Back Better initiative.	Green
2	28.10.2021 [Thu.]	President Biden presents a revised framework for the Build Back Better Act, aiming to consolidate democratic support.	Green
3	19.11.2021 [Fri.]	The House of Representatives passes Build Back better climate legislation	Green
4	19.12.2021 [Sun.]	Senator Manchin announces decision to vote against Build Back Better	Brown
5	19.01.2022 [Wed.]	Senator Manchin expresses renewed concerns about the Build Back Better Act, citing inflation and national debt.	Brown
6	15.07.2022 [Thus.]	Senator Manchin publicly rejects the existing Build Back Better proposal, especially opposing new climate change spending and tax reforms.	Brown
7	27.07.2022 [Wed.]	Senators Manchin and Schumer announce an agreement on the IRA, reviving parts of the legislative agenda focused on climate and tax reforms	Green

¹ Green events are in favor for the related climate policy. Brown events are events that could harm or stop the implementation of the climate policy.

8	03.08.2022 [Wed.]	Congressional Budget Office publish cost estimates of IRA	/
9	07.08.2022 [Sun.]	The Senate passes the IRA with a 51-50 vote	Green
10	12.08.2022 [Fri.]	The House of Representatives approves the IRA	Green
11	16.08.2022 [Tue.]	President Biden signs the IRA into law	Green

Because of their influential nature, the event study in the following sections will focus on Events 6 and 7 because of the influential nature of the events. The events before July 2022, are mostly about the Build Back Better Act, which had goals beyond the IRA. This makes it hard to determine the time and details of climate-related news from these events. After July 2022, cost estimates and legislative approval were expected and there was less uncertainty.

During event 6, Senator Manchin publicly rejected the existing Build Back Better proposal. This is a massive setback for Democrats and immensely reduced the chance of passing climate legislation. However, on July 27, Manchin and Charles Schumer reconciled the IRA, releasing its contents and ensuring the climate legislation's passage of the Build Back Better proposal. The likelihood of passing the climate policy improved to close to 100% after this announcement.

Multiple events occurring simultaneously make it hard to identify each individual impact on the financial market. A quick sequence of events makes it difficult to identify market reactions to a specific event, as the event windows may overlap. Therefore, the event study will examine Events 6 and 7, which do not have overlapping event windows. Analyzing those events will lead to a better understanding of the market reaction.

3 Hypothesis and Approach

The goal of this study is to investigate how the IRA affects various sectors of the European financial market and what firm characteristics impact market reactions. The following hypotheses are formulated to guide the research:

Hypothesis 1: The announcement and implementation of the Inflation Reduction Act (IRA) will result in varying abnormal returns across different sectors.

Given that the IRA includes significant regulations for promoting clean energy and reducing GHG emissions, it is expected that sectors directly benefiting from these provisions will exhibit significant positive abnormal returns. Conversely, other sectors may show negative abnormal returns due to anticipated regulatory challenges and competitive disadvantages.

Hypothesis 2: Companies with high greenhouse gas (GHG) emissions will encounter abnormal returns following the implementation of the IRA.

Firms with higher GHG emissions are likely to face increased regulatory costs. The IRA could increase the pressure on the EU to answer with a policy, increasing the climate transition risk for companies. This expectation leads to the hypothesis that firms with high GHG emissions will experience significant negative abnormal returns because investors adjust their valuations based on the anticipated financial impact of the IRA and potential newly introduced environmental regulations.

Hypothesis 3: Companies with substantial foreign sales will experience different abnormal returns compared to those primarily focusing on domestic sales.

Firms with significant international exposure may be more affected by the policy changes introduced by the IRA. This hypothesis suggests that such firms might exhibit more unstable or negative abnormal returns, as their revenue might be more effected by the negative impact of the IRA, such as trade barriers.

By testing these hypotheses, the study seeks to provide empirical evidence on the broader economic consequences of the IRA on the European market, enhancing our understanding of how major legislative actions in one economy can influence others. This analysis will help policymakers, investors, and corporations to navigate the global financial landscape in the context of evolving climate policies.

4 Data

This section analyzes the relevant research data. The Euro Stoxx 600 Index includes 600 large corporations from 17 European countries, providing a comprehensive barometer of European equity markets. Thomas Reuters provided the daily closing prices of the Euro Stoxx 600 constituents from January 1, 2020, to December 31, 2022. After missing value cleanup, the dataset consists of 579 firms. Firm returns and MSCI World Index returns are determined using the natural logarithm.

Table 2 summarizes the descriptive statistics for market returns. The dataset includes 782 observations with a mean daily return of 0.08% and a standard deviation of 2.53%. The minimum and maximum returns observed are -13.99% and 16.58%, respectively. The skewness value of -0.0072 suggests a slight negative skew, and the kurtosis value of 5.8485 indicates a leptokurtic distribution, suggesting more extreme values than a normal distribution. This return data is then used in the event study for the market model.

Table 2: Descriptive statistics for the MSCI Index²

Obs.	Mean	Std Dev	Min	25%	50%	75%	Max	Skewness	Kurtosis
782	0,08%	2,53%	-13,99%	-1,16%	0,08%	1,41%	16,58%	-0,0072	5,8485

The equal-weighted Euro Stoxx 600 returns provide a broader view of the European market performance, representing the average returns of all 579 companies for each day. The descriptive statistics for these returns show a mean of -0.01% and a standard deviation of 1.35%. The minimum and maximum returns are -12.44% and 7.82%, respectively. The skewness is -1.214, indicating a left-skewed distribution, and the kurtosis is 12.797, indicating significant deviations from normality with frequent extreme returns.

Table 3: Descriptive statistics for the equal weighted Euro Stoxx 600³

Obs.	Mean	Std Dev	Min	25%	50%	75%	Max	Skewness	Kurtosis
782	-0,01%	1,35%	-12,44%	-0,55%	0,04%	0,63%	7,82%	-1,214	12,797

Figure 1 depicts the average daily log return of the equal-weighted Euro Stoxx 600 over the period, highlighting key events with vertical red lines to illustrate volatility and market

² Data for MSCI Index is provided by Thomas Reuters and covers daily closing prices from January 1, 2020, to December 31, 2022. Returns are calculated with the natural logarithm.

³ The equal-weighted returns are computed to represent the average performance across all companies within the Euro Stoxx 600 index. This method highlights the broader market trends beyond the influence of large-cap firms

behavior. Periods of significant volatility can be linked to macroeconomic and geopolitical events:

- Early 2020: COVID-19 pandemic onset.
- Mid-2020 to Early 2021: Recovery phases and vaccine announcements.
- 2021: Stability with occasional spikes due to economic recovery and inflation concerns.
- Late 2021 to 2022: Rising inflation, supply chain disruptions, geopolitical tensions,

Figure 1: Daily Returns of the Euro Stoxx 600 and key events of the IRA⁴

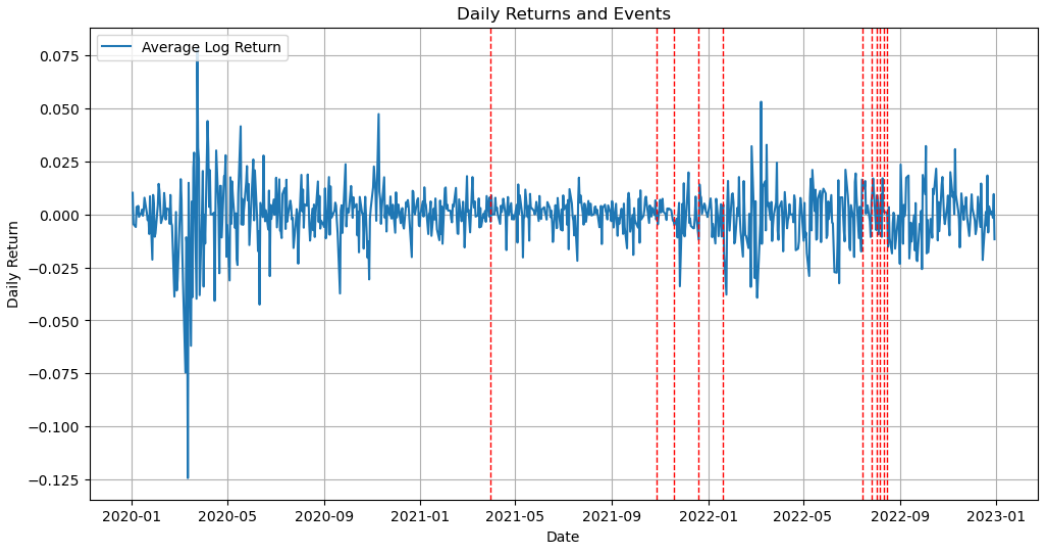


Table 4 summarizes the composition of the Euro Stoxx 600. The sector-wise distribution shows a balanced representation across various sectors, with Financials (17%), Industrials (16%), and Consumer Cyclicals (13%) being the most prominent.

Table 4: Composition of the Euro Stoxx 600

Industry	Company Count	In Percent
Basic Materials	53	9%
Consumer Cyclicals	77	13%
Consumer Non-Cyclicals	50	9%
Energy	20	3%
Financials	100	17%
Healthcare	51	9%
Industrials	94	16%
Real Estate	39	7%
Technology	68	12%
Utilities	27	5%
Total	579	

⁴ The daily log-returns are calculated based on the equal weighted Euro Stoxx 600 from January 2020 to December 2022. Key events of the IRA are illustrated in red.

Table 5 provides a comprehensive view of the return characteristics for each sector. The mean returns are close to zero across all industries, indicating a balanced performance. The standard deviations reveal varying levels of volatility, with Consumer Cyclical exhibiting the highest standard deviation at 2.64%.

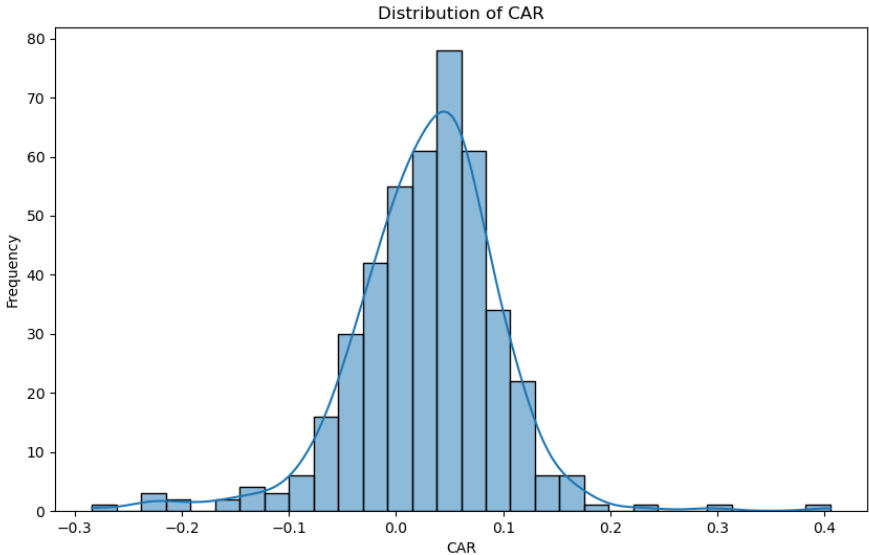
Table 5: Descriptive statistics for each sector⁵

Industry	Mean	Std Dev	Min	25%	50%	75%	Max	Skewness	Kurtosis	Company Count
Basic Materials	-0.003%	2.402%	-82,125%	-1,018%	0,00	1,108%	52,593%	-2,377	79,093	53
Consumer Cyclical	-0.021%	2.650%	-41,892%	-1,201%	0,00	1,214%	41,885%	-0,190	11,403	77
Consumer Non-Cyclical	-0.003%	1.924%	-36,114%	-0,826%	0,00	0,878%	22,235%	-0,409	13,657	50
Energy	-0.004%	2.545%	-33,219%	-1,172%	0,00	1,216%	20,256%	-0,607	11,454	20
Financials	-0.008%	2.389%	-51,397%	-1,017%	0,00	1,079%	29,592%	-0,726	14,983	100
Healthcare	-0.015%	2.268%	-40,553%	-1,028%	0,00	1,082%	25,932%	-0,746	15,232	51
Industrials	-0.003%	2.430%	-41,405%	-1,093%	0,00	1,141%	36,298%	-0,232	12,686	94
Real Estate	-0.061%	2.328%	-42,051%	-1,046%	0,00	0,994%	27,137%	-0,223	15,362	39
Technology	-0.029%	2.542%	-36,306%	-1,086%	0,00	1,120%	66,320%	0,026	23,329	68
Utilities	-0.002%	2.206%	-34,115%	-0,925%	0,0	1,012%	22,680%	-1,159	19,511	27

4.1 Explanatory Data Analysis for the cross-sectional regression

The EDA focuses on highlighting the main factors that affect the CAR of the companies in the data set. The average CAR is 0.03, with a standard deviation of 0.07. This suggests that, on average, there are positive abnormal returns. However, there is considerable fluctuation, with returns ranging from -0.28 to 0.41.

Figure 2: Distribution of CAR - Brown Event⁶



⁵ The variability in standard deviations across industries indicates differing levels of volatility. This suggests that certain sectors are more sensitive to market conditions.

⁶ The distribution of CAR highlights the variability in firm-specific reactions to the Brown Event, with returns ranging from -0.28 to 0.41. This variability underscores the diverse market perceptions and reactions to the event.

Table 6: Descriptive statistics of the Independent Variables – Brown Event⁷

	CAR	Log(Total Emissions)	Log(Scope 1)	Log(Scope 2)	Intensity	Environmental Pillar Score
mean	0.03	5.01	4.57	5.91	23.41	70.85
std	0.07	1.23	1.42	1.42	238.01	18.26
min	-0.28	1.13	-0.10	1.04	0.00	25.20
25%	-0.01	4.21	3.68	5.03	0.02	60.18
50%	0.03	4.98	4.48	6.05	0.17	73.90
75%	0.07	5.71	5.37	6.96	0.83	84.99
max	0.41	8.08	8.05	8.97	3291.25	98.42

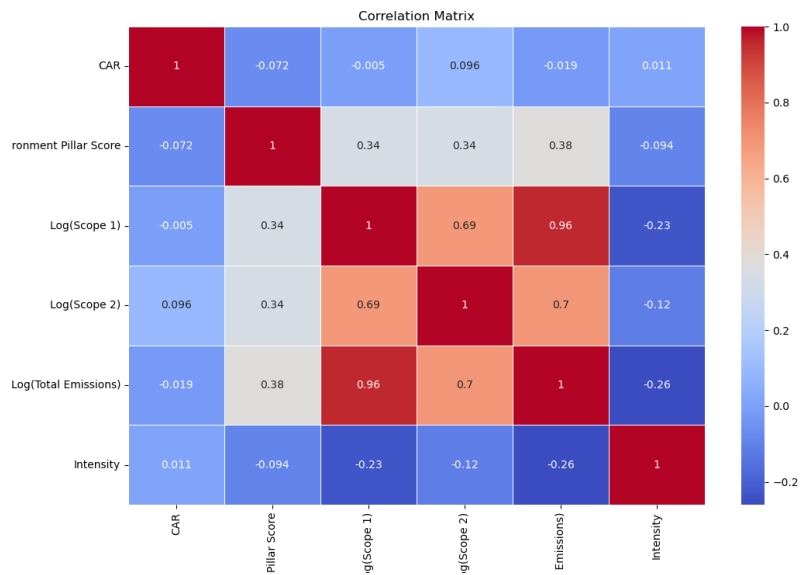
Firm-specific emissions data indicate significant deviations between the researched companies. The average log of total emissions is 5.01, with a standard deviation of 1.23. The mean of direct emissions (Scope 1) is 4.57 with a standard deviation of 1.42, whereas the mean of indirect emissions from energy consumption (Scope 2) is 5.91 with a comparable standard deviation. The carbon intensity shows considerable variability as well, with an average value of 23.41 and a standard deviation of 238.01.

The average score for the environmental pillar is 70.85, with a standard deviation of 18.26. This suggests that most organizations have moderate to good environmental performance. However, there is a wide range of values, from 2.52 to 98.42, indicating significant variability in environmental sustainability efforts.

Figures 3 and 4 present correlation matrices that offer a comprehensive view of the relationships between key variables, providing insights into how these factors might influence cumulative abnormal returns (CAR) at the brown and green event.

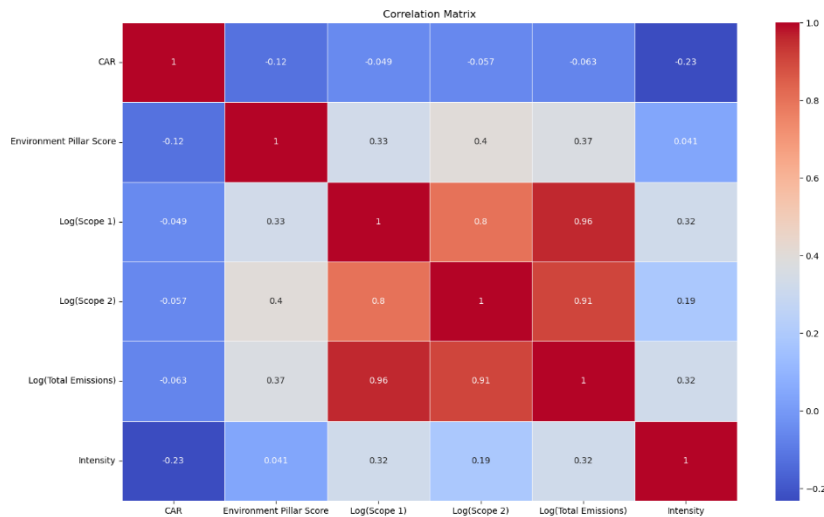
⁷The independent variables include firm-specific emissions data, with significant deviations noted across companies. The data highlights the diversity in environmental impact among firms and its potential influence on market returns.

Figure 3: Correlation matrix – Brown Event⁸



When comparing the two correlation matrices, differences can be observed in the relationships between CAR and various emission metrics. These differences offer insights into how the data may have been influenced by different events or periods.

Figure 4: Correlation matrix – Green Event



The correlation coefficients between CAR and emissions metrics in both matrices are quite small, which suggests only weak relationships. For instance, the correlation between CAR and

⁸ The correlation matrix provides insights into the relationships between key variables during the Brown Event. Notable shifts in correlations, particularly regarding emissions metrics, suggest changing market sensitivities.

Log(Total Emissions) shifts from -0.019 in the first matrix to -0.063 in the second matrix. While this change might indicate a slight increase in the negative relationship, the values are still close to zero, implying that the relationship remains weak. Similarly, the correlation between CAR and Log(Scope 1 Emissions) changes from -0.005 to -0.049, reflecting a small shift that could suggest growing market sensitivity to direct emissions. However, this change is also minor.

The most notable shift is in the correlation between CAR and Log(Scope 2 Emissions), which moves from a positive 0.096 to a negative -0.057, possibly indicating a reversal in market perception. Nevertheless, these correlation values are still relatively small.

In summary, while the differences between the two matrices may hint at evolving market perceptions, the small magnitude of these correlations means we should be cautious when drawing strong conclusions. These shifts, although interesting, suggest that the relationships between emissions metrics and abnormal returns are weak, and further analysis would be needed to substantiate any significant market trends.

4.2 Explanatory Data Analysis of the variable foreign sales

In this section, the descriptive statistics for the cross-section regression with foreign sales will be presented. Table 7 shows the foreign sales percentages of firms on July 15, 2022, and July 27, 2022.

Table 7: Descriptive statistics of the foreign Sales variables at the brown and green event⁹

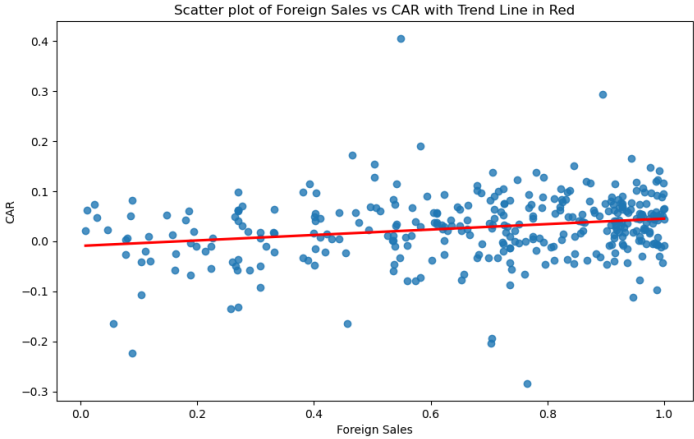
	Brown Event	Green Event
count	343	382
mean	0.68	0.68
std	0.27	0.28
min	0.01	0.01
25%	0.53	0.52
50%	0.74	0.75
75%	0.92	0.93
max	1.00	1.00

The scatter plot analysis (figure 5 and 6) shows that during the brown event on July 15, 2022, European firms with higher foreign sales generally experienced better cumulative abnormal returns (CAR). This weak positive relationship indicates that foreign sales helped mitigate the negative impacts of the announcement against the Inflation Reduction Act (IRA). European

⁹ The foreign sales data were analyzed at two critical points: July 15, 2022 (brown event) and July 27, 2022 (green event).

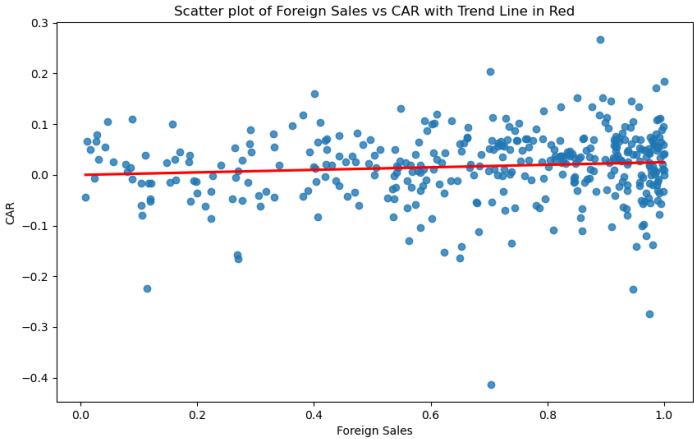
firms with significant foreign revenue were seen as less vulnerable to US domestic policy changes, leading to more favorable market reactions.

Figure 5: Scatter plot of Foreign Sales and CAR – Brown Event



During the green event on July 27, 2022, when the IRA was announced, European firms with higher foreign sales also experienced slightly better CAR. However, the relationship is weak, suggesting that while foreign sales provided some resilience, other factors might have been more influential.

Figure 6: Scatter plot of Foreign Sales and CAR – Green Event



5 Methodology

The event research methodology is a powerful tool for assessing how certain events affect a company's stock price, trading volume, or volatility. This thesis follows the event study approach presented by MacKinlay (1997). In general, researchers examine abnormal returns (AR), which is the difference between the observed return and expected return, to determine the impact of these events. Brown and Warner (1980) state that event studies must follow three methodological assumptions. The first assumption relates to the semi-strong variant of the Efficient Market Hypothesis (EMH), the market effectively and impartially incorporates new information into stock prices, which should promptly reflect the economic effect of the event (Fama, 1991). The rate of price adjustment reveals whether the market overreacted or underreacted to the new information. The second assumption is that the occurrence is unexpected, making it easier to relate the effect to the actual event. The third premise requires that the event is distinct and not mixed with others.

5.1 Event and Estimation Window

The event window and estimation window are key components in the event study methodology. The event window surrounds the event, while the estimation window predicts returns for the event window. Furthermore, the event day anchors the analysis and may not always match the official announcement due to potential leaks before the actual date. The event window, denoted as $[T1, 0, T2]$, typically spans 1 to 11 days, centered around the event day. The estimation window, marked as $[T0, T1-30]$, starts with the first observed day, $T0$. In general, longer windows improve accuracy but may include structural changes. Sensitivity to estimation window length is minimal at 100 days, with optimal results using around 250 days of data (MacKinlay, 1997).

In my study, I use 253 daily observations from day -250 to day +3. The first 210 days $[-250, -40]$ make up the estimation window. I included a 30-day buffer period between the estimation window and event window. Therefore, my event window spans $[-10, +3]$. If the announcement is made after market close, the event day, day 0, is adjusted to move to the next day.

5.2 Abnormal Returns

Abnormal returns are the difference between the actual returns of a security and its expected returns based on some model or benchmark over a specific period. These returns represent abnormal returns that cannot be explained by the market's overall movements. Abnormal returns are used in my study to assess the impact of the IRA on the price of a security.

$$AR_{\{i,t\}} = R_{\{i,t\}} - E(R_{\{i,t\}}) \quad (1)$$

where:

$AR_{\{i,t\}}$ is defined as the Abnormal Return of stock i on day t

$R_{\{i,t\}}$ is defined as the observed Return of stock i on day t

$E(R_{\{i,t\}})$ is defined as the Expected Return for stock i on day t , predicted by a model

I use continuously compounded returns, as they improve the normality of the return distribution.

Therefore, the observed returns $R_{\{i,t\}}$ take the natural logarithmic form:

$$R_{\{i,t\}} = \ln\left(\frac{P_{\{i,t\}}}{P_{\{i,t-1\}}}\right) \times 100 \quad (2)$$

where:

$R_{\{i,t\}}$ is the continuously compounded return of stock i on day t

$P_{\{i,t\}}$ is the closing price per share of stock i on day t

$P_{\{i,t-1\}}$ is the closing price per share of company stock i on day t

5.3 Expected Returns

An abnormal price change of a stock refers to a deviation from the expected returns that would have occurred if the event had not taken place. Estimating expected returns requires the use of asset pricing models to estimate the “No News” returns. Inaccuracies in estimating returns might result in false assessments of abnormal returns.

There are several different models to predict returns. In the literature, one can often read the mean-adjusted model, the market model, and multifactor models. The mean-adjusted approach employs the average return during a pre-event period as the expected return of the corresponding asset. The market model uses ordinary least squares (OLS) regression to analyze the relationship between stock returns and a market index. This is done to account for market fluctuations. The multifactor model expands upon the market model by incorporating other factors, such as size, value, and momentum, derived from models like the Fama-French three-factor model. These techniques try to isolate returns that can be attributed to the event. However, the market model is most commonly used to generate expected returns in the literature and produces superior results to other models (Armitage, 1995; Cable & Holland,

1999). Therefore, I will use the market model as my main model and the mean adjusted model as a robustness test, which is also the customary conduct in the literature.

5.3.1 Mean-Adjusted Model

In the mean-adjusted model, the abnormal return in the event window is defined as the return of observation i on day t minus the average return of observation i in the estimation window:

$$AR_{\{i,t\}} = R_{\{i,t\}} - \overline{R_{\{i\}}} \quad (3)$$

where

$$\overline{R_{\{i\}}} = \frac{1}{T_1 - T_0} \sum_{t \in [T_0, T_1]} R_{\{i,t\}} \quad (4)$$

5.3.2 Market Model

The market model is a statistical method used to predict the normal return for a stock based on the return of a broader market index. It is based on the assumption that there is a linear relationship between the return of a stock and the return of the market (MacKinlay, 1997). The model can be represented as:

$$E(R_{\{i,t\}}) = \alpha_i + \beta_i R_{\{m,t\}} + \epsilon_{\{i,t\}} \quad (5)$$

where

$R_{\{i,t\}}$ is the return of stock i at time t ,

$R_{\{m,t\}}$ is the return of the market index at time t ,

α_i is the intercept of the regression equation

β_i is the slope of the regression equation for stock i , indicating the stock's sensitivity to market movements,

$\epsilon_{\{i,t\}}$ is the error term, representing unexplained fluctuations in stock i 's return at time t .

The market model is considered to be an improvement over the constant mean return model because it removes the portion of the return related to market variations, thereby reducing the variance of the abnormal return (Cable & Holland, 1999).

5.4 Hypothesis testing

We can combine abnormal returns over time and across different securities. This section will explain cumulative abnormal returns (CAR), average abnormal returns (AAR), and cumulative average abnormal returns (CAAR).

CAR are a measure to quantify the overall influence of an event on stock returns throughout a specified timeframe. The analysis of CAR offers the possibility of evaluating the extent to which an event has impacted the stock price of a company. The CAR over a specific event window is calculated by summing the abnormal returns for all days within the event window:

$$CAR(\tau_1, \tau_2) = \sum_{t=\tau_1}^{\tau_2} AR_{\{i,t\}} \quad (6)$$

where

$CAR(\tau_1, \tau_2)$ is the Cumulative Abnormal Return from time τ_1 to τ_2

τ_1 is the start day of the event window relative to the event date

τ_2 is the end day of the event window relative to the event date

To calculate the effect per sector, I calculate the AAR by averaging abnormal returns across sectors to evaluate if the event response is sector-specific or a general trend. The sectoral daily average abnormal returns within the event period τ_1, τ_2 are computed as:

$$AAR_{j,\tau} = \frac{1}{N_j} \sum_{i=1}^{N_j} AR_{it} \quad (7)$$

Here, j corresponds to the sector and N_j indicates the count of firms within each sector.

The CAAR accounts for the aggregation of abnormal returns across both securities and time. Similar to CAR, CAAR summarizes average abnormal returns over a specific period. Therefore, CAAR represents the sum of average abnormal returns.

The CAAR per sector is calculated as follows:

$$CAAR(\tau_1, \tau_2, j) = \sum_{\tau=\tau_1}^{\tau_2} AAR_{j\tau} \quad (7)$$

With CAR and CAAR, we can evaluate the impact of an event on the performance of stocks compared to expectations. A positive CAR/CAAR indicates that the event had a positive impact on the firm, resulting in returns higher than market expectations. A negative CAR indicates that the event had a negative impact on the firm. A CAR/CAAR value of zero or close to zero indicates that the event had minimal or no effect on returns.

5.5 Test Statistics

The hypothesis testing in this study is established to determine whether the CAR differ significantly from zero, indicating that the event has impacted the value of the companies involved. The null hypothesis states that the CAR is equal to zero, suggesting no significant impact from the event:

$$\begin{aligned} H_0: \mu &= 0 \\ H_1: \mu &\neq 0 \end{aligned} \quad (7)$$

where μ is the mean of AR, CAR, AAR or CAAR.

5.5.1 Parametric Tests

Parametric tests are employed to validate abnormal returns, on the assumption that the sample data is derived from a normal distribution. The t-test assesses whether the mean of the sample is significantly different from zero. It assumes that the returns are normally distributed and independent.

To calculate the t-test for AR and standard errors:

$$t_{AR_{\{i,t\}}} = \frac{AR_{\{i,t\}}}{S_{AR_{\{i\}}}} \quad (8)$$

$$S_{AR_{\{i\}}}^2 = \frac{1}{M_{\{i\}} - 2} \sum_{t=T_0}^{T_1} (AR_{\{i,t\}})^2 \quad (9)$$

where:

$AR_{\{i,t\}}$ is the abnormal return from stock i on date t

$S_{AR_{\{i\}}}$ is the standard error of the regression from the AR of company i in the estimation window

$M_{\{i\}}$ is the number of returns

To calculate the t-stat for the Cumulative Abnormal Returns, we must adjust the standard error:

$$t_{CAR_{\{i,t\}}} = \frac{CAR_{\{i\}}}{S_{CAR_{\{i\}}}} \quad (10)$$

$$S_{CAR_{\{i\}}}^2 = L_2 S_{AR_{\{i\}}}^2 \quad (11)$$

where

L_2 is defined as the event window length

To analyze the significance of the AAR and CAAR, I use the Cross-Sectional T-Test. The test for the AAR is calculated as follows:

$$t_{AAR_{j,t}} = \sqrt{N} \frac{AAR_{j,t}}{S_{AAR_{j,t}}} \quad (10)$$

$$S_{AAR_{j,t}}^2 = \frac{1}{N-1} \sum_{i=1}^N (AR_{i,t} - AAR_{j,t})^2 \quad (11)$$

where:

N is the Number of Components

The Cross-Sectional T-Test for CAAR is calculated as:

$$t_{CAAR_t} = \sqrt{N} \frac{CAAR}{S_{CAAR}} \quad (14)$$

$$S_{CAAR}^2 = \frac{1}{N-1} \sum_{i=1}^N (CAR_i - CAAR)^2 \quad (15)$$

Introduced by Patell (1976), the Patell test standardizes abnormal returns by their estimated standard deviation, preventing manipulation by securities with large variances. It also adjusts for forecast errors, improving robustness against heteroskedasticity. The standard abnormal returns (SAR) are calculated by standardizing abnormal returns using the forecast error corrected standard deviation and is calculated as:

The test statistic is calculated as follows:

$$z_{Patell,t} = \frac{ASAR_{t}}{S_{ASAR_{t}}} \quad (16)$$

The standardized abnormal returns are calculated as:

$$SAR_{i,t} = \frac{AR_{i,t}}{S_{AR_{i,t}}} \quad (17)$$

$$S_{AR_{i,t}}^2 = S_{AR_{i}}^2 \left(1 + \frac{1}{M_{i}} + \frac{(R_{\{m,t\}} - \overline{R_{\{m\}}})^2}{\sum_{t=T_0}^{T_1} (R_{\{m,t\}} - \overline{R_{\{m\}}})^2} \right) \quad (18)$$

where

$\overline{R_{\{m\}}}$ is the average market returns in the estimation period¹⁰:

$$\overline{R_{\{m\}}} = \frac{1}{L_1} \sum_{t \in [T_0, T_1]} R_{\{m,t\}} \quad (19)$$

$ASAR_t$ is calculated as the of $SAR_{i,t}$ over the the sample:

$$ASAR_{\{t\}} = \sum_{i=1}^N SAR_{\{i,t\}} \quad (20)$$

And $S_{ASAR_{\{t\}}}^2$ is calculated as:

$$S_{ASAR_{\{t\}}}^2 = \sum_{i=1}^N \frac{M_{\{i\}} - 2}{M_{\{i\}} - 4} \quad (21)$$

To calculate the Patell test for the CAAR, we must calculate the cumulative standardized abnormal returns for each company. The test statistic is calculated as:

$$Z_{Patell} = \frac{1}{\sqrt{N}} \sum_{i=1}^N \frac{CSAR_{\{i\}}}{S_{CSAR_{\{i\}}}} \quad (22)$$

$CSAR_{\{i\}}$ denotes the cumulative standardized abnormal return of firm i :

$$CSAR_{\{i\}} = \sum_{t=T_1+1}^{T_2} SAR_{\{i,t\}} \quad (23)$$

which has expectation zero and variance:

$$S_{CSAR_{\{i\}}}^2 = L_2 \frac{M_{\{i\}} - 2}{M_{\{i\}} - 4} \quad (24)$$

5.5.2 Nonparametric Tests

A major problem in statistical tests of abnormal returns is that stock prices are not normally distributed. Nonparametric tests do not assume a specific data distribution, making them useful when normality assumptions are questionable. They are robust against outliers and non-normal distributions and account for cross-correlation, serial correlation, and event-induced volatility (Kolari & Pynnonen, 2011).

¹⁰ L1 represents the length of the estimation period

The Generalized Sign test compares the proportion of positive abnormal returns during the event window to the proportion during a non-event period, accounting for asymmetric return distributions. Evidence from Corrado and Zivney (1992) shows that the test is especially useful in detecting small abnormal returns. The generalized sign test examines whether the number of stocks with positive cumulative abnormal returns in the event window exceeds the number expected in the absence of abnormal performance (Cowan, 1992).

$$z_{gsign} = \frac{w - N\hat{p}}{\sqrt{N\hat{p}(1 - \hat{p})}} \quad (25)$$

where:

w is the number of the $AR_{\{i,t\}}$ that are positive

\hat{p} is the fraction of the $AR_{\{i,t\}}$ during the estimation window (across both i and t that are positive)

\hat{p} is estimated as:

$$\hat{p} = \frac{1}{N} \sum_{i=1}^N \frac{1}{L_1} \sum_{t=T_0}^{T_1} \Phi_{\{i,t\}} \quad (26)$$

$$\Phi_{\{i,t\}} = \begin{cases} 1, & \text{if } AR_{\{i,t\}} > 0 \\ 0 & \text{otherwise} \end{cases} \quad (27)$$

5.6 Cross-sectional regression

This section examines the impact of various firm-specific and market-specific factors on the CAR observed around the announcement of the IRA. In our regression analysis, the CAR is the dependent variable.

To understand the determinants of CAR, I include several independent variables in the regression model. These include GHG emissions across different scopes, carbon intensity, and revenues generated in the US. Specifically, I use the following variables:

- Log (Total Emissions): measures the natural logarithm of total GHG emissions, represented by the sum of Scope 1 and 2 emissions.
- Log (Scope 1): measures the natural logarithm of direct (Scope 1) GHG emissions.
- Log (Scope 2): measures the natural logarithm of indirect (Scope 2) GHG emissions.
- Carbon Intensity: ratio of total emissions to market value, indicating carbon intensity.

- The Environment Pillar Score, provided by Thomas Reuters, is an aggregate score reflecting a firm's environmental performance.
- Foreign Sales: measures the ratio of revenues generated in foreign countries.

Additionally, several control variables to account for other factors that might influence CAR are included:

- Log (Revenues): natural logarithm of total revenues.
- ROE (Return on Equity): measures profitability relative to shareholders' equity.
- Leverage: ratio of debt to equity.
- Log (Size): natural logarithm of the market value.
- Operating Margin: ratio of operating income to revenues, indicating operational efficiency.

The regression model is specified as follows:¹¹

$$CAR_i = \alpha + \beta_1(GHG_Foreign) + \beta_2 \text{Log}(Revenues_i) + \beta_3 ROE_i + \beta_4 Leverage_i + \beta_5 \text{Log}(Size_i) + \beta_6 \text{Operating margin}_i + \sum \gamma_j \text{Industry Dummies}_j + \epsilon_i$$

where:

- CAR_i represents the cumulative abnormal return for firm i over the event window.
- α is the intercept.
- β_1 is the coefficient for the variables of interest, such as GHG emissions (Log (Scope 1, 2, or Total Emissions)), Carbon Intensity or Foreign Revenues
- $\beta_2, \beta_3, \beta_4, \beta_5, \beta_6$ are the coefficients for the control variables (Revenues, Firm Size, Leverage, ROE, and Operating margin).
- $\sum \gamma_j \text{Sector Dummies}_j$ represents the sector dummy variables.
- ϵ_i represents the error term or residual for the i observation

The regression provides insights into the impact of different factors on the CAR surrounding the events. More precisely, the coefficients for GHG emissions, including Scope 1, 2, and Total Emissions, demonstrate the impact of direct, indirect and total emissions on investor perceptions. The carbon intensity coefficient measures how much GHG a company emits relative to its market size. The foreign sales coefficient analyzes the impact of enterprises'

¹¹ $GHG_Foreign$ represents a placeholder for all the independent variables

exposure to foreign markets. The control variables, such as firm size, leverage, ROE, and operating margin, might influence CAR and offer further contextual information. The sector dummy variables were included to capture and control for industry-specific effects and trends.

5.6.1 Test statistics

To evaluate the significance of the regression coefficients, t-tests, F-tests, and R-squared values are conducted. These statistics determine the reliability and explanatory power of the model.

The t-test is used to assess the significance of individual regression coefficients. The t-statistic for each coefficient β is calculated as:

$$t = \frac{\beta}{SE(\beta)} \quad (28)$$

Where $SE(\beta)$ is the standard error of the coefficient. A higher absolute value of the t-statistic indicates a greater level of significance. The corresponding p-values are compared against a chosen significance level to determine if the coefficients are statistically significant.

The F-test is used to evaluate the overall significance of the regression model. The F-statistic is calculated as:

$$F = \frac{\left(\frac{SSR}{k}\right)}{\left(\frac{SSE}{n-k-1}\right)} \quad (29)$$

where:

- SSR is the sum of squares due to regression.
- SSE is the sum of squares due to error.
- k is the number of independent variables.
- n is the number of observations.

A higher F-statistic indicates that the model explains a significant portion of the variance in the dependent variable.

R-Squared and adjusted R-squared measures the proportion of variance in the dependent variable that is explained by the independent variables. Adjusted R-squared accounts for the number of predictors in the model. It, therefore, provides a more accurate measure when multiple independent variables are used.

R-squared is calculated as:

$$R^2 = 1 - \frac{SSE}{SST} \quad (30)$$

where SST is the total sum of squares.

Adjusted R-squared is calculated as:

$$\text{Adjusted } R^2 = 1 - \left(\frac{1 - R^2}{n - k - 1} \right) (n - 1) \quad (31)$$

6 Empirical Analysis

This section presents the empirical analysis of the impact of the IRA on the Euro Stoxx 600. The analysis is divided into two main sections: the event study, which examines the immediate market reactions to the IRA announcements, and the cross-sectional regression analysis, which investigates the determinants of CAR around these events.

6.1 Overall impact on the EuroStoxx600

This section of the empirical analysis evaluates the impact of events 6 and 7 of the IRA on the Euro Stoxx 600.

Table 8: Cumulative Average Abnormal Returns per Event¹²

	CAAR	CsecT	Patell
Event 6	3.10%	10.156***	11.173***
Event 7	2.00%	5.992***	6.697***

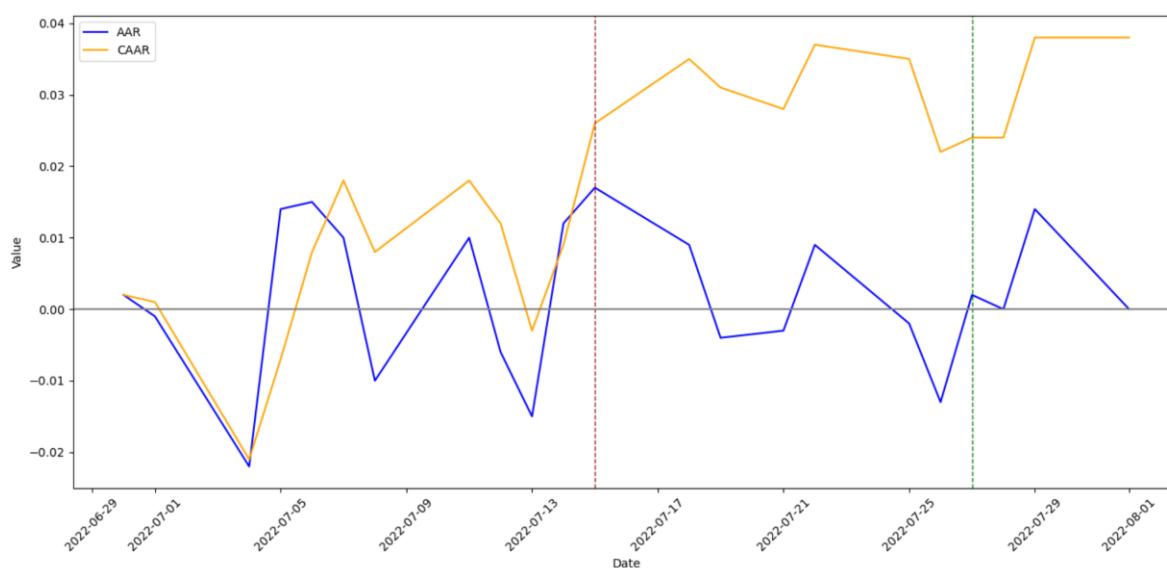
Table 9 provides the overall findings of the events. Event 6 had a CAAR of 3.10%, and statistical testing confirmed its market impact. This finding is statistically significant, as the t-test value of 10.156*** and the Patell test value of 11.173*** show that the market's positive response is highly significant at a significance level of 1%. This large favorable reaction might be linked to investors' belief that rejecting the proposal will avoid regulatory costs and economic disruptions from IRA. Companies possibly affected by such laws might have contributed to the positive CAAR.

The CAAR for Event 7 stands at 2.00%, t-test value, and Patell, both indicating high statistical significance at the 1% level. The market's positive response to this event could reflect the perceived benefits of the new agreement. The revised IRA proposal included substantial subsidies and incentives for clean energy and green technologies.

Figure 2 provides a visual representation of the daily AAR and CAAR for the period from 01.07.2022 until 01.08.2022. The blue line represents the AAR, while the yellow line represents the CAAR, which is the aggregate sum of the AAR over the analysis period.

¹² CAAR calculations for Event 6 and Event 7 are based on a [-10, +3] event window, market mode, and with statistical significance confirmed with the t-test and Patell test. The symbols *, **, and *** indicate statistical significance at the 0.10, 0.05, 0.01 level respectively, using a two-sided test.

Figure 7: Development of AAR and CAAR for Event 6 and 7 ¹³



The graph includes vertical lines that highlight the brown event 6 and the green event 7, respectively. Prior to the events, both AAR and CAAR fluctuate around the zero line, suggesting no significant abnormal returns.

Following Manchin's rejection of the proposal on July 15, there is a notable positive shift in AAR and therefore also in CAAR. The announcement of the agreement on the IRA on July 27 leads to a positive trend in CAAR, however, not as big as on Event 6. The rise in CAAR could reflect investor optimism and positive sentiment towards the new agreement.

6.2 Event Study per sector – Brown Event

This section analyzes the CAAR in different sectors to research how different sectors react to the brown event. Firstly, the response of different sectors to the brown event on July 15, 2022, will be examined.

Table 10 presents the CAAR for various sectors within an event window of 10 days before to 3 days after the event, including the Patell test and T-test results to assess statistical significance.

¹³ The vertical lines indicate key events 6 and 7 surrounding the IRA. The positive shifts in both AAR and CAAR post-announcement highlight the market's reaction to the legislative developments, reflecting investor sentiment towards the policy's potential impact on various industries.

Table 9: Cumulative Average Abnormal Returns per sector – Brown Event¹⁴

	CAAR	CsecT	Patell
Financials	-1.00%	-1.442	-1.214
Industrials	5.80%	10.095***	7.885***
Utilities	2.30%	1.093	1.452
Non-Cyclicals	2.70%	4.664***	3.080**
Consumer Cyclicals	6.80%	10.854***	7.595***
Technology	2.00%	2.212*	1.854*
Real Estate	4.00%	5.379***	4.176
Basic Materials	3.30%	3.856***	3.172**
Energy	-2.00%	-1.206	-1.844*
Healthcare	2.70%	3.253**	2.40*

We can see that most sectors have reacted positively to the rejection of the policy. However, Energy reacted negatively with a CAAR of -2.00%, indicating that the Energy sector might have benefitted from the implementation of the policy. Financials also shows negative CAAR. However, the reaction is not significant.

Industrials, Non-Cyclicals, Consumer Cyclicals, Technology, Basic Material, Real Estate and Healthcare demonstrated significant positive CAAR following the event, indicating strong investor confidence. The most notable reactions were seen in Consumer Cyclicals and Industrials, and Real Estate. We can see CAAR of 6.80% for Consumer Cyclicals, Industrials of 5.80%, and Real Estate of 4.00%, all with highly significant test results. The Healthcare sector is directly targeted in the policy and showed a positive response with a CAAR of 2.70%.

6.3 Event Study per sector – Green Event

In this section, I will analyze the CAAR across various sectors in response to the July 27, 2022, legislative event favoring the IRA. The CAAR, that can be found in Table 11, indicates a range of investor expectations and perceived effects. Compared to the brown event, we can see the overall trend that the reactions are smaller and fewer industries show significant returns. We can see significant positive CAAR for Industrials, Consumer Cyclicals, and Real Estate and Basic Materials.

¹⁴ The CAAR reflect sector-specific investor reactions to the rejection of the IRA proposal. The symbols *, **, and *** indicate statistical significance at the 0.10, 0.05, 0.01, respectively, using a two-sided test.

Table 10: Cumulative Average Abnormal Returns per Industry – Green Event ¹⁵

	CAAR	CsecT	Patell
Financials	0.00%	0.065	-0.193
Industrials	3.60%	6.352***	4.985***
Utilities	1.30%	0.481	1.117
Non-Cyclicals	0.40%	0.652	0.76
Consumer Cyclicals	4.00%	5.661***	4.503***
Technology	1.30%	1.132	0.147
Real Estate	4.90%	5.899***	4.988***
Basic Materials	3.80%	5.539***	3.393***
Energy	1.70%	1.651*	0.719
Healthcare	-1.90%	-1.739*	-2.561*

In contrast, the Healthcare sector demonstrated a negative reaction, with a statistically significant CAAR of -1.90% that shows investor concerns regarding the sector’s future. This negative trend indicates substantial reservations about the legislative changes impacting the healthcare sector. However, we cannot find any CAAR with statistical significance for the following sectors: Financials, Utilities, Non-Cyclicals, Technology.

Overall, the data reflects general optimism about the IRA, particularly in sectors directly benefiting from its focus on sustainability and infrastructure. However, we see cautious or negative reactions in sectors like healthcare.

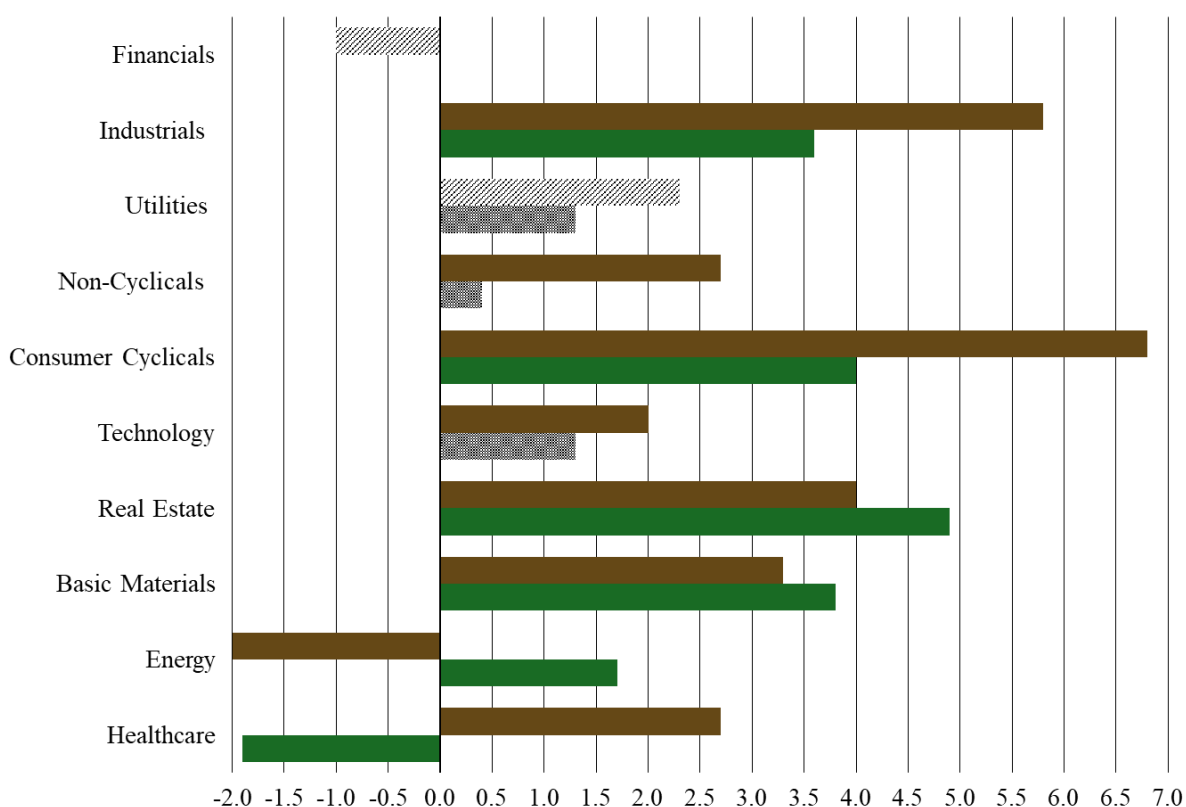
6.4 Comparison of the CAAR on both events

Upon closely examining figure 3 that contrasts the CAAR across different sectors for July 15 and July 27, 2022, we can see some shifts in returns due to the brown and green event related to the IRA.

The energy sector shows a negative CAAR on July 15, reflecting investor concerns about the brown event. Investors might have priced in the potential benefit from the IRA for the energy sector, leading to a setback in the industry. However, on July 27, investor sentiment might shift positively, suggesting that the implementation of the legislation diminished earlier concerns and highlighted potential benefits of the IRA to the energy sector.

¹⁵ The CAAR reflect sector-specific investor reactions to the positive announcement of the IRA proposal. The symbols *, **, and *** indicate statistical significance at the 0.10, 0.05, 0.01, respectively, using a two-sided test.

Figure 8: Comparison of Industry CAAR – Green vs. Brown Event¹⁶



The positive shift in the energy sector contrasts sharply with Healthcare, which showed positive abnormal returns on the brown event and a negative CAAR on the green event. This shows potential negative effects on the healthcare sector of the IRA. It shows that investors are worried about the legislative changes. Particularly, regulatory reforms or cost implications might adversely affect the sector.

Other sectors, such as Industrials, Consumer Cyclicals, Real Estate, and Basic Materials displayed strong positive reactions by July 27 and July 15, indicating robust investor confidence. These sectors likely benefited from specific aspects of the legislation, such as incentives for infrastructure and consumer spending, which are directly relevant to their operational and financial landscapes.

Most notably, we see very high CAAR during the brown event for the Consumer Cyclical sector and the Industrials sector. Both sectors are characterized by rather low ESG factors and

¹⁶ Figure 3 illustrates the cumulative average abnormal returns (CAAR) across different industries in response to the brown event (July 15, 2022) and the green event (July 27, 2022). The brown bars represent statistically significant CAAR during the brown event and green bars for the green one. The dotted bars represent statistically non-significant CAAR during the green event and the dashed bars represent statistically non-significant returns during the brown event.

high GHG emissions. For example, we can see that the automotive industry in Europe is directly targeted by the IRA. This might have led to positive returns after the brown event. Furthermore, the Industrials sector might have benefited from the rejection of the IRA after the brown event.

6.5 Cross-sectional regression analysis

The regression analysis provides insights into the influence of various factors on CAR around the brown and green event.

Table 11: Regression Analysis – Brown Event – Market Model¹⁷

	(1)	(2)	(3)	(4)	(5)
Environmental Pillar Score					-0.0002 (0.187)
Intensity				0.00001434 (0.466)	
Log(Scope2)			0.0006 (0.847)		
Log(Scope 1)		-0.0078** (0.043)			
Log (Total Emissions)	-0.0087** (0.045)				
Observations	436	436	436	436	436
R ²	0.175	0.175	0.167	0.168	0.17
Adj. R ²	0.145	0.145	0.137	0.138	0.14
F-Stat	5.922	5.93	5.603	5.643	5.74
Industry Fixed Effects	YES	YES	YES	YES	YES
Control Variables	YES	YES	YES	YES	YES

During the brown event, significant relationships are identified. The coefficient for Log (Scope 1 Emissions) is -0.0078, statistically significant at the 5% level ($p = 0.043$), indicating that firms with higher direct emissions tend to have lower abnormal returns. The coefficient for Log (Total Emissions) is -0.0087, significant at the 5% level ($p = 0.045$), suggesting that overall higher emissions are viewed negatively by investors.

¹⁷ Table 12 shows the regression analysis results for cumulative abnormal returns (CAR) during the brown event. Independent variables are listed on the left, with their coefficients in the middle and p-values under it. Positive coefficients indicate a direct relationship, while negative coefficients indicate an inverse one. Statistical significance is marked by stars: * ($p < 0.10$), ** ($p < 0.05$), and *** ($p < 0.01$).

Table 12: Regression Analysis – Green Event – Market Model¹⁸

	(1)	(2)	(3)	(4)	(5)
Environmental Pillar Score					-0.0003*** (0.0930)
Intensity				-0.00001*** (0.0001)	
Log(Scope2)			-0.0007 (0.8730)		
Log(Scope 1)		-0.0007 (0.8540)			
Log (Total Emissions)	-0.0019 (0.6630)				
Observations	480	480	480	480	480
R ²	0.144	0.144	0.1444	0.19	0.149
Adj. R ²	0.116	0.116	0.116	0.163	0.121
F-Stat	5.196	5184	5.184	7.24	5.402
Industry Fixed Effects	YES	YES	YES	YES	YES
Control Variables	YES	YES	YES	YES	YES

For the green event, the regression coefficients highlight different significant relationships. The environmental pillar score has a coefficient of -0.0003, statistically significant at the 10% level ($p = 0.093$), indicating that firms with higher environmental scores experienced lower abnormal returns. Carbon intensity has a coefficient of -0.00001, highly significant ($p < 0.0001$), underscoring a negative relationship.

6.6 Cross-sectional regression analysis – Foreign Sales

In this section, Hypothesis 3 will be analyzed. For that, the cross-sectional analysis with the share of foreign sales will be analyzed. The regression analysis for CAR on July 15, 2022, shows that higher foreign sales are associated with significantly higher CAR, suggesting firms with greater international exposure were positively impacted by the brown event. A 1% increase in foreign sales corresponds to a 0.0326% increase in CAR.

¹⁸ Table 13 shows the regression analysis results for cumulative CAR during the green event. Independent variables are listed on the left, with their coefficients in the middle and p-values under it. Positive coefficients indicate a direct relationship, while negative coefficients indicate an inverse one. Statistical significance is marked by stars: * ($p < 0.10$), ** ($p < 0.05$), and *** ($p < 0.01$).

Table 13: Regression Analysis: Foreign Sales and CAR¹⁹

	15.07.2022	25.07.2022
Foreign Sales	0.0326** (0.017)	0.0135 (0.327)
Observations	343	382
R ²	0.213	0.162
Adj. R ²	0.177	0.128
F-stat	5.914	4.279
Industry Fixed Effects	Yes	Yes
Control Variables	Yes	Yes

In contrast, for the green event on July 27, 2022, foreign sales did not significantly impact CAR.

The analysis reveals contrasting effects of foreign sales on CAR during different events related to the IRA. Companies with higher foreign sales were perceived as more stable against negative market reactions during the brown event. It seems that companies with a larger share of foreign sales might be affected more strongly by the IRA. However, this relationship during the green event cannot be confirmed. These findings highlight the importance of considering both international exposure and sector-specific dynamics when assessing the financial impact of the IRA on the European market.

¹⁹ Table 14 shows the regression analysis results for CAR during the green and brown event. The independent variable of interest is the share of foreign sales. P-values in brackets. Statistical significance is marked by stars: * (p < 0.10), ** (p < 0.05), and *** (p < 0.01).

7 Robustness

To validate the reliability of the findings, several robustness tests were conducted. These tests ensure that the results are not influenced by specific model specifications, assumptions, or sample characteristics.

One key robustness check involved reducing the event window to [-5, +3] to focus more precisely on the immediate market reaction to the events. This adjustment aims to isolate the effect of the IRA announcement, ensuring the observed abnormal returns are more likely attributable to the event itself.

The mean-adjusted return model was used to calculate expected returns. This model uses the average return over a pre-event estimation period to estimate expected returns. Additionally, the Generalized Sign test was applied to validate significance, accounting for asymmetric return distributions and mitigating the impact of extreme values.

Table 14: CAAR per Industry – Mean Adjusted – Brown Event²⁰

15.07.2022 - Brown Event - Mean Adjusted						
Days	Industry	CAAR	# of CARs considered	Patell	Cross sectional T	Generalized Sign Z
-5,3	Financials	0.003	100	0.221	0.612	0.908
-5,3	Industrials	0.041	94	6.371***	9.298***	6.242***
-5,3	Utilities	0.025	27	1.677\$	1.638	0.424
-5,3	Consumer Non-Cyclicals	0.007	50	1.107	1.459	2.270*
-5,3	Consumer Cyclicals	0.058	76	7.737***	12.485***	6.407***
-5,3	Technology	0.012	67	0.982	1.36	0.873
-5,3	Real Estate	0.027	39	3.424***	4.071***	3.319***
-5,3	Basic Materials	0.031	53	3.419***	4.071***	2.934**
-5,3	Energy	0	20	-0.455	0.016	0.444
-5,3	Healthcare	0.003	51	0.171	0.466	-0.164

- **Industrials and Consumer Cyclicals:** consistently showed positive CAAR in the initial analyses. Previously, the market saw CAAR of 3.60% and 4.00%, respectively, while the mean-adjusted model showed slightly higher CAAR of 4.1% and 5.8%. This indicates strong investor optimism towards the IRA's impact on these sectors.
- **Real Estate and Basic Materials:** exhibited significant positive CAAR. Real Estate had a CAAR of 4.90% in section 6 compared to 2.7% in the mean-adjusted model. Basic Materials showed a CAAR of 3.80% in section 6 and 3.1% in the robustness tests.

²⁰ Table 15 shows the CAAR for different industries during the brown event using the mean-adjusted model and event window of -5 and +3 days. Statistical significance is marked by stars: * (p < 0.10), ** (p < 0.05), and *** (p < 0.01).

- **Technology and Financials:** Showed neutral or insignificant positive reactions. Technology had a CAAR of 1.30% in section 6 and 1.2% in the mean-adjusted model, while Financials had a CAAR of 0.00% in section 6 and 0.3% in the robustness tests.
- **Utilities, Healthcare and Energy:** Showed deviations. Utilities had an insignificant positive CAAR of 1.30% in section 6 and a marginally significant positive return of 2.5% in the mean-adjusted model. Healthcare showed a negative CAAR of -1.90% in section 6 but an insignificant positive CAAR in the mean-adjusted model. Furthermore, the Energy sector showed a negative return of -2% in the market adjusted model and no significant returns in the robustness test.
- **Consumer Non-Cyclicals:** demonstrated consistent results with insignificant positive CAAR.

Table 15: CAAR per Industry – Mean Adjusted – Green Event²¹

27.07.2022 - Green Event - Mean Adjusted						
Days	Industry	CAAR	# of CARs considered	Patell	Cross sectional T	Generalized Sign Z
-5,3	Financials	0.028	100	4.996***	5.625***	4.299
-5,3	Industrials	0.037	94	6.231***	6.468***	5.013***
-5,3	Utilities	0.01	27	1.527	0.415	1.59
-5,3	Consumer Non-Cyclicals	0.017	50	2.558*	2.548*	3.107**
-5,3	Consumer Cyclicals	0.041	76	5.410***	5.887***	5.007***
-5,3	Technology	0.047	67	4.136	4.356	2.357*
-5,3	Real Estate	0.048	39	5.761***	7.712***	4.263
-5,3	Basic Materials	0.03	53	3.728***	4.703	3.782***
-5,3	Energy	0.014	20	0.697	1.466	1.338
-5,3	Healthcare	0.004	51	-0.61	0.329	0.683

- **Industrials and Consumer Cyclicals:** consistently showed positive CAAR. Section 6 reported CAAR of 3.60% and 4.00%, respectively, while the mean-adjusted model showed 3.70% and 1.70%.
- **Real Estate and Basic Materials:** showed similar trends. Real Estate had a CAAR of 4.90% in Section 6 and 4.80% in the mean-adjusted model. Basic Materials had a CAAR of 3.80% in Section 6 and 3.00% in the mean-adjusted model.
- **Financials and Technology:** showed positive reactions with varying significance. Financials had a CAAR of 0.00% in Section 6 and 2.80% in the mean-adjusted model. Technology had a CAAR of 1.30% in Section 6 and 4.70% in the mean-adjusted model.

²¹ Table 15 shows the CAAR for different industries during the brown event using the mean-adjusted model and event window of -5 and +3 days. Statistical significance is marked by stars: * (p < 0.10), ** (p < 0.05), and *** (p < 0.01).

- **Utilities:** showed a weak positive reaction. Utilities had an insignificant positive CAAR of 1.30% in Section 6 and 1.00% in the mean-adjusted model.
- **Healthcare and Energy:** showed notable deviations. Healthcare had a negative CAAR of -1.90% in Section 6 but an insignificant positive in the mean-adjusted model. Energy showed a CAAR of 1.7%, but in the robustness test no significant result.

Overall, the comparison between Section 6 and the mean-adjusted robustness tests reveals both consistencies and differences in market reactions. Most sectors, including Industrials, Consumer Cyclical, Real Estate, and Basic Materials, consistently showed positive CAAR, reflecting robust investor optimism.

7.1 Robustness test of the regression analysis

The regression analysis of the IRA announcements on 15.07.2022 and 27.07.2022 highlights the effect of GHG emissions on the CAR. In this robustness test, the same analysis was conducted by only changing the CAR, which has been calculated with the mean-adjusted model and changed event window as presented previously.

Table 16: Regression Analysis – Brown Event – Mean Adjusted Model²²

	15.07.2022 - Mean Adjusted - Brown Event					
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Sales						0.0002*** (0.008)
Environmental Pillar Score					0.0159 (0.6180)	
Intensity				0.00003* (0.087)		
Log(Scope2)			0.0048* (0.060)			
Log(Scope 1)		-0.0008 (0.797)				
Log (Total Emissions)	0.0012 (0.741)					
Observations	430	430	430	430	430	430
R ²	0.135	0.135	0.142	0.141	0.135	0.149
Adj. R ²	0.103	0.104	0.111	0.11	0.104	0.118
F-Stat	4.289	4.359	4.627	4.581	4.355	4.828
Industry Fixed Effects	YES	YES	YES	YES	YES	YES
Control Variables	YES	YES	YES	YES	YES	YES

Brown Event

Both Section 6 and the robustness tests found that foreign sales positively impacted CAR. The robustness tests demonstrated a significant positive relationship, indicating that firms with higher foreign sales experienced higher abnormal returns.

The robustness tests found a significant positive relationship between carbon intensity and CAR, contrasting with Section 6's generally negative impact. This suggests that during the brown event, higher carbon intensity was perceived more favorably. Furthermore, the robustness test confirmed a significant positive relationship for Log (Scope 2 Emissions), implying that higher indirect emissions were perceived positively, reflecting transparency or cleaner energy investments, which was not indicated in Section 6.

²² This table shows the regression results for the brown event. The dependent variables represent the CAR, calculated over the shorter event window with the mean adjusted model. Independent variables are listed on the left, with their coefficients in the middle and p-values in brackets. Significance levels as previously defined.

Table 17: Regression Analysis – Green Event – Mean Adjusted Model²³

	27.07.2022 - Mean Adjusted - Green Event					
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Sales						0.0145 (0.146)
Environmental Pillar Score					-0.0005*** (0.002)	
Intensity				-0.00001*** (0.001)		
Log(Scope2)			-0.0041 (0.287)			
Log(Scope 1)		-0.0013 (0.732)				
Log (Total Emissions)	-0.0048 (0.252)					
Observations	440	440	440	440	440	440
R ²	0.171	0.168	0.17	0.235	0.186	0.172
Adj. R ²	0.141	0.139	0.141	0.208	0.157	0.143
F-Stat	5.812	5.716	5.797	8.681	6.458	5.877
Industry Fixed Effects	YES	YES	YES	YES	YES	YES
Control Variables	YES	YES	YES	YES	YES	YES

Green Event

In both section 6 and the robustness tests, foreign sales did not significantly impact CAR. This indicates that international exposure was not a strong determinant of market reaction. Carbon intensity showed a significant negative impact on CAR, with the robustness tests confirming this relationship (coefficient of -0.00001, p-value < 0.01). Furthermore, we can see a significant negative relationship between the environmental pillar score and CAR. This is the same finding as in section 6.

7.2 Discussion of the robustness test

This section will describe the robustness test performed, which is introduced to validate the key findings of this thesis. It is important to understand that although robustness tests are essential for confirming the accuracy of empirical findings, they do not provide the ultimate evaluation of an analysis's accuracy. The different findings between the main analysis and the robustness do not change the key findings of the study.

²³ This table shows the regression results for the brown event. The dependent variables represent the CAR, calculated over the shorter event window with the mean adjusted model. Independent variables are listed on the left, with their coefficients in the middle and p-values in brackets. Significance levels as previously defined.

Robustness tests are conducted to assess the stability of results. They often use different model specifications and different samples. These tests often change parameters or other methodological techniques that may not be completely in line with the main analytical framework. Consequently, differences in the outcomes of robustness tests are expected and do not inherently indicate a flaw in the primary analysis. Rather, it provides a broader perspective on the data. The main model used in this analysis was chosen because it aligns with the research aims both theoretically and empirically. The market model and the event window were specifically chosen to capture the market reactions to the IRA announcements. While the robustness test applied a different event window and mean adjusted model, the primary model remains the best fit for the research questions addressed. The robustness test narrowed down the event window to [-5, +3] days in order to capture the immediate market response to the IRA announcement. The narrow focus of this approach can improve accuracy but may overlook more general trends and investor behaviors that are included in the original, slightly longer time frame. The main analysis offers a deeper understanding of the market's reaction, which is essential for understanding the whole influence of the IRA. In conclusion, while the robustness test provides valuable additional insights, it does not reduce the validity of the primary analysis. The differences observed are expected given the alternative specifications and should be seen as an enrichment rather than a contradiction of the findings. The primary analysis, with its chosen models and approach, offers a reliable and valid assessment of the IRA's impact on the European stock market.

8 Summary of results

In this section, the main findings from the empirical analysis of the impact of the IRA on the Euro Stoxx 600 are summarized. This includes answering the hypotheses proposed in the earlier sections.

Hypothesis 1: The green and brown event will result in varying CAR across different sectors.

The research revealed significant differences in market reactions across sectors during both events. Significant negative abnormal returns during the brown event can be seen in the energy sector, which indicates that investors are concerned about the potential long-term effects of not implementing the IRA. Investors may fear continued regulatory challenges and uncertainty for the sector. In contrast, the analysis showed positive abnormal returns during the green event for the energy sector. It is likely that investors viewed the provisions of the IRA, such as subsidies for clean energy technologies, as favorable for the sector's long-term growth and regulatory stability. During the Brown event, the healthcare sector experienced positive abnormal returns. This indicates that investors had a favorable outlook regarding the decision to not implement the IRA. Conversely, during the green event, the healthcare industry experienced significant negative returns. The negative investor sentiment was likely influenced by investor concerns about the regulatory consequences of the IRA, which could include changes to Medicare and associated financial burdens, likely influenced the negative investor sentiment. Overall, the industrial and consumer cyclical sectors showed strong positive abnormal returns during both events, but higher CAAR during the brown event. This indicates that investors viewed the rejection of the IRA positively. However, it seems that the implemented version of the IRA does not impose harm to the sectors as initially expected. The real estate sector exhibited strong positive reactions during the green event. This could be related to incentives for green building and infrastructure.

Hypothesis 2: Companies with high GHG emissions encounter abnormal returns following the IRA's Implementation.

The empirical analysis supports Hypothesis 2, indicating that firms with high GHG emissions experienced significant abnormal returns following the implementation of the IRA. During the Brown Event, firms with higher Scope 1 and total emissions experienced statistically significant negative abnormal returns. This suggests that investors perceive firms with higher emissions as more vulnerable to potential regulatory costs. This trend continued during the green event,

where high levels of greenhouse gas emissions were associated with lower levels of abnormal returns. This is an indication of investors' concerns about the financial impact of environmental regulations.

In the Brown event, the rejection of the proposal initially raised investor concerns that the absence of new legislation would prolong uncertainty and potential future regulatory pressure on high emitting companies. However, during the green event, the investors probably expected that these firms would face increased regulatory burdens and costs because of stricter environmental policies. In both cases, investors likely anticipated that companies with significant GHG emissions would incur higher costs, leading to a negative adjustment in their valuations. This consistent market reaction highlights the increasing importance of investors considering the financial risks associated with high emissions.

Hypothesis 3: Companies with substantial foreign sales experience abnormal returns.

The empirical analysis provides a nuanced understanding of Hypothesis 3, particularly considering the trade barriers included in the IRA. During the brown event, which involved the rejection of the IRA, firms with higher proportions of foreign sales experienced positive abnormal returns. This suggests that investors viewed the rejection of the IRA — and by extension, the rejection of its potential trade barriers — as a relief for companies with significant international exposure. Without the restrictive trade provisions, these firms were seen as less likely to face competitive disadvantages in the US market, leading to a positive adjustment in their valuations. However, the green event, which marked the passage of the IRA, showed that foreign sales did not significantly impact CAR. Once the IRA was enacted, the initial concerns about trade barriers may have been overshadowed. The market might have focused on other aspects of the legislation, such as the subsidies for domestic clean energy production and stricter environmental regulations. These provisions were more directly relevant to companies based on their sector and operational focus, rather than their geographical distribution of sales. As a result, the protective effect of foreign sales observed during the brown event did not carry over once the IRA was passed.

This contrast in market reactions indicates that while the rejection of trade barriers initially benefited firms with substantial foreign sales, this factor became less relevant when the legislation was eventually implemented. The passage of the IRA likely shifted investor attention toward the specific sectoral impacts of the law.

9 Limitations and avenues for future research

While the study provides valuable insights, it is not without limitations. The choice of event windows could affect the results. Different windows could yield slightly different results. Data limitations, particularly for companies with incomplete or less accurate data, could affect the results. In addition, the study focuses on the IRA but does not fully account for overlapping events during the event window that could influence market reactions. The event study methodology and regression models rely on certain assumptions that, if violated, could affect the validity of the results.

The findings of this paper open up several avenues for future research. Extending the analysis to a longer time frame could capture the long-term effects of the IRA on European and other global markets, providing insights into how sustained legislative changes influence market dynamics over time. Examining the impact of the IRA on other regions outside of Europe would provide a more comprehensive understanding of its international impact. Further research could also examine the comparative impact of similar climate policies in different countries, providing valuable insights into the effectiveness of different legislative approaches. Another promising area of research could be to examine how different types of investors, such as institutional versus retail investors, respond to climate legislation, shedding light on market dynamics and investment strategies. Finally, the role of corporate governance and its influence on how companies respond to such regulatory changes could be explored, particularly in the context of managing transition risks and aligning with sustainability goals.

10 Conclusion

The empirical analysis of the IRA on the Euro Stoxx 600 has revealed important observations regarding the impact of major US legislative policies on European financial markets. The study examines the impact on different sectors and firm characteristics. The results show the broader economic impact of the IRA. The analysis shows that the market reaction to the IRA varied significantly across sectors. For example, the energy sector experienced negative abnormal returns during the brown event and positive abnormal returns during the green event. This suggests that investors initially feared that the absence of the IRA would lead to uncertainty and regulatory challenges for the energy sector. However, the green event of the IRA, with its substantial subsidies for clean energy, was viewed positively. This signals potential long-term growth and stability for the sector. The healthcare sector showed positive abnormal returns during the brown event and significant negative returns during the green event. This shows that investors initially welcomed the rejection of the IRA. This may have been related to concerns about the regulatory burden and cost pressures that would have resulted from the policy. Once the IRA was nearly passed, these concerns materialized, and negative market reactions can be seen. Investors anticipated higher costs for healthcare companies.

The study also confirmed that high GHG emitting firms faced significant negative abnormal returns after both the brown and green event. During the brown event, investors perceived that the rejection of the IRA would not protect high-emitting firms from future regulatory costs. Similarly, during the green event, investors are concerned about the financial impact of stricter environmental regulations on high-emitting companies. This consistent market reaction highlights the growing importance of ESG factors in investment decisions and the financial risks associated with GHG emissions. Furthermore, the analysis of companies with substantial foreign sales provided mixed results. During the brown event, investors likely saw the rejection of the IRA and its associated trade barriers as beneficial, leading firms with higher proportions of foreign sales to experience positive abnormal returns. However, in the green event, the IRA did not show a significant impact of foreign sales on CAR. This shift suggests that the rejection of trade barriers initially provided relief to firms with significant international exposure. However, sector-specific impacts became more prominent in determining market reactions during the green event.

11 Appendix

Table 18: Descriptive statistics for the control variables – Brown Event

	Log(Revenues)	ROE	Leverage	Log(Size)	Operating Margin
mean	7.01	0.13	115.64	4.17	14.73
std	0.71	0.28	137.47	0.58	35.17
min	4.93	-3.60	0.00	2.85	-515.46
25%	6.54	0.07	38.65	3.73	7.37
50%	7.05	0.13	71.49	4.12	14.00
75%	7.48	0.21	130.80	4.56	23.47
max	8.76	2.82	1071.47	6.16	164.66

Table 19: Descriptive statistics of the Independent Variables – Green Event

	CAR	Log(Total Emissions)	Log(Scope 1)	Log(Scope 2)	Intensity	Environmental Pillar Score
mean	0.02	5.11	4.67	4.67	237.30	70.60
std	0.07	1.15	1.34	1.04	1392.59	18.55
min	-0.41	1.88	-0.10	0.95	0.00	2.52
25%	-0.02	4.35	3.76	3.99	1.49	60.18
50%	0.03	5.09	4.67	4.73	7.13	73.78
75%	0.06	5.75	5.44	5.36	52.71	84.94
max	0.27	8.08	8.05	7.34	3232.93	98.42

Table 20: Descriptive statistics of the Control Variables – Green Event

	Log(Revenues)	ROE	Leverage	Log(Size)	Operating Margin
mean	7.034543221	0.12	121.41	4.18	15.47
std	0.666635291	0.53	218.89	0.58	17.31
min	5.187802639	-9.80	-891.31	2.89	-159.50
25%	6.580651158	0.07	39.21	3.73	7.27
50%	7.051837724	0.13	72.93	4.13	13.78
75%	7.474168111	0.21	131.96	4.57	22.40
max	8.760402152	2.82	3777.05	6.17	84.03

Figure 9: Distribution of CAR - Green Event

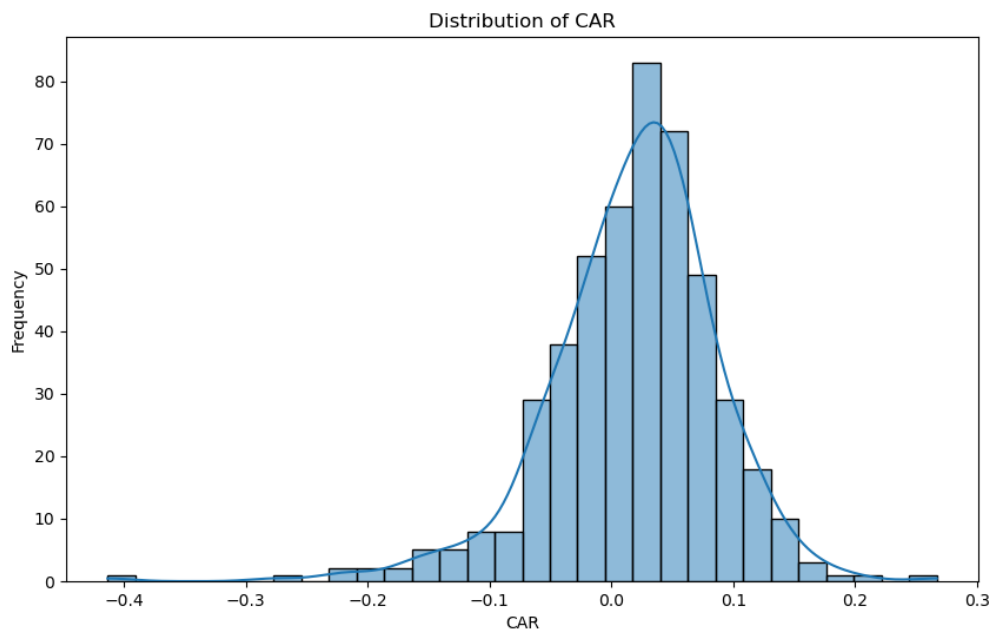


Table 21: AAR for the brown event – market model²⁴

		AAR Values													
		AAR (-10)	AAR (-9)	AAR (-8)	AAR (-7)	AAR (-6)	AAR (-5)	AAR (-4)	AAR (-3)	AAR (-2)	AAR (-1)	AAR (0)	AAR (1)	AAR (2)	AAR (3)
Financials	AAR	-0.40%	0.00%	-3.60%	0.50%	2.00%	1.30%	-1.20%	1.30%	-1.10%	-2.50%	0.60%	1.80%	1.10%	-0.90%
	Patell Z	-1.521	0.877	-19.927***	3.763***	10.814***	6.824***	-6.089***	7.999***	-5.931***	-13.466***	2.429*	9.185***	5.408***	-4.907***
	CsectT	-2.490*	0.221	-18.888***	2.129*	12.881***	8.683***	-9.738***	5.288***	-9.288***	-9.596***	3.409***	8.216***	6.717***	-7.330***
Industrials	AAR	0.40%	0.20%	-2.60%	1.70%	2.10%	1.20%	-1.30%	1.90%	-0.90%	-0.70%	1.70%	1.50%	1.00%	-0.40%
	Patell Z	1.837\$	1.588	-13.053***	8.412***	10.336***	6.026***	-6.353***	9.217***	-4.405	-3.472***	8.605***	7.585***	5.004***	-1.824\$
	CsectT	2.445*	1.804\$	-10.242***	10.037***	12.452***	9.466***	-8.518***	12.406***	-6.976***	-3.653***	8.428***	11.664***	6.316***	-1.893\$
Utilities	AAR	2.70%	-1.60%	-2.70%	0.50%	1.10%	0.50%	0.40%	0.60%	-0.20%	-1.80%	0.70%	1.50%	1.40%	-0.70%
	Patell Z	7.838***	-3.323***	-7.795***	1.294	2.665**	0.711	2.236*	1.472	-0.84	-5.358***	1.618	4.456***	3.637***	-3.179**
	CsectT	5.258	-1.292	-5.059	0.941	3.212**	1.293	0.564	1.846\$	-0.556	-4.390***	2.047\$	2.765*	2.432*	-1.358
Non-Cyclicals	AAR	0.90%	0.50%	-0.50%	1.30%	-0.20%	0.40%	0.00%	0.70%	-0.50%	-0.90%	0.70%	0.70%	0.60%	-1.00%
	Patell Z	3.667***	2.459*	-2.446*	5.916***	-1.53	1.799\$	0.299	3.203**	-2.107*	-4.267	3.125**	2.925**	2.925**	-4.440***
	CsectT	4.922	2.295*	-2.121*	5.773***	-0.701	1.878\$	0.206	4.313***	-2.204*	-7.952***	3.230**	4.557	3.475**	-3.964***
Consumer Cyclicals	AAR	0.20%	-0.40%	-2.30%	1.90%	1.50%	1.60%	-1.30%	1.90%	-0.60%	-1.00%	1.50%	2.50%	1.30%	0.00%
	Patell Z	0.569	-1.23	-9.372***	7.987***	5.697***	6.182***	-4.595***	8.047***	-2.242*	-3.982***	6.301***	9.863***	5.348***	-0.156
	CsectT	1.255	-1.765\$	-8.384***	5.951***	5.417***	8.008***	-5.535***	11.642***	-4.101**	-5.123***	5.419***	13.692***	6.729***	-0.004
Technology	AAR	-0.20%	-0.80%	-1.80%	2.20%	1.40%	1.10%	-1.50%	0.70%	-0.70%	-1.50%	0.80%	2.00%	-0.30%	0.60%
	Patell Z	-0.982	-1.981*	-7.124***	7.925***	5.221***	4.194	-4.529***	3.654***	-2.767**	-5.965***	3.356***	6.495***	-1.26	0.698
	CsectT	-0.682	-2.637*	-6.439***	5.998***	5.098***	6.047***	-3.006**	2.699**	-3.712***	-5.588***	2.551*	5.649***	-1.468	2.260*
Real Estate	AAR	0.30%	-3.20%	0.50%	2.50%	1.30%	-0.30%	-0.60%	1.20%	0.00%	-2.30%	2.20%	1.80%	0.60%	0.00%
	Patell Z	0.676	-11.852***	2.298*	9.579***	4.514**	-1.107	-2.653**	4.411	0.22	-8.029***	8.478***	6.450***	2.231*	0.409
	CsectT	1.045	-5.437***	1.489	8.610***	5.969***	-0.715	-2.067*	3.785***	-0.088	-4.301***	8.142***	5.761***	3.380**	0.134
Basic Materials	AAR	-0.90%	1.00%	-3.70%	0.90%	2.80%	1.20%	-1.70%	1.00%	-0.80%	-1.60%	1.40%	2.10%	1.90%	-0.30%
	Patell Z	-3.291***	3.954***	-13.797***	4.092	9.828***	4.450***	-5.911***	3.896***	-3.394***	-6.165***	6.207***	7.626***	5.772***	-1.397
	CsectT	-3.922***	6.642***	-8.703***	4.219***	8.818***	4.911***	-6.488***	4.211***	-2.713**	-5.859***	6.224***	9.677***	3.645***	-1.51
Energy	AAR	-1.30%	2.70%	-4.70%	-1.80%	3.00%	1.20%	-0.50%	-1.10%	-0.30%	-3.40%	1.40%	2.80%	0.40%	-0.30%
	Patell Z	-2.649**	5.775***	-11.028***	-3.963***	5.994***	2.321*	-1.347	-2.453*	-0.636	-7.942***	3.325***	5.832***	1.018	-1.147
	CsectT	-2.728*	7.573***	-6.640***	-4.068***	5.209	2.588*	-1.740\$	-2.479*	-1.209	-10.388***	3.899***	9.931***	1.729	-0.926
Healthcare	AAR	0.80%	0.20%	0.10%	1.70%	-0.20%	0.70%	-0.10%	-0.70%	0.10%	-1.00%	1.60%	-0.20%	0.30%	-0.60%
	Patell Z	2.804**	1.097	-0.28	6.392***	-1.204	2.316*	0.09	-2.292*	0.009	-3.575***	6.311***	-0.962	1.055	-2.783**
	CsectT	2.991**	0.906	0.375	5.067***	-1.043	2.897**	-0.382	-2.686**	0.492	-3.957***	10.032***	-0.74	1.081	-2.727**

²⁴ Table 19 presents the AAR, calculated with the market model, for the brown event across different sectors within the Euro Stoxx 600 index. The table summarizes the AAR over the event window surrounding the July 15, 2022, rejection of the Inflation Reduction Act (IRA) proposal. Positive AAR indicate sectors that experienced abnormal gains due to market reactions, while negative AAR suggest a decline in investor confidence. Statistical significance is indicated by stars: * for p < 0.10, ** for p < 0.05, and *** for p < 0.01, denoting varying levels of confidence in the results."

Table 22: AAR for the green event – market model²⁵

		AAR Values													
		AAR (-10)	AAR (-9)	AAR (-8)	AAR (-7)	AAR (-6)	AAR (-5)	AAR (-4)	AAR (-3)	AAR (-2)	AAR (-1)	AAR (0)	AAR (1)	AAR (2)	AAR (3)
Financials	AAR	-1.10%	-2.50%	0.50%	1.80%	1.10%	-0.90%	0.20%	-0.10%	0.70%	-1.30%	0.40%	-0.50%	1.60%	0.10%
	Patell Z	-5.873***	-13.401***	2.307*	9.091***	5.239***	-4.982***	1.096	0.211	3.421***	-6.566***	1.604	-1.894\$	8.835***	0.192
	CsectT	-9.292***	-9.597***	3.316**	8.235***	6.576***	-7.484***	0.706	-0.414	5.360***	-7.328***	2.929**	-1.639	11.228***	0.418
Industrials	AAR	-0.009	-0.006	0.016	0.016	0.01	-0.40%	-0.10%	0.90%	-0.50%	-1.20%	0.10%	0.70%	1.60%	-0.30%
	Patell Z	-4.323	-3.427***	8.438***	7.60***	4.779***	-1.956\$	-0.051	4.701***	-2.666**	-5.731***	0.334	3.974***	8.316***	-1.336
	CsectT	-6.801***	-3.591***	8.292***	11.841***	6.108***	-2.002*	-0.591	6.317***	-3.337**	-6.169***	0.765	2.896**	7.130***	-1.636
Utilities	AAR	-0.20%	-1.80%	0.80%	1.50%	1.50%	-0.70%	-1.90%	0.40%	-0.10%	0.30%	0.10%	0.50%	0.80%	0.20%
	Patell Z	-0.79	-5.254***	1.798\$	4.365	3.787***	-2.981**	-5.540***	3.081**	-0.021	1.228	0.016	1.399	2.893**	0.198
	CsectT	-0.527	-4.362***	2.178*	2.791**	2.510*	-1.284	-4.328***	0.305	-0.118	0.434	0.246	1.124	3.337**	0.597
Non-Cyclicals	AAR	-0.005	-0.009	0.007	0.007	0.006	-1.00%	-0.30%	1.00%	0.50%	-0.80%	0.30%	-0.60%	0.70%	0.10%
	Patell Z	-2.064*	-4.235	3.044**	2.931**	2.823**	-4.415	-0.202	4.033***	2.295*	-2.472*	0.727	-2.729**	2.905**	0.204
	CsectT	-2.196*	-7.979***	3.204**	4.59	3.369**	-4.042***	-0.656	5.766***	4.146***	-2.589*	1.231	-2.599*	3.524***	0.539
Consumer Cyclical	AAR	-0.60%	-1.00%	1.40%	2.50%	1.20%	-0.10%	-0.30%	1.10%	-0.40%	-2.70%	0.10%	0.30%	1.60%	0.80%
	Patell Z	-2.194*	-3.941***	6.052***	9.767***	4.975***	-0.386	-0.383	4.525***	-1.355	-11.108***	0.098	1.495	6.266***	3.037**
	CsectT	-4.10***	-5.113***	5.224***	13.745***	6.279***	-0.325	-1.034	6.920***	-1.917\$	-11.232***	0.356	1.097	4.964***	3.452***
Technology	AAR	-0.70%	-1.50%	0.80%	2.00%	-0.30%	0.60%	0.00%	1.20%	-0.70%	-2.00%	1.00%	-1.10%	1.40%	0.60%
	Patell Z	-2.718**	-5.910***	3.260**	6.466***	-1.329	0.623	0.291	2.987**	-1.716\$	-6.930***	2.527*	-4.191	5.320***	1.870\$
	CsectT	-3.667***	-5.588***	2.486*	5.673***	-1.606	2.243*	0.056	3.079**	-2.569*	-6.815***	2.766**	-3.996***	4.890***	2.920**
Real Estate	AAR	0.00%	-2.30%	2.20%	1.80%	0.60%	0.00%	-0.60%	4.20%	-1.00%	-1.50%	-1.30%	1.60%	2.10%	-0.90%
	Patell Z	0.271	-7.796***	8.334***	6.463***	2.155*	0.262	-2.096*	16.163***	-3.906***	-5.745***	-5.808***	6.189***	7.702***	-3.526***
	CsectT	0	-4.274***	8.163***	5.825***	3.266**	0.133	-3.018**	16.954***	-5.422***	-5.522***	-4.229***	5.986***	8.161***	-3.413**
Basic Materials	AAR	-0.80%	-1.60%	1.40%	2.10%	1.80%	-0.30%	-0.70%	-0.20%	0.10%	-1.10%	0.40%	1.10%	1.90%	-0.20%
	Patell Z	-3.40***	-6.161***	6.071***	7.577***	5.618***	-1.483	-1.708\$	-1.568	0.139	-4.278	1.367	4.278	7.199***	-0.956
	CsectT	-2.716**	-5.882***	6.137***	9.675***	3.580***	-1.609	-2.113*	-0.531	0.504	-4.961***	1.808\$	4.6	9.558***	-1.356
Energy	AAR	-0.40%	-3.40%	1.40%	2.80%	0.40%	-0.30%	-2.20%	1.40%	0.90%	-0.20%	0.40%	0.00%	2.20%	-1.20%
	Patell Z	-0.655	-7.915***	3.268**	5.773***	0.978	-1.173	-4.546***	2.851**	1.902\$	-0.097	1.038	-0.836	4.892***	-2.790**
	CsectT	-1.275	-10.503***	3.874***	9.915***	1.668	-0.996	-6.138***	4.355***	3.177**	-0.4	1.272	0.042	6.397***	-4.091***
Healthcare	AAR	0.20%	-0.90%	1.60%	-0.20%	0.30%	-0.60%	0.60%	0.40%	-1.40%	0.20%	-0.50%	-1.40%	-0.20%	0.00%
	Patell Z	0.083	-3.499***	6.308***	-0.872	1.1	-2.737**	2.125*	1.005	-4.307	0.871	-2.870**	-5.222***	-1.126	-0.44
	CsectT	0.605	-3.870***	10.132***	-0.663	1.082	-2.718**	1.761\$	1.282	-4.446	0.78	-1.707\$	-2.261*	-0.676	0.157

²⁵ Table 19 presents the AAR, calculated with the market model, for the green event across different sectors within the Euro Stoxx 600 index. The table summarizes the AAR over the event window surrounding the July 27, 2022. Positive AAR indicate sectors that experienced abnormal gains due to market reactions, while negative AAR suggest a decline in investor confidence. Statistical significance is indicated by stars: * for p < 0.10, ** for p < 0.05, and *** for p < 0.01, denoting varying levels of confidence in the results."

Table 23: Regression Analysis: Green and Brown Event – Full Table - Market Model²⁶

	Brown Event (15.07.2022)					Green Event (27.07.2022)				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Environment Pillar Score					-0.0002 (0.187)					-0.0003* (0.0930)
Intensity				0.00001434 (0.466)					-0.00001*** (0.0000)	
Log(Scope2)			0.0006 (0.847)					-0.0007 (0.8730)		
Log(Scope 1)		-0.0078** (0.043)					-0.0007 (0.8540)			
Log(Total Emissions)	-0.0087** (0.045)					-0.0019 (0.6630)				
Log(Sales)	0.0061 (0.511)	0.0057 (0.535)	-0.005 (0.557)	-0.0028 (0.725)	-0.0021 (0.787)	-0.0217** (0.0240)	-0.0230** (0.0160)	-0.0233*** (0.0100)	-0.0126 (0.127)	-0.0208** (0.0130)
ROE	0.0214* (0.082)	0.0223* (0.07)	0.0214* (0.084)	0.0209* (0.091)	0.0225* (0.069)	0.0001 (0.9860)	0.0002 (0.9790)	0.0001 (0.9830)	-0.0074 (0.229)	0.0001 (0.9860)
Leverage	-0.00003265 (0.191)	-0.00003594 (0.148)	-0.00003675 (0.142)	-0.0000364 (0.145)	-0.00003221 (0.201)	-0.0032** (0.0310)	-0.0032** (0.0280)	-0.0032** (0.0290)	-0.0029* (0.045)	-0.0033** (0.0270)
Log(Size)	-0.0007 (0.934)	-0.0014 (0.875)	0.0001 (0.631)	0.0019 (0.83)	0.0041 (0.626)	0.0116 (0.2120)	0.0120 (0.1980)	0.0123 (0.1760)	0.0005 (0.952)	0.0128 (0.1550)
Operating margin	-0.00008962 (0.35)	-0.00009947 (0.296)	-0.0001 (0.201)	0.00004958 (0.717)	-0.0001 (0.245)	0.0001 (0.6660)	0.0001 (0.6740)	0.0001 (0.6730)	0.0002 (0.353)	0.0001 (0.6320)
Industry_Consumer Cyclical	0.0225 (0.112)	0.022 (0.122)	0.0335** (0.011)	0.0335** (0.011)	0.0331** (0.012)	-0.0005 (0.9690)	0.0007 (0.9580)	0.0010 (0.9380)	-0.0057 (0.643)	0.0019 (0.8780)
Industry_Consumer Non-Cyclic	-0.0081 (0.594)	-0.0072 (0.632)	-0.0005 (0.973)	-0.0002 (0.987)	-0.0017 (0.907)	-0.0306** (0.0320)	-0.0296** (0.0370)	-0.0295** (0.0370)	-0.0363*** (0.007)	-0.0293** (0.0340)
Industry_Energy	-0.043** (0.035)	-0.0417** (0.041)	-0.0404** (0.049)	-0.0029** (0.046)	-0.0417** (0.041)	-0.0188 (0.3350)	-0.0185 (0.3430)	-0.0189 (0.3380)	-0.0265 (0.165)	-0.0194 (0.3190)
Industry_Financials	-0.0584*** (0.0)	-0.0589*** (0.0)	-0.038*** (0.008)	-0.0029*** (0.003)	-0.0407*** (0.002)	-0.0457*** (0.0040)	-0.0434*** (0.0060)	-0.0428*** (0.0030)	-0.0514*** (0.000)	-0.0424*** (0.0010)
Industry_Healthcare	-0.0003 (0.984)	-0.0001 (0.994)	0.0083 (0.584)	-0.0029 (0.573)	0.007 (0.643)	-0.0632*** (0.0000)	-0.0621*** (0.0000)	-0.0619*** (0.0000)	-0.0673*** (0.000)	-0.0620*** (0.0000)
Industry_Industrials	0.0234* (0.081)	0.0239* (0.073)	0.0322** (0.012)	-0.0029** (0.011)	0.0299** (0.02)	-0.0009 (0.9450)	0.0003 (0.9830)	0.0004 (0.9760)	-0.0062 (0.600)	-0.0006 (0.9580)
Industry_Real Estate	0.0084 (0.644)	0.0066 (0.721)	0.0182 (0.311)	-0.0029 (0.356)	0.018 (0.311)	0.0077 (0.6990)	0.0087 (0.6640)	0.0092 (0.6390)	0.0034 (0.855)	0.0098 (0.6090)
Industry_Technology	-0.0198 (0.19)	-0.0224 (0.152)	-0.0064 (0.65)	-0.0029 (0.629)	-0.0104 (0.456)	-0.0320*** (0.0300)	-0.0307** (0.0440)	-0.0300** (0.0330)	-0.0353*** (0.007)	-0.0321** (0.0180)
Industry_Utilities	-0.0011 (0.95)	-0.0005 (0.976)	-0.0028 (0.869)	-0.0029 (0.866)	-0.0033 (0.849)	-0.0349*** (0.0360)	-0.0352** (0.0340)	-0.0356** (0.0320)	-0.0277* (0.087)	-0.0353** (0.0330)
const	0.042 (0.277)	0.0404 (0.296)	0.0434 (0.264)	0.04 (0.307)	0.0456 (0.241)	0.1566*** (0.0000)	0.1561*** (0.0000)	0.1565*** (0.0000)	0.1346*** (0.000)	0.1550*** (0.0000)
Observation	436	436	436	436	436	480	480	480	480	480
R ²	0.175	0.175	0.167	0.168	0.17	0.144	0.144	0.144	0.19	0.149
adj. R2	0.145	0.145	0.137	0.138	0.14	0.116	0.116	0.116	0.163	0.121
F-stat	5.922	5.93	5.603	5.643	5.74	5.196	5.184	5.184	7.24	5.402
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

²⁶ Table 21 presents the results of the regression analysis for the green and brown event using the Market Model. The table includes key variables such as Log (Scope 1 Emissions), Log(Scope 2 Emissions), and Log(Total Emissions), and control variables. Each variable's coefficient is displayed alongside its corresponding p-value, and significance level, with statistical significance indicated by * (p < 0.10), ** (p < 0.05), and *** (p < 0.01). The results highlight the impact of these environmental and financial metrics on cumulative abnormal returns (CAR) during the events.

Table 24: Regression Analysis: Foreign Sales and CAR – Full Table²⁷

	15.07.2022	25.07.2022
Foreign Sales	0.0326** (0.017)	0.0135 (0.327)
Log(Revenues)	-0.002 (0.819)	-0.0253*** (0.006)
ROE	0.0387*** (0.002)	0.0007 (0.916)
Leverage	-0.00002008 (0.479)	-0.0041** (0.012)
Log(Size)	-0.0018 (0.848)	0.0099*** (0.33)
Operating Margin	-0.00007406 (0.732)	0.0003 (0.243)
Industry_Consumer Cyclical	0.0343** (0.011)	-0.0028 (0.836)
Industry_Consumer Non-Cyclical	0.0015 (0.921)	-0.0239 (0.117)
Industry_Energy	-0.0503** (0.021)	-0.0043 (0.849)
Industry_Financials	-0.0286* (0.052)	-0.0297** (0.046)
Industry_Healthcare	0.0054 (0.731)	-0.0705*** (0.000)
Industry_Industrials	0.0291** (0.025)	0.0009 (0.945)
Industry_Real Estate	0.0138 (0.526)	0.0417 (0.194)
Industry_Technology	-0.0231 (0.11)	-0.0406*** (0.008)
Industry_Utilities	0.0159 (0.392)	-0.0313 (0.102)
const	0.0228 (0.612)	0.1666 (0.000)
Observations	343	382
R ²	0.213	0.162
Adj. R ²	0.177	0.128
F-stat	5.914	4.279
Industry Fixed Effects	Yes	Yes
Control Variables	Yes	Yes

²⁷ Table 22 presents the results of the regression analysis examining the impact of foreign sales on cumulative abnormal returns (CAR) during the brown and green events associated with the IRA. The table includes coefficients for key variables, such as Foreign Sales (%), and control variables. Statistical significance is denoted by * (p < 0.10), ** (p < 0.05), and *** (p < 0.01).

Table 25 Regression Analysis: Green and Brown Event – Mean Adjusted Model²⁸

	15.07.2022 - Mean Adjusted - Brown Event						27.07.2022 - Mean Adjusted - Green Event					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Sales						0.0002*** (0.008)						0.0145 (0.146)
Environmental Pillar Score					0.0159 (0.6180)						-0.0005*** (0.002)	
Intensity				0.00003* (0.087)					-0.00001*** (0.001)			
Log(Scope2)			0.0048* (0.060)						-0.0041 (0.287)			
Log(Scope 1)		-0.0008 (0.797)							-0.0013 (0.732)			
Log (Total Emissions)	0.0012 (0.741)						-0.0048 (0.252)					
Log(Revenues)	0.0103 (0.177)	0.0131* (0.083)	0.0069 (0.318)	0.0149** (0.023)	0.0119* (0.067)	0.0112 (0.074)	-0.0446*** (0.001)	-0.0484*** (0.001)	-0.0462*** (0.001)	-0.0371*** (0.0001)	-0.0454*** (0.002)	-0.0502*** (0.003)
ROE	-0.0034 (0.739)	-0.003 (0.767)	-0.0031 (0.759)	-0.004 (0.693)	-0.0032 (0.7540)	-0.0014 (0.892)	0.0017 (0.768)	0.0018 (0.753)	0.0017 (0.767)	-0.0065 (0.254)	0.0016 (0.777)	0.0019 (0.743)
Leverage	-0.0001 (0.483)	-0.00001 (0.494)	-0.00001 (0.569)	-0.00001 (0.53)	-0.00001 (0.4860)	-0.000006 (0.775)	-0.0024* (0.077)	-0.0025* (0.064)	-0.0024* (0.076)	-0.0022 (0.102)	-0.0026* (0.059)	-0.0027 (0.048)
Log(Size)	-0.0173** (0.016)	-0.0182** (0.012)	-0.0165** (0.017)	-0.0215*** (0.003)	-0.0177 (0.0110)	-0.0195 (0.005)	0.0416*** (0.002)	0.043*** (0.001)	0.0427*** (0.002)	0.0297*** (0.001)	0.0449*** (0.002)	0.0417*** (0.002)
Operating Margin	-0.00004 (0.581)	-0.00002 (0.768)	-0.00003 (0.751)	0.0001 (0.312)	-0.00002609 (0.738)	-0.00006 (0.473)	-0.0001 (0.549)	-0.0001 (0.546)	-0.0001 (0.555)	-0.000008 (0.969)	-0.0001 (0.489)	-0.0001 (0.593)
const.	0.0214 (0.503)	0.0157 (0.622)	0.0159 (0.615)	0.0095 (0.767)	0.00001582 (0.919)	0.0126 (0.693)	0.2132*** (0.002)	0.212*** (0.001)	0.2126*** (0.001)	0.1892*** (0.001)	0.214*** (0.001)	0.2105*** (0.001)
Observations	430	430	430	430	430	430	440	440	440	440	440	440
R ²	0.135	0.135	0.142	0.141	0.135	0.149	0.171	0.168	0.17	0.235	0.186	0.172
Adj. R ²	0.103	0.104	0.111	0.11	0.104	0.118	0.141	0.139	0.141	0.208	0.157	0.143
F-Stat	4.289	4.359	4.627	4.581	4.355	4.828	5.812	5.716	5.797	8.681	6.458	5.877
Industry Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

²⁸ Table 23 presents the results of the regression analysis for the green and brown event using the Mean-Adjusted Model. The table includes key variables such as Foreign Sales, Log(Scope 1 Emissions), Log(Scope 2 Emissions), and Log(Total Emissions), and control variables. Each variable's coefficient is displayed alongside its corresponding p-value and significance level, with statistical significance indicated by * (p < 0.10), ** (p < 0.05), and *** (p < 0.01). The results highlight the impact of these environmental and financial metrics on cumulative abnormal returns (CAR) during the events.

12 Resources

- Andreae, M. O., Jones, C. D., & Cox, P. M. (2005). Strong present-day aerosol cooling implies a hot future. *Nature*, *435*(7046), 1187–1190. <https://doi.org/10.1038/nature03671>
- Armitage, S. (1995). EVENT STUDY METHODS AND EVIDENCE ON THEIR PERFORMANCE. *Journal of Economic Surveys*, *9*(1), 25–52. <https://doi.org/10.1111/j.1467-6419.1995.tb00109.x>
- Bansal, R., Kiku, D., & Ochoa, M. (2016). *Price of Long-Run Temperature Shifts in Capital Markets* (w22529). National Bureau of Economic Research. <https://doi.org/10.3386/w22529>
- Birindelli, G., Miazza, A., Paimanova, V., & Palea, V. (2023). Just “blah blah blah”? Stock market expectations and reactions to COP26. *International Review of Financial Analysis*, *88*, 102699. <https://doi.org/10.1016/j.irfa.2023.102699>
- Bolton, P., & Kacperczyk, M. (2021). Do investors care about carbon risk? *Journal of Financial Economics*, *142*(2), 517–549. <https://doi.org/10.1016/j.jfineco.2021.05.008>
- Brown, S. J., & Warner, J. B. (1980). Measuring security price performance. *Journal of Financial Economics*, *8*(3), 205–258. [https://doi.org/10.1016/0304-405X\(80\)90002-1](https://doi.org/10.1016/0304-405X(80)90002-1)
- Cable, J., & Holland, K. (1999). Modelling normal returns in event studies: A model-selection approach and pilot study. *The European Journal of Finance*, *5*(4), 331–341. <https://doi.org/10.1080/135184799336993>
- CBO. (2022, September 7). *CBO Scores IRA with \$238 Billion of Deficit Reduction*. <https://www.crfb.org/blogs/cbo-scores-ira-238-billion-deficit-reduction>
- Choi, D., Gao, Z., & Jiang, W. (2020). Attention to Global Warming. *Review of Financial Studies*, *33*(3), 1112–1145. <https://doi.org/10.2139/ssrn.3180045>
- CITI. (2023, Februar 23). *US Inflation Reduction Act: The EU Response*. <https://www.citigroup.com/global/insights/us-inflation-reduction-act-the-eu-response>

- Clea, C. (2022, Oktober 26). Emmanuel Macron calls for 'Buy European Act' to protect regional carmakers. *POLITICO*. <https://www.politico.eu/article/emmanuel-macron-buy-european-act-CAR-united-states-china/>
- Corrado, C. J., & Zivney, T. L. (1992). The Specification and Power of the Sign Test in Event Study Hypothesis Tests Using Daily Stock Returns. *The Journal of Financial and Quantitative Analysis*, 27(3), 465. <https://doi.org/10.2307/2331331>
- Cowan, A. R. (1992). Nonparametric event study tests. *Review of Quantitative Finance and Accounting*, 2(4), 343–358. <https://doi.org/10.1007/BF00939016>
- Curtin, J., McInerney, C., Ó Gallachóir, B., Hickey, C., Deane, P., & Deeney, P. (2019). Quantifying stranding risk for fossil fuel assets and implications for renewable energy investment: A review of the literature. *Renewable and Sustainable Energy Reviews*, 116, 109402. <https://doi.org/10.1016/j.rser.2019.109402>
- Dyck, A., Lins, K. V., Roth, L., & Wagner, H. F. (2019). Do institutional investors drive corporate social responsibility? International evidence. *Journal of Financial Economics*, 131(3), 693–714. <https://doi.org/10.1016/j.jfineco.2018.08.013>
- El Ghouli, S., Guedhami, O., Kwok, C., & Mishra, D. R. (2011). Does Corporate Social Responsibility Affect the Cost of Capital. *Journal of Banking and Finance*, 35(9), 2388–2406. <https://doi.org/10.1016/j.jbankfin.2011.02.007>
- Engle, R. F., Giglio, S., Kelly, B., Lee, H., & Stroebel, J. (2020). Hedging Climate Change News. *The Review of Financial Studies*, 33(3), 1184–1216. <https://doi.org/10.1093/rfs/hhz072>
- Fama, E. F. (1991). Efficient Capital Markets: II. *The Journal of Finance*, 46(5), 1575–1617. <https://doi.org/10.1111/j.1540-6261.1991.tb04636.x>

- Hong, H., & Kacperczyk, M. (2009). The price of sin: The effects of social norms on markets. *Journal of Financial Economics*, 93(1), 15–36.
<https://doi.org/10.1016/j.jfineco.2008.09.001>
- Hong, H., Karolyi, G. A., & Scheinkman, J. A. (2020). Climate Finance. *The Review of Financial Studies*, 33(3), 1011–1023. <https://doi.org/10.1093/rfs/hhz146>
- Ilhan, E., Sautner, Z., & Vilkov, G. (2021). Carbon Tail Risk. *The Review of Financial Studies*, 34(3), 1540–1571. <https://doi.org/10.1093/rfs/hhaa071>
- Kleimann, D., Poitiers, N., Sapir, A., Tagliapietra, S., Véron, N., Veugelers, R., & Zettelmeyer, J. (2023). How Europe should answer the US Inflation Reduction Act. *Policy Contribution, Bruegel*(04/2023).
- Kolari, J. W., & Pynnonen, S. (2011). Nonparametric rank tests for event studies. *Journal of Empirical Finance*, 18(5), 953–971. <https://doi.org/10.1016/j.jempfin.2011.08.003>
- Krueger, P., Sautner, Z., & Starks, L. T. (2020). The Importance of Climate Risks for Institutional Investors. *The Review of Financial Studies*, 33(3), 1067–1111.
<https://doi.org/10.1093/rfs/hhz137>
- Krüger, P. (2015). Corporate goodness and shareholder wealth. *Journal of Financial Economics*, 115(2), 304–329. <https://doi.org/10.1016/j.jfineco.2014.09.008>
- MacKinlay, A. C. (1997). Event Studies in Economics and Finance. *Journal of Economic Literature*, 35(1), 13–39.
- Matsumura, E. M., Prakash, R., & Vera-Muñoz, S. C. (2014). Firm-Value Effects of Carbon Emissions and Carbon Disclosures. *The Accounting Review*, 89(2), 695–724.
<https://doi.org/10.2308/accr-50629>
- Nordhaus, W. D. (1977). Economic Growth and Climate: The Carbon Dioxide Problem. *The American Economic Review*, 67(1), 341–346.

- Nordhaus, W. D. (2019). Climate Change: The Ultimate Challenge for Economics. *American Economic Review*, 109(6), 1991–2014. <https://doi.org/10.1257/aer.109.6.1991>
- Nordhaus, W. D., Houthakker, H., & Solow, R. (1973). The Allocation of Energy Resources. *Brookings Papers on Economic Activity*, 1973(3), 529. <https://doi.org/10.2307/2534202>
- Pástor, L., Stambaugh, R. F., & Taylor, L. A. (2021). Sustainable investing in equilibrium. *Journal of Financial Economics*, 142(2), 550–571. <https://doi.org/10.1016/j.jfineco.2020.12.011>
- Patell, J. M. (1976). Corporate Forecasts of Earnings Per Share and Stock Price Behavior: Empirical Test. *Journal of Accounting Research*, 14(2), 246. <https://doi.org/10.2307/2490543>
- Pham, H. N. A., Ramiah, V., Moosa, N., Huynh, T., & Pham, N. (2018). The financial effects of Trumpism. *Economic Modelling*, 74, 264–274. <https://doi.org/10.1016/j.econmod.2018.05.020>
- Pham, H., Nguyen, V., Ramiah, V., Saleem, K., & Moosa, N. (2019). The effects of the Paris climate agreement on stock markets: Evidence from the German stock market. *Applied Economics*, 51(57), 6068–6075. <https://doi.org/10.1080/00036846.2019.1645284>
- Phillips, P. C. B., Leirvik, T., & Storelvmo, T. (2020). Econometric estimates of Earth's transient climate sensitivity. *Journal of Econometrics*, 214(1), 6–32. <https://doi.org/10.1016/j.jeconom.2019.05.002>
- Ramiah, V., Anh Pham, H. N., & Moosa, I. (2015). Are European Environmental Regulations Excessive? *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.2560357>
- Ramiah, V., Martin, B., & Moosa, I. (2013). How does the stock market react to the announcement of green policies? *Journal of Banking & Finance*, 37(5), 1747–1758. <https://doi.org/10.1016/j.jbankfin.2013.01.012>

- Ramiah, V., Morris, T., Moosa, I., Gangemi, M., & Puican, L. (2016). The effects of announcement of green policies on equity portfolios: Evidence from the United Kingdom. *Managerial Auditing Journal*, 31(2), 138–155. <https://doi.org/10.1108/MAJ-08-2014-1065>
- Ramiah, V., Pichelli, J., & Moosa, I. (2015). Environmental regulation, the Obama effect and the stock market: Some empirical results. *Applied Economics*, 47(7), 725–738. <https://doi.org/10.1080/00036846.2014.980572>
- Reboredo, J. C., & Ugolini, A. (2022). Climate transition risk, profitability and stock prices. *International Review of Financial Analysis*, 83, 102271. <https://doi.org/10.1016/j.irfa.2022.102271>
- Renneboog, L., Horst, J. ter, & Zhang, C. (2008). Socially responsible investments: Institutional aspects, performance, and investor behavior. *Journal of Banking and Finance*, 32(9), 1723–1742. <https://doi.org/10.1016/j.jbankfin.2007.12.039>
- Rueda-Cantuche, J. M., Pedauga, L. E., Ruiz-García, J. C., & Ciriaci, D. (2024). Green transition, single market and EU's open strategic autonomy: The impact of state aid. *European Commission*, 2811–6925. <https://data.europa.eu/doi/10.2873/404258>
- Sakano, R., Obeng, K., & Azam, G. (1997). SUBSIDIES AND INEFFICIENCY: STOCHASTIC FRONTIER APPROACH. *Contemporary Economic Policy*, 15(3), 113–127. <https://doi.org/10.1111/j.1465-7287.1997.tb00483.x>
- Sharfman, M. P., & Fernando, C. S. (2008). Environmental risk management and the cost of capital. *Strategic Management Journal*, 29(6), 569–592. <https://doi.org/10.1002/smj.678>
- Tang, D. Y., & Zhang, Y. (2020). Do shareholders benefit from green bonds? *Journal of Corporate Finance*, 61, 101427. <https://doi.org/10.1016/j.jcorpfin.2018.12.001>

Venturini, A. (2022). Climate change, risk factors and stock returns: A review of the literature.

International Review of Financial Analysis, 79, 101934.

<https://doi.org/10.1016/j.irfa.2021.101934>

Zerbib, O. (2019). The effect of pro-environmental preferences on bond prices: Evidence from green bonds. *Journal of Banking and Finance*, 98(1), 39–60.

<https://doi.org/10.1016/j.jbankfin.2018.10.012>