Impact of the Inflation Reduction Act on the United States stock market, energy sector and the automotive industry

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Abstract

The present article evaluates the impact of the Inflation Reduction Act's (IRA) approval on the United States stock market, specifically on the energy sector and automotive industry. The article applies the event study methodology by estimating a Mean-adjusted return model and a Market return model with dummy variables for the events. The model is estimated around four events related to the bill's approval. The article concludes that the stock market as a whole did not experience abnormal returns in the event windows related to the bill's approval. However, the energy sector as a whole, the renewable energy segment, and surprisingly, the oil and gas industry presented abnormal returns around key events of the approval process. In the case of the automotive industry, the study does not find conclusive evidence of abnormal returns around the events.

1 Introduction

On September 27, 2021, the US administration presented the Build Back Better Act, a bill containing a broad set of subsidies for the green energy sector, the automotive industry, and the manufacturing sector in the United States. Almost one year later and after a long negotiation process, the bill was substantially transformed by the Senate and was finally approved with the name of Inflation Reduction Act (IRA). The approved bill included massive stimulus to accelerate investments in renewable energy and the production of electric vehicles in the United States.

According to the Penn-Wharton Budget Model (Huntley Ricco & Arnon 2022), the bill contains a total provision of \$384.9 billion for climate change and renewable energy, from which 63.7% is dedicated to renewable energies and 5.9% is dedicated to stimulating the electric vehicles adoption and production in the United States, 12.1% goes to the manufacturing industry, 11.8% goes to environmental policies, 5.3% to agriculture and 1.2% to water investments (Badlam et al. 2022). The bill is not only relevant for its financial volume but also for the magnitude of its impact on the United States CO_2 emissions. It is estimated that the IRA's impact on the United States emissions will be significant, as it will "cut annual emissions in 2030 by an additional 1 billion metric tons" (Jenkins, J.D. et al. 2022).

The present study uses the standard event study methodology to evaluate the impact of the bill's approval on the United States stock market. In particular, it analyses the impact on the energy

sector and the automotive industry. For that, I evaluate five different benchmark indexes: the NASDAQ Clean Energy Edge Index, the S&P 500 Automobiles Industry Index, the S&P Kensho Electric Vehicles Index, the Dow Jones U.S. Oil & Gas Index, and the S&P500 Energy Index.

The event study methodology is applied by estimating a Mean-adjusted return model and a Market return model with dummy variables for the key events. The model is estimated using three days and five days windows around four key events: the presentation of the bill to Congress, the announcement of Senator's Manchin opposition to the bill, the agreement with Senator Manchin which was key to the approval, and the vote of the bill by the Senate. Normally, the use of event study methodologies to evaluate the impact of legislation approval has particular challenges, as the results of legislative votes are known in advance given the number of representatives from each party. For this study, I took advantage of several particularities in the IRA approval process that allowed me to apply successfully the event study methodology.

2 Literature Review: Event study methodology and its application to legislative processes

2.1 The event study methodology

The event study methodology is well-established in the field of financial economics. There is plenty of literature that discusses and replicates the methodology, beginning in the late sixties until today. In their seminal article Fama Fisher, Jensen, and Roll (1969) evaluated how stock prices incorporate the information of stock splits. By doing so, they settled the basis of what we know today as event studies. To evaluate the price reaction to stock split, they estimate the regression $log_e(R_{ij}) = \alpha_j + \beta_j log_e L_t + \epsilon_{jt}$, where R_{ij} is the stock's return, and L_t is the market's return.

It is important to highlight that, Fama Fisher, Jensen, and Roll do not include the period of the analyzed event in the estimation. They estimate the parameters without the event's period and then, with the estimated parameters, they calculate the error ϵ_{jt} for the event's dates, the mean of the error is considered as the measure of the abnormal return. The authors evaluate the different estimation methods, they conclude that even when the data is not normally distributed, OLS provides estimators that are unbiased and consistent. They also highlight the problems of the T-statistic for hypothesis testing given the non-normality of residuals.

In Brown and Warner's article (1980), the authors extend Fama Fisher, Jensen, and Roll's methodology. By using the same principle, they evaluate three different regression models for stock prices and evaluate the accuracy of each one of them. According to them, the notion of abnormal return requires a benchmark value for comparisons, which leads them to evaluate three possible benchmarks. The first model called the Mean Adjusted Return Model establishes that the expected return of an asset i is given by a constant $E(\tilde{R}_{it}) = K_i$, where the abnormal return of asset i on period t corresponds simply to the difference between the observed return and the mean return $\epsilon_{i,t} = R_{i,t} - K_i$.

The second model evaluated by Brown and Warner is the Market Return model in which the

expected return of an asset is equal to the market return $E(\tilde{R}_{i,t}) = E(\tilde{R}_{m,t})$. Finally the authors evaluate the Market and Risk Adjusted Return model in which the expected return of an asset is given by the CAPM model with $E(\tilde{R}_{it}) = E(\tilde{R}_{zt}) + \beta_i \left[E(\tilde{R}_{mt}) - E(\tilde{R}_{zt}) \right]$. Here the abnormal return is given by $R_{it} - R_{zt} - \beta_i [R_{mt}) - E(R_{zt})])$.

The authors select randomly 250 securities and introduce artificial abnormal returns into the historical data using monthly returns, then they evaluate the capacity of the three models to identify the abnormal returns. Surprisingly they find that the models produce similar results and that "beyond a simple, one-factor market model, there is no evidence that more complicated methodologies convey any benefit. In fact, we have presented evidence that more complicated methodologies can actually make the researcher worse off" (Brown & Warner 1980).

Dyckman, Philbrick, and Stephan (1984) replicate Brown and Warner's simulation with daily data and include 2 additional return models: Scholes-Williams and Dimson models. The article concludes that the Market Return Model is slightly better than the Mean Adjusted Return and the Market Adjusted Return models in detecting abnormal returns. The Scholes-Williams and Dimson did not improve the capacity to detect abnormal returns, which reinforces the argument in favor of simple models. Finally, the authors conclude that the capacity to detect abnormal returns of models decreases considerably when the date is unknown and the portfolios are smaller. Dyckman, Philbrick, and Stephan also analyzed the potential problems of T-tests given the non-normality of residuals, they conclude that "nonnormality of individual-security daily-return residuals has little effect on the inferences drawn from the use of the t-test applied to portfolios" (Dyckman, Philbrick, and Stephan 1984).

In a second article, Brown and Warner evaluate again different return models using daily data and reinforce the evidence in favor of simpler return models. Additionally, the authors conclude that estimation methods different from OLS do not provide clear advantages for the return models. MacKinlay (1997) uses a market return model with the specification $R_{it} + \alpha_i + \beta_i R_{mt} + \epsilon_{it}$ to evaluate the impact of news on the market return. The author highlights the limited gains of using multifactor models for event studies and concludes that a fundamental requirement for event studies to be successful is that the event date can be identified precisely, otherwise, the methodology loses much of its statistical power.

Blinder (1998) makes a review of the evolution of event studies methodology. Blinder underlines the increasing popularity at that time for an estimation method that includes the event period on the data-set while including at the same time a dummy variable for the analyzed events. This way, the return equation will be: $R_{i,t} = \alpha_i + \beta_i R_{mt} + \Sigma_{j=1}^{N} \gamma_j D_j + \epsilon_{it}$ where is the dummy variable equal to 1 for each event j and γ_j is the abnormal return parameter for event j. The existence or not of the abnormal return is evaluated by the significance of γ_j. One important warning of Blinder regarding this specification is that the hypothesis testing will not be very powerful statistically speaking if the signs of the effects are different. In those cases, it is better to estimate different regressions for each event.

Khotari and Warner (2006) review the evolution of event studies through time. They conclude that the core methodology has not changed substantially since Fama, Fisher, Jensen, and Roll's (1969)

seminar article, however, new methodological consensus has appeared to improve estimations. For example, Khotari and Warner point out that events with long-horizon impacts have important limitations, while events with short-term impacts remain effective and statistically powerful.

2.2 Event study methodology applied to legislative processes

Ali and Kallapur (2001) apply the event study methodology to the bill approval process on the United States to determine the effects of the Private Securities Litigation Reform Act of 1995. They measured the price reactions of events that changed the likelihood of the approval of the law. The authors include a set of events that provided new information to markets regarding the law's approval, this included a presidential veto and its subsequent override by Congress.

Ali and Kallapur identify three particular challenges to applying the event study methodology for law approval processes: first, it is difficult to identify all the major events that affect the approval process. Second, It is necessary to identify the precise date in which that information is provided to the markets. Third, it is necessary to identify when the markets first anticipated the effects of such events. For the estimation they use the Market Return model with dummy variable for the dates of the events: $R_t = \alpha_0 + \Sigma_{j=1}^{N} \beta_j D_j + \epsilon_{it}$. The authors conclude there is evidence of negative market price reactions to events that increased the likelihood of the law's approval.

Rezaee and Pankaj (2005) apply the event study methodology to the The Sarbanes-Oxley Act approval process in 2002. Using a three-day cumulative abnormal return window the authors evaluate 12 Congressional events using the Mean Adjusted Return Model with dummy variables for the events: $R_t = \alpha_0 + \Sigma_{j=1}^{N} \beta_j D_j + \epsilon_{it}$. Rezaee and Pankaj found positive significant abnormal returns around the events that increased the probabilities of the law's approval.

In both cases, the authors underscore that to apply the event study methodology analyzed events must provide new information that was not previously available to the market. As I will explain later, the particular circumstances surrounding the IRA's approval generated a set of events that comply with this requirement.

3 Data: daily data between January 2 of 2018 and December 30, 2022

The data used for the stock indexes and the market return corresponds to the daily closing values for the period between January 2 2018 and December 30, 2022. As the IRA's investments focus mainly on the energy sector and the automotive industry group, I will analyze those two sectors. The analysis for the energy sector is divided into two different parts: first I analyze the whole energy sector, including non-renewable and renewable energy companies. Following Bessec and Fouquau (2024), I use the S&P500 Energy index and the Dow Jones U.S. Oil & Gas Index.

Then, I focus on the specific renewable energy segment. To measure the impact on the clean energy segment I use the NASDAQ Clean Energy Edge Index, this Index composed of 56 U.S. listed stocks, tracks the performance of companies that are "primarily manufacturers, developers,

distributors and/or installers of clean energy technologies" (NASDAQ 2024). For the final part of the energy sector analysis, I evaluate the impact on the oil and gas companies by using the Dow Jones U.S. Oil & Gas Index, which contains the main 45 U.S. companies from the oil and gas sector.

For the automotive industry, I use first the S&P 500 Automobiles Industry Index which tracks the behavior of the automotive industry as a whole in the United States (SP500-251020,2023). Then, I use the S&P Kensho Electric Vehicles Index which contains 44 U.S.-listed companies producing electric vehicles and associated subsystems and infrastructure (S&P Globa,2024a).

In the case of the NASDAQ Clean Energy Edge Index, the data was downloaded directly from NASDAQ's webpage(NASDAQ, 2024). For the S&P Kensho Electric Vehicles Index, the S&P 500 Energy index, and the Dow Jones U.S. Oil & Gas Index, the data was downloaded from the S&P Global's webpage (S&P Global,2024a, 2024b, 2024c). Finally, for the S&P 500 Automobiles Industry index, the data was extracted from Yahoo Finance using Python's yfinance Package (SP500-251020, 2023).

For the market return data, I used Fama and French market daily risk premium and daily risk-free return (Fama & French 2024). Fama and French calculate the market return variable using as a basis the data from the Center for Research in Security Prices (CRSP), specifically from the CRSP US Total Market Index, which represents 100% of the US equity market. However, the market index on the Fama-French library refers to the market risk premium $R_m - R_{risk-free}$, therefore, to obtain the market return I added back the risk-free rate.

The data on the risk-free rate was also obtained from Fama and French library (Fama & French 2024). The details of the construction of the Fama-French library can be found on (Fama & French 2023).

Graph 1 presents the historical behavior of the variables' returns, while Table 1 presents basic descriptive statistics of the data.

Graph 1: Daily returns between January 2, 2018 and December 30 2022, 1 149 observations
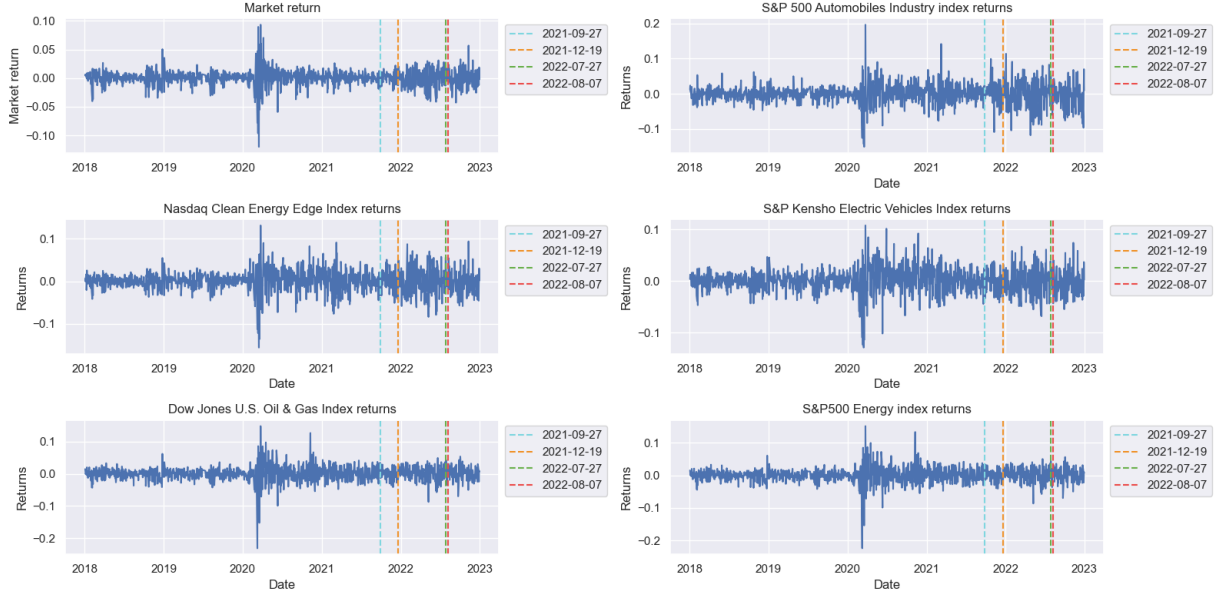
Source: Own elaboration with data from Fama & French (2023), ECO. (2023) and SP500-251020, (2023)

Note: Market return was obtained from Fama-French data library (Fama & French 2024), which is built based on the Center for Research in Security Prices market index that represents 100% of the US equity market.

**Table 1: Descriptive statistics, 1 149 observations**

	Mkt	Ret_NASDAQ CEGEI	Ret^SP500_auto	Ret_Kensho_evi	Ret_DJ usogi	Ret_SP500_ei
count	1250	1250	1250	1250	1250	1250
mean	0.000	0.001	-0.001	0.000	0.000	0.000
std	0.014	0.025	0.029	0.023	0.023	0.023
min	-0.120	-0.156	-0.151	-0.129	-0.232	-0.224
25%	-0.005	-0.011	-0.013	-0.013	-0.011	-0.010
50%	0.001	0.002	0.000	0.001	0.001	0.000
75%	0.007	0.013	0.013	0.013	0.012	0.012
max	0.093	0.131	0.197	0.108	0.149	0.151
kurtosis	10.750	4.096	4.658	3.269	13.710	13.024
skewness	-0.549	-0.360	-0.069	-0.234	-0.981	-0.885

Source: Own elaboration with data from Fama & French (2023), ECO. (2023) and SP500-251020, (2023)

The visualization of the data shows that the 6 variables are centered around 0, this is confirmed by the summary statistics in Table 1. It is possible to observe an important increase in volatility

around the pandemic. In the period that encompasses the four events, there is also an increase in volatility, this may be explained by the increases in the United States Fed Fund rates, which began in April 2022. All six indexes have very similar standard deviations and higher volatility than the market. All the variables, except for the S&P Kensho Electric Vehicles Index, present a Kurtosis considerably different from 3, especially the automotive industry index. To observe more clearly the variables' behavior around the dates of the event, I present on Graph 2 a zoom around the analyzed events.

Graph 2: Daily returns between July 27 2021 and September 07 2022, 256 observations
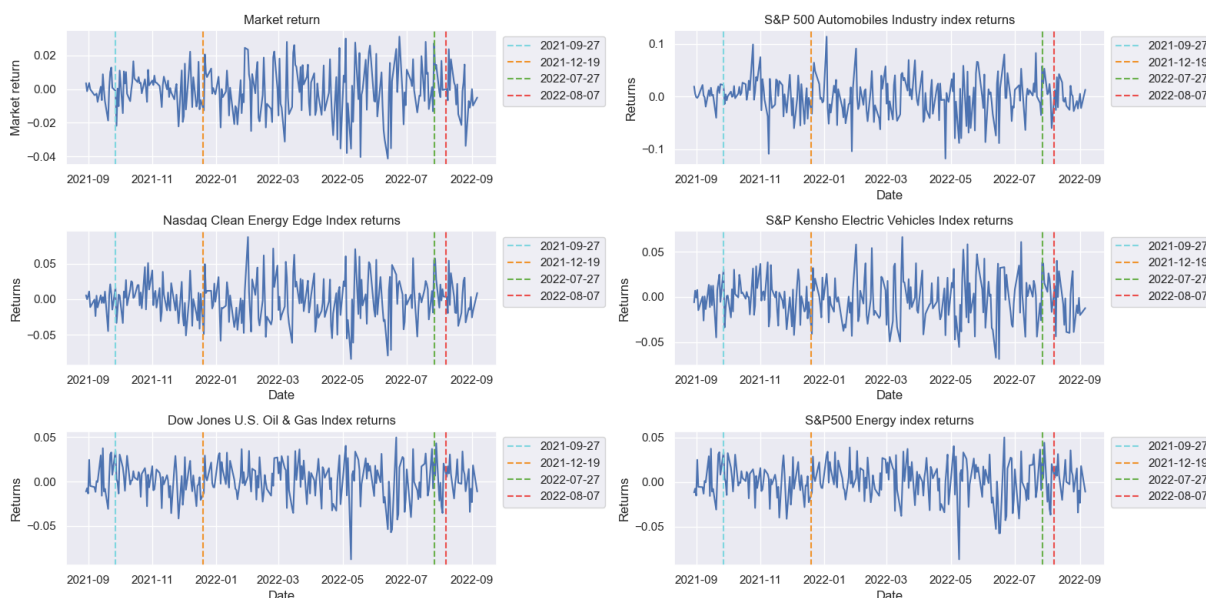
Source:Own elaboration with data from Fama & French (2023), ECO. (2023) and SP500-251020, (2023)

Graph 3: Correlation heat-map, 1 149 observations

Graph 3 presents the correlation heat map between the variables. The five indexes have correlation coefficients with the market greater than 0.65. The NASDAQ Clean Energy Edge Index is strongly correlated with the S&P Kensho Electric Vehicles Index, something that reflects the strong ties between both sectors. Interestingly all the correlation coefficients are positive, and the smallest value is 0.46 between the S&P500 Energy Index and the S&P 500 Automobiles Index.

To evaluate the normality of the variables, I applied the Jarque-Bera normality test. The results are presented in Table 2. As can be seen, the null hypothesis of normality is rejected for the six variables. In line with the observation of Fama, Fisher, Jensen, and Roll (1969), the returns do not follow a normal distribution.

Table 2: Jarque-Bera normality tests, 1 149 observations

	Mkt	Ret_NASDAQ CEGEI	Ret^SP500_auto	Ret_Kensho_evi	Ret_DJ usogi	Ret_SP500_ei
Statistic	6028.100	891.645	1119.735	561.989	9904.894	8920.116
p-value	0.000	0.000	0.000	0.000	0.000	0.000

The histograms and Kernel Density plots for each variable are presented on Graph 4.

Graph 4: Histograms and Kernel density plot, 1 149 observations
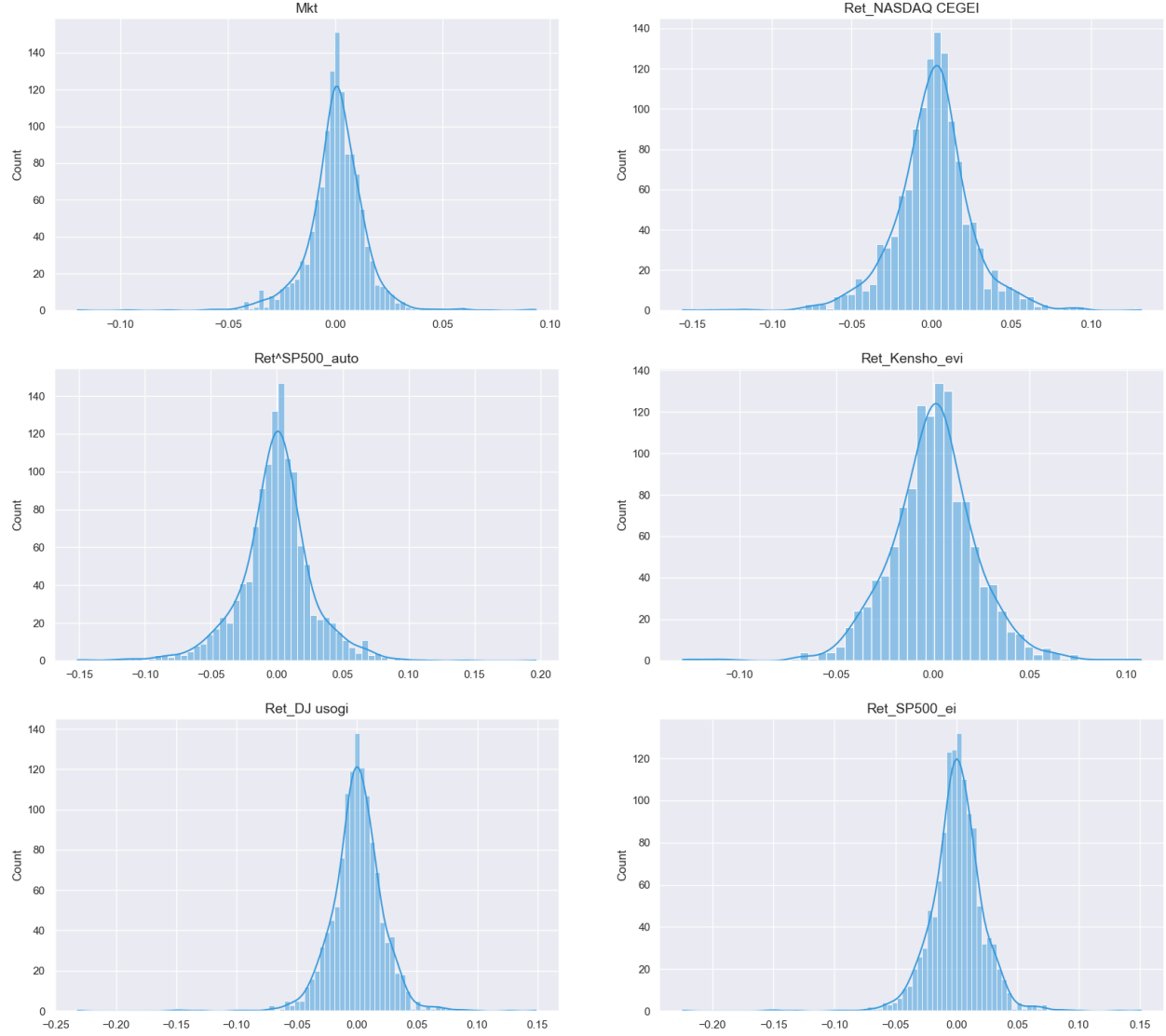
Source: Own elaboration with data from Fama & French (2023), S&P Global (2024a, 2024b, 2024c), NASDAQ (2024) and SP500-251020, (2023)

4 Methodology

To determine the existence of abnormal returns, it is necessary to compare an asset or portfolio with a benchmark, normally, the benchmark used is the market portfolio. However, if the benchmark used also experienced abnormal returns, the event study would fail to identify the abnormal returns of the analyzed asset. Therefore, in this case, it is necessary to evaluate in the first place if the market portfolio experiences abnormal returns. Following Rezaee and Pankaj (2004), I evaluate this possibility using the Mean Adjusted Return model as proposed by Brown and Warner (1980) with additional dummy variables for the events. The estimated model is:

$$R_{m,t} = \alpha_{i,0} + \Sigma_{j=1}^{4}\beta_{i,j}D_j + \epsilon_{i,t} \tag{1}$$

Where:

- $R_{m,t}$ is the market return for period t.

- $\alpha_{i,0}$ is the average market return.

- D_j is the dummy variable for the event j.

- β_j is the abnormal return of the event j.

Following Fama, Fisher, Jensen and Roll(1969) and Dyckman, Philbrick, & Stephan (1984), I will estimate the model using OLS estimators and apply the T-test for significance as the indexes evaluated give shape to portfolios big enough to avoid the problems generated by non-normality.

For the estimation I will use an abnormal return model with dummy variables for the 4 events of interests, therefore, the event period is included in the estimation. Following Ali and Kallapur (2001) and Khotari and Warner (2006),the specification of the model to estimate is:

$$R_{i,t} = \alpha_{i,0} + \beta_{i,1}R_{m,t} + \Sigma_{j=1}^{4}\beta_{i,j}D_j + \epsilon_{i,t} \tag{2}$$

Where:

- R_t is the return of the correspoding index.

- R_{mt} is the market return.

- D_j is the dummy variable for the event j.

- β_j is the abnormal return of the event j.

One of the main challenges of event study for law approval processes as highlighted by Ali and Kallapur (2001) is that the dates of the events analyzed must be identifiable and they must provide new information that was not previously available. However, the information regarding the approval process of a law or regulation is something known in advance given the congressional composition and the previous stances of congress members. As I will explain, due to particular circumstances surrounding its approval, the Inflation Reduction Act approval process had several events clearly identifiable that provided new information to markets.

During the period of the bill debate, Democrats had a comfortable majority in Congress, with 235 Democrats vs. 200 Republicans. However, in the Senate, the composition was 50 Senators for Democrats and 50 for Republicans. In this situation, the Vicepresident had the tie-breaker vote, which implied that the bill required all the 50 Democrat votes to be approved. However, on December 19, 2021, after the bill had been approved by Congress, Democrat Senator Bill Manchin publicly announced his vote against the bill and forced a negotiation with the Administration. This announcement made through a public statement represented a surprise and provided new

information to the market as the bill could not be approved without Senator Manchin's vote.

During several weeks Senator Manchin's negative to vote the bill created incertitude regarding whether it would be approved or not. On July 27, 2022, the White House announced an agreement with Senator Manchin to pass the bill. My hypothesis is that the announcements of Manchin vote against and later in favor, provide new information for markets to internalize.

Consequently, I will analyze 4 key dates related to the Inflation Reduction Act approval process:

- First, the bill's presentation on September 27 2021 under the original name of the Build Back Better Act.

- Second, Senator Manchin's announcement of its opposition to the Build Back Better Act on December 19, 2021.

- Third the agreement with Senator Manchin on July 27, 2022.

- And fourth, the Senate approval on August 7, 2022.

Around these 4 key dates, I will evaluate a window of one day before and after the events, for a total of three trading days including the event. Additionally, as a robustness check, I will evaluate a five-day window: the event day, two days before, and two days after. For the hypothesis test, I will use ordinary T statistics to evaluate the significance of the event parameters, this is in line with Dyckman, Philbrick, and Stephan (1984). In the case of the Senate approval on August 7, 2022, the event occurred on a non-trading day, therefore I use as event day the next trading day which is August 8, August 5, and August 9 were used as the previous and next trading days respectively.

5 Results

First, I evaluate if the market in general experienced abnormal returns during the analyzed events. The estimation results for Equation 1 with a three-day window are presented in Table 3. As can be observed, the parameters for the events' dummy variables are not significant, which means that the market as a whole did not experience abnormal returns during the events. Robustness checks with a five-day window around the events were applied, as can be seen in Table 3A in Annex 1, the results are the same for the five-day window. Therefore, market return can be used as a benchmark.

Table 3: OLS estimation of equation 1 with 3-day window for daily Market abnormal returns between January first 2018 and December 30 2022

	coef	std err	t	P>|t|	[0.025	0.975]
No. Observations:		1149		R-squared:		0.002
Dep. Variable:		Mkt		Adj. R-squared:		-0.002
Model:		OLS		F-statistic:		0.4819
Covariance Type:		Non-robust		Prob (F-statistic):		0.749
const (alpha)	0.000	0.000	0.962	0.336	0.000	0.001
sept_24_to_sept_28_2021	-0.008	0.008	-0.922	0.357	-0.024	0.009
dec_17_to_dec_21_2021	0.000	0.008	0.006	0.995	-0.016	0.017
jul_26_to_jul_28_2022	0.008	0.008	0.982	0.326	-0.008	0.025
aug_05_to_aug_09_2022	-0.003	0.008	-0.329	0.742	-0.019	0.014
Omnibus:		267.745		Durbin-Watson:		2.333
Prob(Omnibus):		0		Jarque-Bera (JB):		5168.087
Skew:		-0.551		Prob(JB):		0
Kurtosis:		13.331		Cond. No.		19.7

*sept_24_to_sept_28_2021 corresponds to the original bill presentation, dec_17_to_dec_21_2021 is the event window when Senator Manchin announced its opposition to the bill, jul_26_to_jul_28_2022 corresponds to the agreement with Senator Manchin, and aug_05_to_aug_09_2022 is the event window of the bill's approval by Senate.

Source: Own elaboration with data from Fama & French (2023)

In the next step, I estimate equation 2 using the OLS method to evaluate the presence of abnormal returns in the Energy sector in general, for that, I use the S&P500 Energy Index. Results presented in Table 4 indicate that the Index experienced a significant and positive abnormal return of approximately 2.4% around the original bill presentation. This result is robust as seen in the estimation for a five-day window presented in Table 4A in Annex 1. Table 4 also shows a positive and significant (at 10% significance) coefficient for the final bill approval, however, as seen in Table 4A on Annex 1, this result does not hold with the robustness check. Graph 5 presents the scatter plot between the daily market returns and the S&P500 Energy Index daily returns.

Table 4: OLS estimation of equation 2 with 3-day window for daily S&P500 Energy Index abnormal returns between January first 2018 and December 30 2022

	coef	std err	t	P>|t|	[0.025	0.975]
No. Observations:		1250		R-squared:		0.426
Dep. Variable:		Ret_SP500_ei		Adj. R-squared:		0.423
Model:		OLS		F-statistic:		184.5
Covariance Type:		Non-robust		Prob (F-statistic):		4.47E-147
const	0.000	0.001	-0.707	0.480	-0.001	0.001
Mkt	1.071	0.035	30.297	0.000	1.002	1.141
sept_24_to_sept_28_2021	0.024	0.010	2.330	0.020	0.004	0.044
dec_17_to_dec_21_2021	-0.002	0.010	-0.210	0.834	-0.022	0.018
jul_26_to_jul_28_2022	-0.003	0.010	-0.305	0.760	-0.023	0.017
aug_05_to_aug_09_2022	0.017	0.010	1.677	0.094	-0.003	0.037
Omnibus:		174.818		Durbin-Watson:		1.923
Prob(Omnibus):		0		Jarque-Bera (JB):		2128.347
Skew:		-0.084		Prob(JB):		0
Kurtosis:		9.39		Cond. No.		70.9

*sept_24_to_sept_28_2021 corresponds to the original bill presentation, dec_17_to_dec_21_2021 is the event window when Senator Manchin announced its opposition to the bill, jul_26_to_jul_28_2022 corresponds to the agreement with Senator Manchin, and aug_05_to_aug_09_2022 is the event window of the bill's approval by Senate.

Source: Own elaboration with data from Fama & French (2023), and S&P Global (2024b)

Graph 5: Scatter plot between daily Market returns and the S&P500 Energy Index daily returns
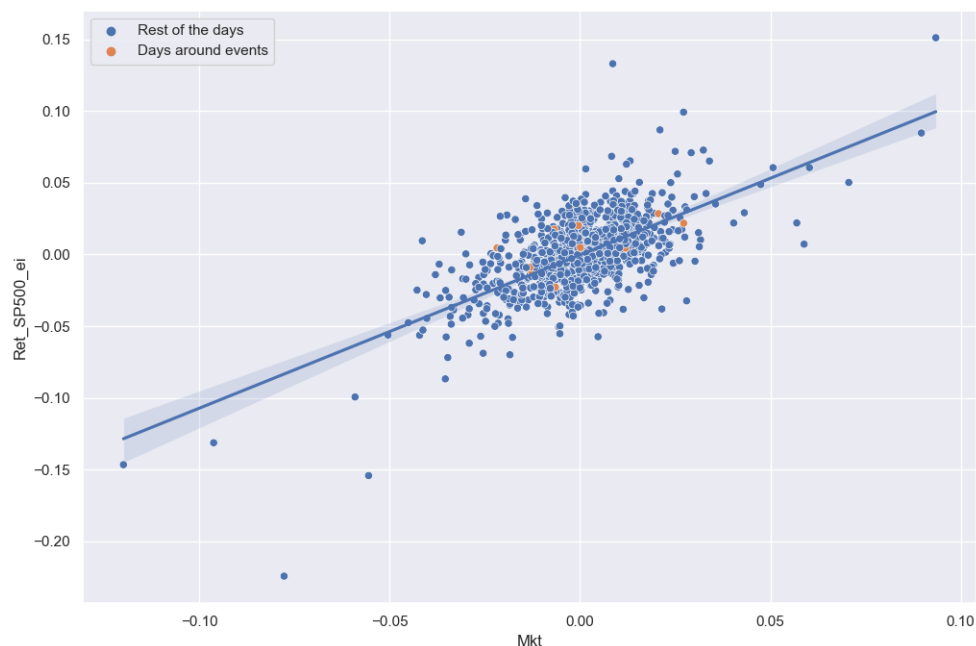
Source: Own elaboration with data from Fama & French (2023), and S&P Global (2024b)

To understand how the bill impacted the renewable energy sector specifically, I use the NASDAQ Clean Energy Edge Index. Table 5 shows the results of the estimations. The dummy corresponding to the agreement with Senator Manchin has a significant and positive coefficient indicating that the announcement was followed by positive abnormal returns of approximately 1.91% on the renewable energy sector. This is consistent with the original hypothesis that the announcement provided new information to markets. The other three coefficients are not significant. As presented in Table 5A, Annex 1, these results are robust to the 5-day window robustness check. Graph 6 presents the scatter plot between the NASDAQ Clean Energy Edge Index and the market returns.

Table 5: OLS estimation of equation 2 with 3-day window for daily NASDAQ Clean Energy Edge Index abnormal returns between January first 2018 and December 30 2022

No. Observations:		1250		R-squared:		0.63
Dep. Variable:		Ret_NASDAQ CEGEI		Adj. R-squared:		0.628
Model:		OLS		F-statistic:		422.9
Covariance Type:		Non-robust		Prob (F-statistic):		2.97E-265
	coef	std err	t	P>|t|	[0.025	0.975]
const	4.31E-05	0	0.101	0.92	-0.001	0.001
Mkt	1.3813	0.03	45.829	0	1.322	1.44
sept_24_to_sept_28_2021	-0.0005	0.009	-0.053	0.958	-0.018	0.017
dec_17_to_dec_21_2021	0.0019	0.009	0.222	0.825	-0.015	0.019
jul_26_to_jul_28_2022	0.0191	0.009	2.192	0.029	0.002	0.036
aug_05_to_aug_09_2022	-0.001	0.009	-0.112	0.911	-0.018	0.016
Omnibus:		72.661		Durbin-Watson:		2.037
Prob(Omnibus):		0		Jarque-Bera (JB):		284.046
Skew:		-0.032		Prob(JB):		2.09E-62
Kurtosis:		5.334		Cond. No.		70.9

*sept_24_to_sept_28_2021 corresponds to the original bill presentation, dec_17_to_dec_21_2021 is the event window when Senator Manchin announced its opposition to the bill, jul_26_to_jul_28_2022 corresponds to the agreement with Senator Manchin, and aug_05_to_aug_09_2022 is the event window of the bill's approval by Senate.

Graph 6: Scatter plot between daily Market returns and the NASDAQ Clean Energy Edge Index daily returns
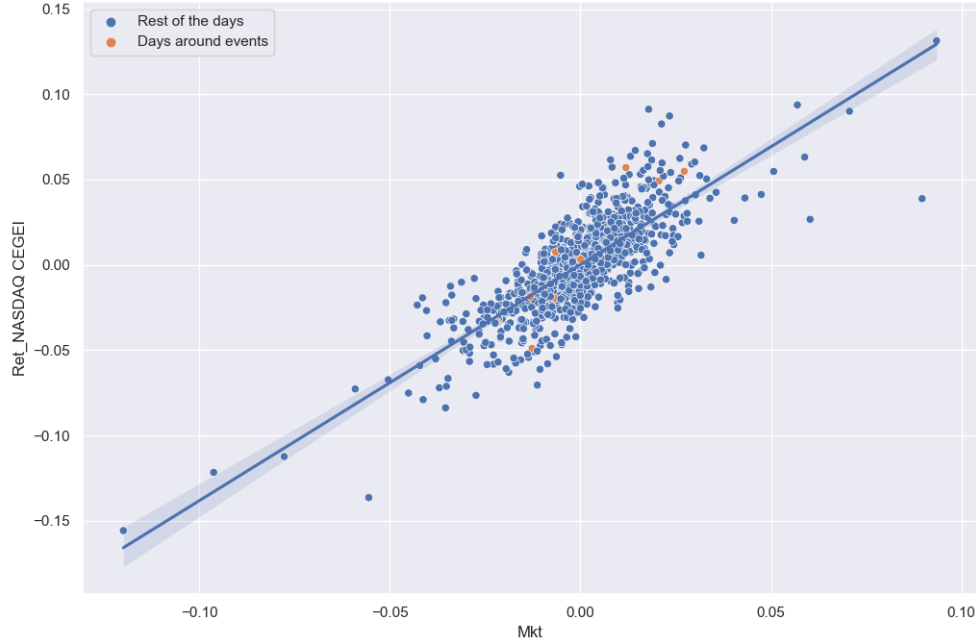
Source: Own elaboration with data from Fama & French (2023), and NASDAQ (2024)

According to the findings of Bessec and Fouqau (2024) and Ardia et al.(2022), polluting or "brown" companies tend to be more sensitive to news and information related to the environment. To evaluate if this is the case also for the IRA's approval, I evaluate the impact of the events on the Dow Jones U.S. Oil & Gas Index. Results are presented in Table 6. Surprisingly the oil and gas industries experienced abnormal returns of 2.3% during the announcement of the original bill. This result is robust to the 5-day window check (See Table 6A, Annex 1).

One possible explanation for this unexpected finding is the presence of a carbon removal tax break in the bill, which might have been interpreted by the market as an opportunity for oil and gas companies to compensate for their CO_2 emissions without affecting their core business. Another possibility is simply that the market expected tougher measures against the gas and oil industries, and that the actual content of the bill was softer than expected. In any case, it is important to remark that the content of the bill originally presented experienced important changes before the final approval. Graph 7 presents the scatter plot between market returns and the Dow Jones U.S. Oil & Gas Index.

Table 6: OLS estimation of equation 2 with 3-day window for daily Dow Jones U.S. Oil & Gas Index abnormal returns between January first 2018 and December 30 2022

No. Observations:		1250		R-squared:		0.437
Dep. Variable:		Ret_DJ usogi		Adj. R-squared:		0.435
Model:		OLS		F-statistic:		193
Covariance Type:		Non-robust		Prob (F-statistic):		2.51E-152
	coef	std err	t	P>|t|	[0.025	0.975]
const	-0.0004	0	-0.776	0.438	-0.001	0.001
Mkt	1.0839	0.035	30.992	0	1.015	1.153
sept_24_to_sept_28_2021	0.0234	0.01	2.316	0.021	0.004	0.043
dec_17_to_dec_21_2021	-0.0016	0.01	-0.156	0.876	-0.021	0.018
jul_26_to_jul_28_2022	-0.0021	0.01	-0.207	0.836	-0.022	0.018
aug_05_to_aug_09_2022	0.0172	0.01	1.703	0.089	-0.003	0.037
Omnibus:		188.633		Durbin-Watson:		1.923
Prob(Omnibus):		0		Jarque-Bera (JB):		2459.089
Skew:		-0.179		Prob(JB):		0
Kurtosis:		9.862		Cond. No.		70.9

*sept_24_to_sept_28_2021 corresponds to the original bill presentation, dec_17_to_dec_21_2021 is the event window when Senator Manchin announced its opposition to the bill, jul_26_to_jul_28_2022 corresponds to the agreement with Senator Manchin, and aug_05_to_aug_09_2022 is the event window of the bill's approval by Senate.

Source: Own elaboration with data from Fama & French (2023), and S&P Global (2024c)

Graph 7: Scatter plot between daily Market returns and the Dow Jones U.S. Oil & Gas Index daily returns
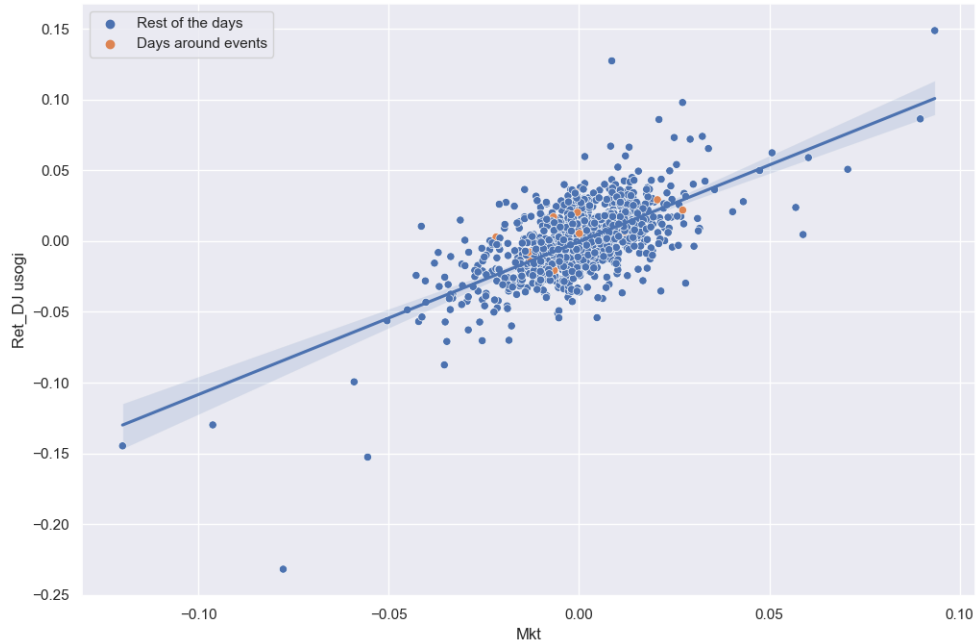
Source: Own elaboration with data from Fama & French (2023), and S&P Global. (2024c)

In the case of the automotive industry represented by the S&P 500 Automobiles Industry Group Index, the results of the estimation of equation 2 are presented in Table 7. The dummy for the presentation of the bill has a significant and positive coefficient indicating abnormal returns of 2.1% approximately. The dummy for the bill's approval has a significant and negative coefficient indicating abnormal returns of -2% approximately. Nevertheless, none of these results is significant on the 5-day window robustness check as seen in Table 7A, Appendix 1. Therefore the results are non-conclusive for the automotive industry. Graph 8 shows the scatter plot between the e non-significant.

Therefore, the S&P 500 Automobiles Industry Group index and market returns.

Table 7: OLS estimation of equation 2 with 3-day window for daily S&P 500 Automobiles Industry Index abnormal returns between January first 2018 and December 30 2022

	coef	std err	t	P>|t|	[0.025	0.975]
No. Observations:		1250		R-squared:		0.443
Dep. Variable:		Ret^SP500_auto		Adj. R-squared:		0.440
Model:		OLS		F-statistic:		197.600
Covariance Type:	Non-robust			Prob (F-statistic):		0.000
const	-0.001	0.001	-1.848	0.065	-0.002	0.000
Mkt	1.346	0.043	31.330	0.000	1.262	1.430
sept_24_to_sept_28_2021	0.021	0.012	1.714	0.087	-0.003	0.046
dec_17_to_dec_21_2021	0.001	0.012	0.079	0.937	-0.023	0.025
jul_26_to_jul_28_2022	0.005	0.012	0.426	0.670	-0.019	0.030
aug_05_to_aug_09_2022	-0.021	0.012	-1.654	0.098	-0.045	0.004
Omnibus:		115.329		Durbin-Watson:		1.990
Prob(Omnibus):		0.000		Jarque-Bera (JB):		740.175
Skew:		-0.051		Prob(JB):		0.000
Kurtosis:		6.768		Cond. No.		70.900

*sept_24_to_sept_28_2021 corresponds to the original bill presentation, dec_17_to_dec_21_2021 is the event window when Senator Manchin announced its opposition to the bill, jul_26_to_jul_28_2022 corresponds to the agreement with Senator Manchin, and aug_05_to_aug_09_2022 is the event window of the bill's approval by Senate.

Source: Own elaboration with data from Fama & French (2023), and SP500-251020, (2023)

Graph 8: Scatter plot between daily Market returns and the S&P 500 Automobiles Industry Group Index daily returns

Source: Own elaboration with data from Fama & French (2023) and SP500-251020, (2023)

Arguably, the impact of the IRA on the automotive industry might be mixed, with leading companies in the electric vehicle space benefiting and the companies that depend on combustion models experiencing a negative impact. To

understand the impact specifically in the electric vehicle segment, I evaluate the S&P Kensho Electric Vehicles Index which contains 44 U.S.-listed companies directly linked to the production of electric vehicles and their infrastructure. Results of the estimations for the S&P Kensho Electric Vehicles Index are presented in Table 8. Results do not indicate evidence of significant abnormal returns around the events. These results hold on the robustness check presented in Table 8A, Annex 1.

Table 8: OLS estimation of equation 2 with 3-day window for daily S&P Kensho Electric Vehicles Index abnormal returns between January first 2018 and December 30 2022

No. Observations:		1250		R-squared:		0.611
Dep. Variable:		Ret_Kensho_evi		Adj. R-squared:		0.61
Model:		OLS		F-statistic:		391.2
Covariance Type:		Non-robust		Prob (F-statistic):		3.27E-252
	coef	std err	t	P>|t|	[0.025	0.975]
const	0.000	0.000	-0.786	0.432	-0.001	0.000
Mkt	1.281	0.029	44.137	0.000	1.224	1.338
sept_24_to_sept_28_2021	0.007	0.008	0.819	0.413	-0.010	0.023
dec_17_to_dec_21_2021	-0.005	0.008	-0.612	0.540	-0.022	0.011
jul_26_to_jul_28_2022	0.006	0.008	0.670	0.503	-0.011	0.022
aug_05_to_aug_09_2022	-0.013	0.008	-1.521	0.128	-0.029	0.004
Omnibus:		113.627		Durbin-Watson:		2.003
Prob(Omnibus):		0.000		Jarque-Bera (JB):		429.586
Skew:		0.371		Prob(JB):		0.000
Kurtosis:		5.774		Cond. No.		70.900

*sept_24_to_sept_28_2021 corresponds to the original bill presentation, dec_17_to_dec_21_2021 is the event window when Senator Manchin announced its opposition to the bill, jul_26_to_jul_28_2022 corresponds to the agreement with Senator Manchin, and aug_05_to_aug_09_2022 is the event window of the bill's approval by Senate.
Source: Own elaboration with data from Fama & French (2023), and S&P Global (2024a)

Graph 9: Scatter plot between daily Market returns and the S&P Kensho Electric Vehicles Index daily returns
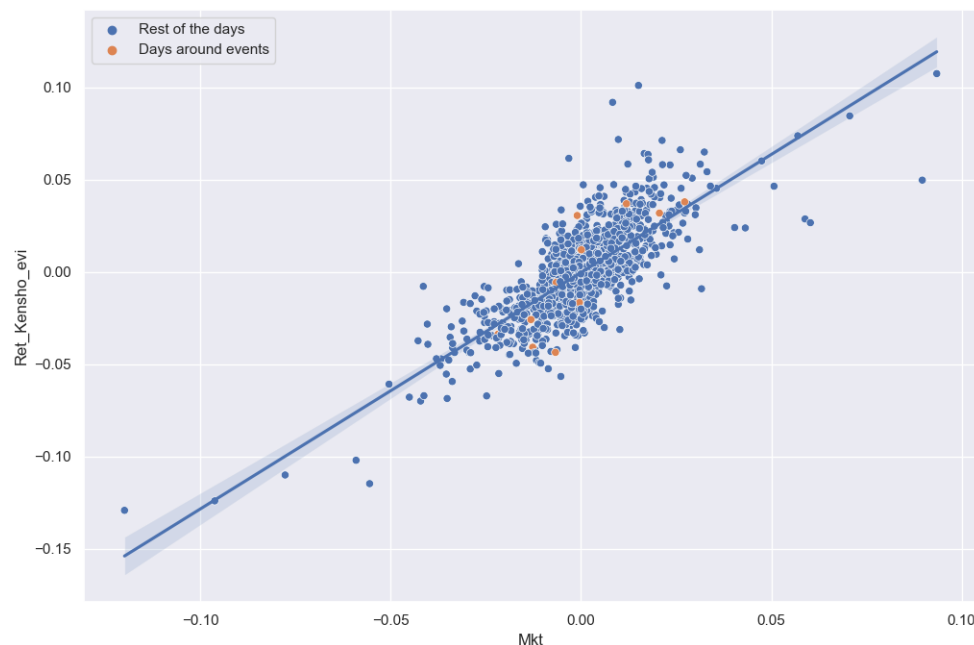
Source: Own elaboration with data from Fama & French (2023)and and S&P Global (2024a)

6 Conclusions

The Inflation Reduction Act represents one of the major policy decisions in history to address climate change and reduce emissions. It has an estimated total investment of $384.9 billion (Huntley Ricco and Arnon 2022) during the next 10 years, mainly on renewable energies and electric vehicles. The present article applied the event study methodology to analyze the impact of the bill on the US stock market specifically on the energy sector and in the automotive industry.

By analyzing the abnormal returns of the market in general, the present study concludes that the market as a whole did not experience abnormal returns during the main events related to the bill approval. Regarding the energy industry, the S&P500 Energy Index experienced an abnormal return of approximately 2.4% around the original bill presentation, while it did not experienced abnormal returns around the other key dates.

Additionally, the NASDAQ Clean Energy Edge Index that measures the performance of companies in the renewable energy segment experienced positive and significant abnormal returns of approximately 1.91% around the agreement with Senator Manchin. Surprisingly the Dow Jones U.S. Oil & Gas Index experienced abnormal returns of 2.3% during the announcement of the original bill, the Build Back Better Act.

Despite the bill's incentives for the production and adoption of electric vehicles in the United Sates, the industry did not experience abnormal returns around the IRA presentation and the two announcements of Senator Manchin. Regarding the IRA's approval, the study did not find conclusive evidence, as the results did not pass the robustness checks. In the case of the electric vehicle segment, the study did not find abnormal returns around the event dates.

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8 Annex 1: Robustness checks with five-day window estimations

Table 3A: OLS estimation of equation 1 with 5-day window for daily Market abnormal returns between January first 2018 and December 30 2022

	coef	std err	t	P>|t|	[0.025	0.975]
No. Observations:		1250		R-squared:		0.002
Dep. Variable:		Mkt		Adj. R-squared:		-0.002
Model:		OLS		F-statistic:		0.474
Covariance Type:		Non-robust		Prob (F-statistic):		0.755
const	0.000	0	0.939	0.348	0	0.001
sept_23_to_sept_29_2021	-0.002	0.006	-0.341	0.733	-0.015	0.01
dec_16_to_dec_22_2021	-0.001	0.006	-0.088	0.93	-0.013	0.012
jul_25_to_jul_29_2029	0.008	0.006	1.253	0.21	-0.004	0.02
aug_04_to_aug_10_2022	0.003	0.006	0.448	0.654	-0.01	0.015
Omnibus:		294.866		Durbin-Watson:		2.338
Prob(Omnibus):		0		Jarque-Bera (JB):		6059.843
Skew:		-0.55		Prob(JB):		0
Kurtosis:		13.73		Cond. No.		15.9

*sept_23_to_sept_29_2021 corresponds to the original bill presentation, dec_16_to_dec_22_2021 is the event window when Senator Manchin announced its opposition to the bill, jul_25_to_jul_28_2022 corresponds to the agreement with Senator Manchin, and aug_04_to_aug_10_2022 is the event window of the bill's approval by Senate.

<div align="center">Source: Own elaboration with data from Fama & French (2023)</div>

Table 4A: OLS estimation of equation 2 with 5-day window for daily S&P500 Energy Index abnormal returns between January first 2018 and December 30 2022

	coef	std err	t	P>|t|	[0.025	0.975]
No. Observations:		1250		R-squared:		0.442
Dep. Variable:		Ret^SP500_auto		Adj. R-squared:		0.439
Model:		OLS		F-statistic:		196.8
Covariance Type:		Non-robust		Prob (F-statistic):		1.23E-154
const	-0.0012	0.001	-1.911	0.056	-0.002	3.14E-05
Mkt	1.3454	0.043	31.287	0	1.261	1.43
sept_23_to_sept_29_2021	0.0119	0.01	1.234	0.217	-0.007	0.031
dec_16_to_dec_22_2021	0.0061	0.01	0.638	0.524	-0.013	0.025
jul_25_to_jul_29_2029	0.0076	0.01	0.789	0.43	-0.011	0.026
aug_04_to_aug_10_2022	-0.0106	0.01	-1.106	0.269	-0.029	0.008
Omnibus:		114.868		Durbin-Watson:		1.995
Prob(Omnibus):		0		Jarque-Bera (JB):		730.832
Skew:		-0.059		Prob(JB):		2.00E-159
Kurtosis:		6.744		Cond. No.		70.9

*sept_23_to_sept_29_2021 corresponds to the original bill presentation, dec_16_to_dec_22_2021 is the event window when Senator Manchin announced its opposition to the bill, jul_25_to_jul_29_2022 corresponds to the agreement with Senator Manchin, and aug_04_to_aug_10_2022 is the event window of the bill's approval by Senate.

<div align="center">Source: Own elaboration with data from Fama & French (2023), and S&P Global (2024b)</div>

Table 5A: OLS estimation of equation 2 with 5-day window for daily NASDAQ Clean Energy Edge Index abnormal returns between January first 2018 and December 30 2022

No. Observations:		1250		R-squared:		0.63
Dep. Variable:		Ret_NASDAQ CEGEI		Adj. R-squared:		0.629
Model:		OLS		F-statistic:		424
Covariance Type:		Non-robust		Prob (F-statistic):		1.06E-265
	coef	std err	t	P>|t|	[0.025	0.975]
const	4.38E-05	0	0.102	0.919	-0.001	0.001
Mkt	1.3803	0.03	45.835	0	1.321	1.439
sept_23_to_sept_29_2021	-0.0051	0.007	-0.76	0.447	-0.018	0.008
dec_16_to_dec_22_2021	-0.0048	0.007	-0.707	0.48	-0.018	0.008
jul_25_to_jul_29_2029	0.0149	0.007	2.209	0.027	0.002	0.028
aug_04_to_aug_10_2022	0.0067	0.007	0.988	0.323	-0.007	0.02
Omnibus:		72.821		Durbin-Watson:		2.034
Prob(Omnibus):		0		Jarque-Bera (JB):		286.1
Skew:		-0.02		Prob(JB):		7.48E-63
Kurtosis:		5.343		Cond. No.		70.9

*sept_23_to_sept_29_2021 corresponds to the original bill presentation, dec_16_to_dec_22_2021 is the event window when Senator Manchin announced its opposition to the bill, jul_25_to_jul_29_2022 corresponds to the agreement with Senator Manchin, and aug_04_to_aug_10_2022 is the event window of the bill's approval by Senate.

Source: Own elaboration with data from Fama & French (2023), and NASDAQ (2024)

Table 6A: OLS estimation of equation 2 with 5-day window for daily Dow Jones U.S. Oil & Gas Index abnormal returns between January first 2018 and December 30 2022

No. Observations:		1250		R-squared:		0.436
Dep. Variable:		Ret_DJ usogi		Adj. R-squared:		0.434
Model:		OLS		F-statistic:		192.7
Covariance Type:		Non-robust		Prob (F-statistic):		4.15E-152
	coef	std err	t	P>|t|	[0.025	0.975]
const	-0.0004	0	-0.843	0.399	-0.001	0.001
Mkt	1.0799	0.035	30.867	0	1.011	1.149
sept_23_to_sept_29_2021	0.0177	0.008	2.263	0.024	0.002	0.033
dec_16_to_dec_22_2021	0.0017	0.008	0.219	0.827	-0.014	0.017
jul_25_to_jul_29_2029	0.0115	0.008	1.472	0.141	-0.004	0.027
aug_04_to_aug_10_2022	0.0002	0.008	0.03	0.976	-0.015	0.016
Omnibus:	189.166			Durbin-Watson:		1.926
Prob(Omnibus):	0			Jarque-Bera (JB):		2469.483
Skew:	-0.183			Prob(JB):		0
Kurtosis:	9.876			Cond. No.		70.9

*sept_23_to_sept_29_2021 corresponds to the original bill presentation, dec_16_to_dec_22_2021 is the event window when Senator Manchin announced its opposition to the bill, jul_25_to_jul_29_2022 corresponds to the agreement with Senator Manchin, and aug_04_to_aug_10_2022 is the event window of the bill's approval by Senate.

Source: Own elaboration with data from Fama & French (2023), and S&P Global (2024c)

Table 7A: OLS estimation of equation 2 with 5-day window for daily S&P 500 Automotive Industry Index abnormal returns between January first 2018 and December 30 2022

No. Observations:		1250		R-squared:		0.442
Dep. Variable:		Ret^SP500_auto		Adj. R-squared:		0.439
Model:		OLS		F-statistic:		196.8
Covariance Type:		Non-robust		Prob (F-statistic):		1.23E-154
	coef	std err	t	P>|t|	[0.025	0.975]
const	-0.0012	0.001	-1.911	0.056	-0.002	3.14E-05
Mkt	1.3454	0.043	31.287	0.000	1.261	1.43
sept_23_to_sept_29_2021	0.0119	0.01	1.234	0.217	-0.007	0.031
dec_16_to_dec_22_2021	0.0061	0.01	0.638	0.524	-0.013	0.025
jul_25_to_jul_29_2029	0.0076	0.01	0.789	0.430	-0.011	0.026
aug_04_to_aug_10_2022	-0.0106	0.01	-1.106	0.269	-0.029	0.008
Omnibus:		114.868		Durbin-Watson:		1.995
Prob(Omnibus):		0		Jarque-Bera (JB):		730.832
Skew:		-0.059		Prob(JB):		2.00E-159
Kurtosis:		6.744		Cond. No.		70.9

*sept_23_to_sept_29_2021 corresponds to the original bill presentation, dec_16_to_dec_22_2021 is the event window when Senator Manchin announced its opposition to the bill, jul_25_to_jul_29_2022 corresponds to the agreement with Senator Manchin, and aug_04_to_aug_10_2022 is the event window of the bill's approval by Senate.

Source: Own elaboration with data from Fama & French (2023), and S&P Global (2024c)

Table 8A: OLS estimation of equation 2 with 5-day window for daily S&P Kensho Electric Vehicles Index abnormal returns between January first 2018 and December 30 2022

No. Observations:		1250		R-squared:		0.611
Dep. Variable:		Ret_Kensho_evi		Adj. R-squared:		0.609
Model:		OLS		F-statistic:		390.1
Covariance Type:		Non-robust		Prob (F-statistic):		1.01E-251
	coef	std err	t	P>|t|	[0.025	0.975]
const	0.000	0.000	-0.761	0.447	-0.001	0.000
Mkt	1.282	0.029	44.116	0.000	1.224	1.338
sept_23_to_sept_29_2021	0.003	0.006	0.523	0.601	-0.009	0.016
dec_16_to_dec_22_2021	-0.006	0.006	-0.880	0.379	-0.018	0.007
jul_25_to_jul_29_2029	0.001	0.006	0.182	0.856	-0.012	0.014
aug_04_to_aug_10_2022	-0.004	0.006	-0.677	0.498	-0.017	0.008
Omnibus:		112.520		Durbin-Watson:		2.005
Prob(Omnibus):		0.000		Jarque-Bera (JB):		426.171
Skew:		0.365		Prob(JB):		0.000
Kurtosis:		5.766		Cond. No.		70.900

*sept_23_to_sept_29_2021 corresponds to the original bill presentation, dec_16_to_dec_22_2021 is the event window when Senator Manchin announced its opposition to the bill, jul_25_to_jul_29_2022 corresponds to the agreement with Senator Manchin, and aug_04_to_aug_10_2022 is the event window of the bill's approval by Senate.

Source: Own elaboration with data from Fama & French (2023), and S&P Global (2024a)