The effects of natural disasters on firm value: Evidence from Hurricane Sandy

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Abstract

The purpose of this paper is to examine how Hurricane Sandy impacted the market value of companies located in disaster areas. We use a dataset of 3,007 firms from the Russell 3000 index during the period 2010-2014. Using the difference-in-differences methodology and the propensity score matching, we find a positive and significant relationship between Hurricane Sandy and firm value. Furthermore, our results indicate that firms located in disaster regions have significant higher return on assets, higher sales growth, lower capital expenditure, and higher dividend yield in the period after 2012. Overall, our findings support for the "build-back-better" hypothesis in the literature.

Keywords: Natural disasters; Hurricane Sandy; Firm value.

JEL Classification: G32

2.1 Introduction

Over the last decades, the number of record disaster events, the number of people affected by natural disasters, and the associated economic losses are dramatically escalating. In detail, we observed an increase of 3,136 natural disaster events worldwide during 20 years (CRED Report). Notably, the international disaster database (EM-DAT) demonstrate that the economic damages expand from 1.63 trillion USD (in the 1980-1999 period) to approximately 2.97 trillion USD (in the 2000-2019 period). One of the main reasons for the growing in the frequency and magnitude of natural disasters and extreme weather events include the rising exposures in hazardous areas, and the increasing wealth and population concentrations in the areas at risk such as coastal regions and, earthquake-prone cities (CRED Report). These notable numbers not only indicate the large-scale effect of natural disasters across the global, but also the vital of developing a greater perception of natural disaster impacts so that proper response mechanisms can be taken to protect lives and property.

Recently, an increasing attention has been paid worldwide to the impact of natural disasters on economic activity. The literature that assesses the economic consequences attributed to natural disasters either focuses on economic growth (Toya & Skidmore, 2007; Noy, 2009; Strobl, 2011), or insurance industry and stock market (Fakhry et al., 2018; Wang & Kutan, 2013; Worthington & Valadkhani, 2004; Worthington, 2008). Nevertheless, there is currently insufficient empirical evidence on how disasters affect firms (Bourdeau-Brien & Kryzanowski, 2017; Leiter et al., 2009; Zhou & Botzen, 2021; Huynh et al., 2020). In fact, natural disasters can also disturb companies through indirect impacts, in addition to direct physical destruction of buildings, equipment, vehicles, and inventory. During the immediate post-impact of a natural disaster, companies are frequently forced to close due to the loss of infrastructure such as water/sewer, electric power, natural gas, transportation, and telecommunications. Furthermore, disasters can result in population displacement, loss of spare income among victims who stay in the affected region, and competition from major outside firms. All of these indirect consequences contribute to a high failure rate among small companies in the aftermath of a disaster (Zhang et al., 2009). Conversely, indirect impacts of natural catastrophes on companies can be beneficial, such as when non-directly affected enterprises take over production from firms with damaged production facilities, or when demand for products and services rises during the recovery phase after a disaster (Zhou & Botzen, 2021).

Contrary conclusions can also be found in the research on long-term disaster consequences. Some researchers claim that natural catastrophes have minimal observable consequences beyond the disruption they produce in the immediate post-impact and short-term recovery periods (Zhang et al., 2009). Other scholars suggest that disasters have long-term effects largely through speeding tendencies that were already underway when the event happened (Bates & Peacock, 2008). They argue that disasters have long-term positive effects because they trigger rebuilding booms and allow communal changes to be accomplished quickly rather than gradually. Similarly, current cross-societal research on the macroeconomic effects of natural catastrophes reveals evidence that climate-related disasters have long-term beneficial economic implications in a variety of dimensions linked to physical capital, human capital, and productivity (Toya & Skidmore, 2007). Overall, understanding the impact of natural catastrophe shocks on companies is definitely an important piece of the puzzle if we want to have a more comprehensive understanding of the entire impact of external shocks on economic activity.

Natural catastrophes receive extensive media coverage, which immediately concentrates public, investors, and political attention on the damage that caused by these events, such as a storm, flood, hurricane or wildfire (Thistlethwaite & Henstra, 2022). Moreover, the impact of natural disaster raises doubts about the future prospects of the company, constitutes a risk for business continuity, and may have an effect on the firm's performance. To our knowledge, the number of empirical studies investigating the relationship between natural disasters and firm performance is very limited (Noth & Rehbein, 2019). Therefore, we suggest filling this gap by investigating the impact of Hurricane Sandy on firm value and the financial characteristics of firm.

We choose Hurricane Sandy as the focus of our study in examining the impact of natural disaster on the market value of individual firms for at least two reasons. Firstly, the Hurricane Sandy caused $50 billion in economic losses in the United States, costlier than any major storm except Hurricane Andrew in 1992 and Hurricane Katrina in 2005 (Tan, 2022). On October 29-30, 2012, Hurricane Sandy devastated New York, notably New York City, its suburbs, and Long Island. Particularly, Sandy flooded the New York City Subway system, several suburban areas, and all road tunnels entering Manhattan except the Lincoln Tunnel. Notably, the New York Stock Exchange was closed for two consecutive days. Fire damaged several houses and businesses, including over hundred homes in Breezy Point, Queens. For many days, large portions of the city and neighboring areas were without power. More important reason, New York topped the list of where companies headquarter located and also the country's top banks, media conglomerates, retailers, and other sorts of enterprises have their headquarters in New York. Building on previous literature, which document that the core business activities of firms occur in close proximity to their headquarters, we determine whether a firm is exposed to Hurricane Sandy using the state location of its headquarter (Bourdeau-Brien & Kryzanowski, 2017; Huynh et al., 2020).

In this study, we contribute to the literature by introducing, for the first time to our knowledge, the relationship between Hurricane Sandy and firm value. The way firms rebuild after a natural disaster event is increasingly important for organizations and investors. Our work therefore contributes to answering a central question: What are the impacts of natural disasters on firm and the financial characteristics of firm? Some articles have also already studied the impact of natural disaster on the stock returns and volatilities of US firms (Bourdeau-Brien & Kryzanowski, 2017), the relationship between drought risk and firm cost of capital (Huynh et al., 2020), how major floods impact the performance of companies in European regions (Leiter et al., 2009; Noth & Rehbein, 2019) or how the 1995 Hanshin-Awaji earthquake affected the stock prices of Japanese insurance companies (Yamori and Kobayashi, 2002), but no previous study to our knowledge deals with the impact of hurricane on firm value and on the determinants of firm value (such as return on assets, sales growth, capital expenditure, or dividend yield). Meanwhile, this question is more topical than ever in the context of the growing in the frequency and magnitude of natural disasters and extreme weather events (CRED Report). Our results are stimulating since they provide evidence of positive and significant relationship between Hurricane Sandy and firm value. Furthermore, we contribute to the extensive empirical literature on the determinants of firm value by showing that Hurricane Sandy has a significant and positive relationship with firm return on assets, sales growth, dividend yield, and negative relationship with firm capital expenditure.

The remainder of our study is organized as follows. The second section briefly outlines the prior relevant literature and proposes prediction about the expected impact of Hurricane Sandy on firm's valuation. The third section presents the data and research methodology, while the fourth section presents and discusses the results of our analysis. The last section concludes.

2.2 Related Literature and Hypotheses

Prior research on the economic implications of natural catastrophes is inconclusive, some scholars argue that natural catastrophes have a favorable impact on economic growth (Albala-Bertrand, 1993; Skidmore & Toya, 2002), while others argue that they have a detrimental impact (Raddatz, 2007; Noy, 2009). From the first perspective, the endogenous growth theory argues that natural catastrophes may contribute to better economic growth, since natural disaster shocks can function as catalysts for reinvestment and enhance capital stock productivity (Shabnam, 2014). Furthermore, vintage capital models are an early branch of endogenous growth models that presume capital always incorporates the greatest available technology at the time of construction. In these models, investment drives technology, which predicts that any faster capital depreciation caused by a natural catastrophic shock would result in better productivity growth since technology will be upgraded. In the literature, this is known as the "build-back-better" theory (Botzen et al., 2019).

For instance, Skidmore & Toya (2002) discovered a partially direct association between the frequency of climatic catastrophes and total factor productivity growth using a cross-section of 89 industrialized and developing nations. Their research made a significant contribution to the literature on the economics of natural catastrophes by explicitly assessing the link between foreign technology absorption and catastrophic incidents. Natural catastrophes, according to their research, update capital stock and drive the adoption of new technologies, which leads to higher total factor productivity (TFP) and GDP growth (GDP). After adjusting for important drivers, the frequency of climatic catastrophes is found to be positively related to TFP growth, human capital accumulation, and GDP per capita growth. One of the explanations for this relationship might be the adoption of new technology. When natural disasters damage a country's capital assets, the economic incentives to replace it with more advanced technologies increase. In other words, natural calamities may present chances to upgrade capital assets, resulting in greater rates of TFP and GDP per capita growth.

Papers studying the effects of natural disasters on financial markets are also inconclusive, with some studies suggesting no significant relationship at the market level (Fakhry et al., 2018; Wang

& Kutan, 2013; Worthington, 2008), while others suggest negative relationship (Yamori & Kobayashi, 2002), and positive relationship (Galido & Khanser, 2013). In particular, Shelor et al. (1992) indicate the increase in the stock price of insurance companies after the October 1989 Loma Prieta earthquake occurred on the California Central Coast in the United States. Notably, the study was the first research that examines the "gaining from loss" hypothesis. This hypothesis demonstrates that insurance firms could benefit from an isolated catastrophic event due to subsequent increased institutional or consumer demand for insurance products and services.

At the firm level, Bourdeau-Briena & Kryzanowski (2017) examine the effect of major natural disaster events (e.g storms, floods, extreme temperature, winter weather, hurricane) on the domestic stock market in the United States. By using event study and ARMA -EGARCH model, the authors indicate that firm stock returns are unaffected by extreme weather events over very short periods of one to five days, after controlling for false discoveries. However, when a two-to-three months event period is used, they show that a small proportion (around 6% or 7%) of the disasters has meaningful impacts on stock returns. Additionally, the stocks of local firms react more strongly to natural catastrophes than that of firms located in nearby states. The authors obtain mixed results for the direction of the impact of natural catastrophes. Their sample is almost equally split between firms experiencing a positive effect and firms facing a negative effect.

Noth & Rehbein (2019) find a positive net effect of natural disaster on Germany firm performance in the direct aftermath of a major flood in 2013. By using event study and different in different method, the authors indicate that firms located in the disaster regions have significantly higher turnover, lower leverage, and higher cash in the period after 2013. According to the authors, the positive net effect can be explained in a variety of ways. While enterprises may reduce investment and lay off staff as a result of lost working capital and a pessimistic economic outlook, governments and insurance companies may reimburse impacted firms for part of their losses, mitigating the negative impacts. Furthermore, replacing outdated capital due to a disaster may result in increased productivity since it allows firms to upgrade their capital stock.

Using similar methodology, Leiter et al., (2009) investigate companies in European regions which were impacted by a major flood in 2000. Their results show on average higher growth of total assets and employment of firms in affected areas than firms in regions unaffected by flooding in the short run. Notably, the positive effect prevails for companies with larger shares of intangible assets. Furthermore, Coelli and Manasse (2014) investigate the impact of a major flood that hit the region of Veneto in 2010 on firms' performance. According to their findings, value added growth of affected businesses is 6.9 percent greater two years after the disaster. The authors also look into the impact of aid transfers in the aftermath of a disaster occurrence. They create four mutually exclusive and exhaustive categories which take into account both the flood and the humanitarian treatment. Their findings show that enterprises exposed to the flood, both those that receive financial help and those that do not, expand faster than reference groups of firms that are neither exposed to the flood nor receive financial aid. The authors also discover a 2% extra growth impact due to the involvement of assistance throughout the recovery period. Therefore, according to this stream of literature, we can hypothesize:

H_1: Hurricane Sandy have positive and significant impact on firm value.

Nevertheless, the AK models (where A stands for productivity and K for the capital stock), suggesting that negative capital shocks from natural disaster have a long-lasting negative influence on output per worker and on the output of the economy. Following this stream of research, Noy (2009) demonstrates that the short-term macroeconomic effects of natural disasters are statistically detectable and more expensive occurrences cause more acute output slowdowns. However, following a disaster of comparable relative severity, emerging nations and smaller economies experience far greater output drops than do industrialized nations or larger economies. A thorough examination of the factors that contribute to these unfavorable macroeconomic output costs finds a number of intriguing trends. Countries with higher levels of government investment, better institutions, higher per capita income, greater trade openness, and higher literacy rates are better able to survive the first shock of a disaster and prevent additional spillovers into the macroeconomy.

At the financial market level, Yamori and Kobayashi (2002) investigated how the 1995 Hanshin-Awaji earthquake in Japan affected the stock prices of Japanese insurance companies after the earthquake struck the Tokyo metropolitan region. The disaster event is the greatest payout since the Japanese earthquake insurance system was founded; this earthquake cost the insurance firms over 77 billion yen. Notably, the authors conducted the first study outside of the US to investigate the gaining from loss hypothesis. They create a portfolio of 13 insurance firms and, using an event research methodology based on Ordinary Least Squares (OLS), assess the daily abnormal returns of the portfolio from day 0 to day 9 following the earthquake. On the day of the earthquake, the authors show an abnormal return that is significantly negative. Based on pre- and post-period estimations, their results are fairly consistent. Contrary to several studies for the US insurance market, they reject the idea that insurance companies might profit from increased demand for their products following a natural disaster. However, their results could be biased because only a small number of portfolio companies are included in this analysis.

At the firm level, Huynh et al. (2020) find a strong positive correlation between drought risk and cost of equity. According to their estimation, companies that experience severe drought have 92 basis points higher cost of equity capital. The authors also offer evidence that enterprises with higher local institutional ownership display a higher cost of equity capital when they are impacted by droughts. Nevertheless, the effect of drought on the expected return is reduced significantly for companies with diversified cash flows/investments, geographically spread business operations, and high cash holdings. In another research, Donadelli et al. (2020) examine how tornado activity affects US stock returns and home prices. In detail, their analysis shows that tornadoes have a detrimental effect on stock returns. However, it appears that only two industries are accountable for this adverse outcome, i.e., consumer discretionary and telecommunications. Therefore, according to this stream of literature, we can hypothesize that:

H_2: Hurricane Sandy have negative and significant impact on firm value.

2.3 Data and methodology

2.3.1 Natural disaster data

We use three data sources to identify the areas which were impacted by Hurricane Sandy. First, we obtain data from the Emergency Events Database (EM-DAT). This database was created with the initial support of the World Health Organization (WHO) and the Belgian Government. Then, it is maintained by the Centre for Research on the Epidemiology of Disasters (CRED). From this dataset we get state-level information, including property and crop losses, impacted states, the number of injuries, fatalities, economic damage estimates and disaster-specific aid contributions for Hurricane Sandy. Second, we obtain data of the flooding areas which caused by Hurricane Sandy from the U.S. Geological Survey's Short-Term Network (STN) database. The dataset provides county-level information, including latitude and longitude data of the flood event. Third, we get GIS information about Hurricane Sandy by using extractions from Ibtracs and Tce-dat database, these datasets provide information about wind speed and the path of the hurricane.

We obtain the headquarters addresses of companies in the Russell 3000 Index from the Worldscope Database. Then, we use Google Earth to find the coordinates of 1107 companies located in 14 impacted states (including Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Caroline, Ohio, Pennsylvania, Virginia, West Virginia). In the next step, we match the firm's coordinates into the disaster impact areas to obtain a list of firms that are directly impacted by Hurricane Sandy. Finally, our treated sample of firms includes those firms that have a distance from their headquarters addresses to the disaster zone equal to 0. Furthermore, we use the rest of the firms as the pool for the control group which includes companies that were not directly impacted by Hurricane Sandy. By using this method, we identify 612 companies in the treatment group and 2395 companies in the control group.

2.3.2 Firm financial charateristics

We obtain data on firm characteristics from the Worldscope Database to supplement our study. All variables are defined in Table 2.1. In order to evaluating the market value of a company, we follow prior research by using Tobin's Q which is computed as the book value of total assets minus the book value of equity and balance sheet deferred taxes plus the market value of equity, all divided by the book value of total assets (Aouadi & Marsat, 2018). Tobin's Q is a forecasting indicator of company performance. A value less than one shows inefficient resource use: the business generates less value on the stock market than its assets are worth. A value larger than one, on the other hand, suggests that the forward-looking market value is greater than the existing worth of its assets. Tobin's Q not only has the benefit of being predicting, but it also addresses some well-known limitations of standard accounting measurements. It is not dependent, for example, on the timing of (unobservable) cash flows in the firm or on management's attempt to manipulate accounting measurements. It represents all areas of performance and offers a thorough foundation for assessing the complete impact of managerial decisions. In addition to Tobin's Q, we use market-to-book ratio as an alternative measure of company market value, to check if our findings continue to hold for different valuation proxy used. Following prior research (Aouadi & Marsat, 2018), we control for firm size (SIZE), profitability (ROA), sales growth (SG), research and development expenditure (RDexpen), leverage (LER), capital expenditure (CAPEX), dividend yield (DIV), firm's age (AGE) in our study. In order to alleviate any concern about the outlier problems, we winsorized all financial data at the 1% and 99% level.

2.3.2 Difference-in-difference approach and Propensity score matching method

In order to exploring the link between firm's market value and Hurricane Sandy, we follow prior research by using difference-in-differences approach for our baseline analysis (Leiter et al., 2009; Noth & Rehbein, 2019). This method allows us to calculate the effect of a treatment (i.e., an independent variable) on an outcome (i.e., dependent variable) by comparing the average change over time in the outcome variable for the treatment group to the average change over time for the control group (Wooldridge, 2002). We use the natural disaster data and firm data to run our baseline regression as below:

$$Q_{it} = \beta_0 + \beta_1 Post2012_t + \beta_2 Sandy*Post2012 + \beta_3 SIZE_{it} + \beta_4 ROA_{it} + \beta_5 SG_{it} + \beta_6 RDexpen_{it} + \beta_7 LER_{it} + \beta_8 CAPEX_{it} + \beta_9 DIV_{it} + \beta_{10} AGE_{it} + \gamma_i + \gamma_t + \varepsilon_{it}$$

Our explanatory variables include Sandy, which is a dummy variable, separating impacted firms from unimpacted firms base on their location. In detail, Sandy variable takes the value of 1 if firms headquarters located in the impacted area, and 0 otherwise. Post2012 is also a dummy variable which take the value of 1 in the years 2012-2014, and 0 otherwise. Therefore, the coefficient β_3 indicates the differential effect on firm's value for companies which have headquarter located in impacted areas after the disaster event compare to companies in unimpacted areas. In our analyses, we clustered standard errors at both firm and year level.

Furthermore, to balance the treated and control group and make them comparable, we use the propensity score matching method (PSM), constraining the control sample to include companies that have similar financial characteristics to the treated sample. This method estimates the probability of being selected into the treatment sample (p(x)), based on observable characteristics (X). Following prior research (i.e Noth & Rehbein 2019, Huynh et al 2020) we use two principal matching variables which include ROA and SIZE in our study. We use value of these variables before the disaster event in the year 2012, as to ensure that the matching parameters are not themselves impacted by the hurricane. After estimating the propensity score, we find exactly one match and without replacement for companies in the treated sample. Additionally, we use a caliper band of 0.01, which means that there are no firms propensity score can be larger than 0.01. We then use these new treatment and control group in further regression as a robustness check for our baseline results.

2.3.3 Research sample

We provide a detailed description of the descriptive statistics in Table 2.2. This table presents the descriptive statistics of our main variables. Panel A summarizes Tobin's Q and explanatory variables of all firms. For the sample include all firms, natural log of Tobin's Q has a mean of 0.501. Furthemore, the Sandy, Post2012 and SandyPost2012 variables vary from 0 to 1 with the mean of 0.199, 0.616 and 0.122 respectively. The mean of the Sandy variable indicates that 20% of firms in the sample were located in the impacted areas. In exploring other financial characteristics in the sample, we note that MB and ROA have an average of 0.724 and 0.087, respectively. Moreover, firm size is on average $14.364 billion. Furthermore, means of other variables such as LER, CAPEX, DIV, RDexpen, SG, AGE, are 0.206, 0.041, 0.014, 0.036, 1.108, and 9.198 respectively.

In order to compare the financial characteristics between firms in the treatment group and firms in the control group. We show their descriptive statistics in Panel B and Panel C, respectively. In particular, the mean of Tobin's Q of treatment firms is 0.486 and the mean of Tobin's Q of control firms is 0.505. After taking the t-test to identify the difference of means, we observe that the descriptive statistics are quite similar between the panel B and panel C. Furthermore, Panel D reports summary statistics of matching samples based on the propensity score matching method. For the sample include matching firms, Tobin's Q has a mean of 0.482. We note that MB and ROA have an average of 0.718 and 0.094, respectively.

To gain insights into our study, we run correlation test between the variables under analysis. The bivariate correlation results indicate that there is no significant correlation between SandyPost2012 variable and Tobin's Q in both Panel A and Panel D samples. As our prediction, there are significant correlation between control variables and Tobin's Q. In detail, the correlation matrix shows that ROA, CAPEX, RDexpen and SG variables have significant and positive correlation with Tobin's Q. In contrast, other control variables such as SIZE, LER, DIV, AGE have negative and significant correlation with Tobin's Q.

Given the significant correlation between certain variables, we tested for multicollinearity by calculating VIF coefficient. In the literature, VIFs are commonly regarded as credible indicators of multicollinearity. Fixed effects models, on the other hand, are designed to be inflated (Baum, 2006). To get meaningful indicators of multicollinearity, we re-estimate a modified model using the OLS technique, which eliminates the fixed effects but generates the same estimated coefficients as the fixed effects model. The modified model is obtained by removing the average of each explanatory variable. The modified variables are then used in an OLS estimation process (Aouadi & Marsat, 2018). Following this strategy, VIFs for all variables under consideration do not exceed 3, showing the absence of severe multicollinearity.

2.4 Empirical Results

2.4.1 Baseline model

We provide our baseline results in Table 2.5. For all firm sample, the results show a positive and significant coefficient of the Sandy*Post2012 variable, indicates that firms impacted by Hurricane Sandy increase their Tobin's Q by 0.042, and increase their Market-to-book ratio by 0.045 compared to the group of unimpacted firms. For the matched firm sample, we also find a positive and significant coefficient of the Sandy*Post2012 variable which indicate that firms impacted by Hurricane Sandy increase their Tobin's Q by 0.069, and increase their Market-to-book ratio by 0.123 compared to the group of unimpacted firms. Therefore, these findings indicate a significant and positive relationship between Hurricane Sandy and firm value. Besides, for all specifications, firm size is negatively related to Tobin's Q and Market-to-book ratio, while profitability is positively and significantly correlated with firm value. Furthermore, sales growth, R&D expenditure, capital expenditure, leverage, and dividend yield are, once again, proven to be highly significant at conventional levels. Overall, we suggest that natural catastrophes might provide a mechanism for companies to invest in newer (and perhaps more productive) capital that would not have been profitable previously owing to the opportunity cost of hanging onto old capital. This capital upgrading mechanism is well established in the literature, especially for highly developed nations (Skidmore & Toya, 2002; Leiter et al., 2009; Noth & Rehbein, 2019).

In order to further explain our finding, we run additional tests on different channels (i.e., return on assets, sales growth, dividend yield, and capital expenditure) that may explain the positive relationship between Hurricane Sandy and firm value. The first channel is the return on assets, since it has been established that firm value is directly related to the firm profitability. Based on previous studies, for instance, Noth & Rehbein (2019) document that companies located in the affected areas have a significant higher turnover in the period after a major flood in 2013, we anticipate a positive association between firm return on assets and Hurricane Sandy. Furthermore, we use sales growth as the second channel, because a greater fraction of firm value is derived from growth opportunities (Aouadi & Marsat, 2018). We expect a positive relationship between Hurricane Sandy and sales growth, as there is an increase in aggregate regional demand after natural disaster events, which strongly support the increase in return on assets and sales growth. In addition, Zhou et Botzen (2021) investigate the short-term effects of storms and floods on firm growth in labor, capital, and sales, using Vietnam's Enterprise Census data (2000-2014) and the economic damage measure only, the authors indicate that the immediate effects of storms on capital growth and sales growth are positive and significant. As revenues grow, we expect that business might raise its per-share dividend yield to attract new investors.

Previous studies have shown a correlation between a manager's risk aversion and a larger incentive to reduce investment expenditure. For instance, Bourdeau-Brien & Kryzanowski (2020) investigate the effects of natural disasters on the financial markets and extrapolate from the US municipal bond transactions how major disasters affect investors' risk-taking tendencies. The authors provide substantial evidence for the hypothesis that natural catastrophes enhance risk aversion at the local level in a statistically and economically significant way. According to Panousi and Papanikolaou (2012) when a corporation experiences uncertainty, managers who are risk-averse will minimized on investment spending. Moreover, Feng et, al. (2022) indicate that businesses in disaster areas decrease their investment and capital expenditures in the aftermath of a disaster. On the basis of this strand of the literature, we anticipate a negative association between Hurricane Sandy and firm capital expenditure.

2.4.2 Channels

Table 2.6 shows the impact of Hurricane Sandy on determinants of firm value using OLS regression. For profitability variable, the results show a positive and significant coefficient which indicate that firms in the treatment group increase their profitability by 0.008 compared to the firms in the control group. Furthermore, firms in treatment group increase their sales growth by 0.025, increase their dividend yield by 0.002, and decrease their capital expenditure by 0.003, compared to the firms in the control group.

As robustness check for our baseline analysis, we investigate the impact of Hurricane Sandy on determinants of firm value for firms in the matching sample. We also find that firms impacted by Hurricane Sandy increase their profitability by 0.006 compared to the group of unimpacted firms. Furthermore, firms in treatment group increase their sales growth by 0.029, increase their dividend yield by 0.001, and decrease their capital expenditure by 0.003, compared to the firms in the control group. Overall, our results are in line with the prediction that firms located in disaster regions have significant higher return on assets, higher sales growth, lower capital expenditure, and higher dividend yield.

It is clear that Hurricane Sandy has an enormous impact on people's lives and livelihoods. After the disaster event, the availability of labor and materials decreased significantly, as well as the disruption in the supply chain has made it difficult for sectors and companies to recover quickly. Therefore, financial support from government aid programs and insurance package is one of the fastest and most substantial ways to mitigate the negative impact of natural disasters and to keep the continuity of the business. This study also has important implications for corporate managers to take advantage of opportunities from the financial support of external stakeholders (i.e the government, or insurance companies), to improve the productivity and efficiency of the business after natural disasters event.

Our finding closely aligns with the prior research, for instance, Noth & Rehbein (2019) find a positive net effect of major floods on firm performance in the direct aftermath of a major flood in 2013 in Germany, or Feng et al., (2022) indicate that businesses in disaster areas decrease their capital expenditures in the aftermath of a disaster, by examining the effects of 33 U.S. hurricanes and 4 tropical cyclones on U.S. public corporations' investment strategies. Nevertheless, there are some restrictions on this paper. In particular, we only look at how Hurrican Sandy has an influence on firm value. We recognize that each disaster has a unique nature and we can not generalize the results to all forms of natural disasters. Moreover, all the evidence for positive net effect for firms in the aftermath of the natural disasters is mostly for developed countries with higher levels of government spending, better institutions, better financial and insurance system, higher per capita income, greater levels of trade openness, and higher literacy rates, which help firms to be prepared, to survive, and to rebuild better the initial shock of disasters. Therefore, it is interesting for future research to investigate whether the positive effect for firms can still be hold in the case of developing countries.

2.5 Conclusion

Although most previous studies explore the impact of natural disasters at the national level and limit the event window to one to five days (Worthington, 2008; Wang & Kutan, 2013), we investigate the long-term effects of natural disasters at the firms level (that is firms' headquarter based in the disaster areas). The attention on local firms is motivated in part by West & Lenze

(1994), who argue that natural disasters are primarily regional in terms of their consequences, and Leiter et al. (2009), who find that companies in disaster-affected regions have higher asset growth than firms in unaffected regions.

In this study, we examine how Hurricane Sandy affects the firm’s market value and firm financial characteristics by using difference-in-differences methodology. We document the positive net effect of Hurricane Sandy on firm value. We suggest that there are a variety of factors that probably have a positive net effect for the market value of companies in the aftermath of natural disasters. Firstly, natural catastrophes destructions can encourage a faster turnover of capital, and they could have favorable results through a faster adoption of new technology. Indeed, replacing outdated production technologies with new ones is benificial for businesses. The second possible reason by the different channels (i.e, return on assets, sales growth, dividend yield, and capital expenditure) through which natural disasters can have an impact on firm value.

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Appendix

Table 2.1 Summary of variables

Variables	*Variable description*
Tobin's Q	Ln ((market value of equity + book value of assets - book value of equity – balance sheet deferred taxes)/book value of assets)
Market-to-book	Ln (market value of equity/book value of equity)
Sandy	Dummy variable, which take the value of 1 if firm's headquarter's located in the impacted area, and 0 otherwise
Post2012	Dummy variable, which take the value of 1 in the years 2012-2014, and 0 otherwise
SandyPost2012	Sandy*Post2012
SIZE	Ln (book value of total assets)
ROA	EBITDA/book value of assets
SG	(Sales in year (t)/sales in year (t - 1))
RDexpen	R&D expenditure/sales
LER	Book value of debt/book value of assets
CAPEX	Capital expenditure/book value of assets
DIV	Dividend per share/stock price per share
AGE	Natural log of the number of days since first listing

Data source: the Worldscope Database.

Table 2.2 Descriptive statistics

Panel A: All firms

Variable	Obs	Mean	Std. Dev.	Min	Max
q	9,419	0.501	0.531	-0.275	0.558
MB	9,419	0.791	0.724	-0.345	0.356
Sandy	9,419	0.199	0.399	0	1
Post2012	9,419	0.616	0.486	0	1
SandyPost2012	9,419	0.122	0.327	0	1
SIZE	9,419	0.364	0.808	0.132	0.501
ROA	9,419	0.087	0.121	-0.405	0.285
LER	9,419	0.206	0.189	0	0.992
CAPEX	9,419	0.041	0.052	0	0.318
DIV	9,419	0.014	0.018	0	0.09
RDexpen	9,419	0.036	0.075	0	0.29
SG	9,419	0.108	0.201	0.812	0.786
AGE	9,419	0.198	0.465	0.985	0.799

Panel B: Firms in the treatment group

Variable	Obs	Mean	Std. Dev.	Min	Max
q	1,872	0.486	0.553	-0.275	0.558
MB	1,872	0.763	0.749	-0.345	0.356
Sandy	1,872	1	0	1	1
Post2012	1,872	0.614	0.487	0	1
SandyPost2012	1,872	0.614	0.487	0	1
SIZE	1,872	0.441	0.875	0.132	0.501
ROA	1,872	0.078	0.127	-0.405	0.285
LER	1,872	0.214	0.199	0	0.953
CAPEX	1,872	0.032	0.046	0	0.318
DIV	1,872	0.017	0.021	0	0.09
RDexpen	1,872	0.031	0.074	0	0.29
SG	1,872	0.098	0.205	0.812	0.786
AGE	1,872	0.181	0.476	0.985	0.799

Panel C: Firms in the control group

Variable	Obs	Mean	Std. Dev.	Min	Max
q	7,547	0.505	0.525	-0.275	0.558
MB	7,547	0.798	0.718	-0.345	0.356
Sandy	7,547	0	0	0	0
Post2012	7,547	0.617	0.486	0	1
SandyPost2012	7,547	0	0	0	0
SIZE	7,547	0.345	0.79	0.132	0.501
ROA	7,547	0.089	0.119	-0.405	0.285
LER	7,547	0.204	0.186	0	0.992
CAPEX	7,547	0.043	0.053	0	0.318
DIV	7,547	0.013	0.017	0	0.09
RDexpen	7,547	0.037	0.075	0	0.29
SG	7,547	0.11	0.2	0.812	0.786
AGE	7,547	0.202	0.462	0.985	0.799

Panel D: Matching firms

Variable	Obs	Mean	Std. Dev.	Min	Max
q	3,631	0.482	0.527	-0.251	0.523
MB	3,631	0.76	0.718	-0.384	0.325
Sandy	3,631	0.491	0.5	0	1
Post2012	3,631	0.601	0.49	0	1
SandyPost2012	3,631	0.294	0.455	0	1
SIZE	3,631	0.482	0.85	0.725	0.017
ROA	3,631	0.094	0.101	-0.182	0.295
LER	3,631	0.205	0.187	0	0.919
CAPEX	3,631	0.038	0.049	0	0.259
DIV	3,631	0.015	0.019	0	0.101
RDexpen	3,631	0.028	0.059	0	0.22
SG	3,631	0.086	0.167	0.795	0.527
AGE	3,631	0.23	0.438	0.028	0.799

Table 2.3 Correlation matrix

Panel A: All firms

	q	MB	Sandy	Post2012	Sandy Post2012	SIZE	ROA	LER	CAPEX	DIV	RDexpen	SG	AGE
q	1.00												
MB	0.88***	1.00											
Sandy	-0.01	-0.02	1.00										
Post2012	0.09***	0.12***	-0.00	1.00									
Sandy Post2012	0.02	0.02*	0.75***	0.29***	1.00								
SIZE	-0.30***	-0.14***	0.02*	0.04***	0.03*	1.00							
ROA	0.16***	0.20***	-0.04***	-0.02	-0.03**	0.21***	1.00						
LER	-0.15***	0.08***	0.02*	0.04***	0.02	0.30***	0.07***	1.00					
CAPEX	0.07***	0.10***	-0.08***	0.05***	-0.04***	0.01	0.23***	0.22***	1.00				
DIV	-0.21***	-0.15***	0.08***	0.03**	0.07***	0.28***	0.06***	0.22***	0.06***	1.00			
RDexpen	0.41***	0.30***	-0.03**	0.03*	-0.02	-0.34***	-0.41***	-0.23***	-0.12***	-0.27***	1.00		
SG	0.23***	0.19***	-0.02*	-0.05***	-0.03*	-0.12***	0.03***	0.03**	0.13***	-0.10***	0.14***	1.00	
AGE	-0.10***	-0.06***	-0.02	-0.08***	-0.04***	0.26***	0.18***	-0.02*	-0.03**	0.17***	-0.15***	-0.20***	1.00

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Panel D: Matching firms

	q	MB	Sandy	Post2012	Sandy Post2012	SIZE	ROA	LER	CAPEX	DIV	RDexpen	SG	AGE
q	1.00												
MB	0.88***	1.00											
Sandy	-0.01	-0.01	1.00										
Post2012	0.07***	0.10***	-0.00	1.00									
Sandy Post2012	0.03	0.05**	0.66***	0.53***	1.00								
SIZE	-0.32***	-0.16***	0.01	0.05**	0.03	1.00							
ROA	0.31***	0.35***	-0.06***	0.01	-0.03	0.12***	1.00						
LER	-0.15***	0.07***	0.04*	0.02	0.03	0.29***	0.06***	1.00					
CAPEX	0.06***	0.10***	-0.11***	0.06***	-0.05**	0.02	0.28***	0.23***	1.00				
DIV	-0.17***	-0.11***	0.09***	0.03*	0.07***	0.25***	0.04*	0.25***	0.06***	1.00			
RDexpen	0.38***	0.28***	-0.04*	0.01	-0.03	-0.32***	-0.26***	-0.23***	-0.11***	-0.27***	1.00		
SG	0.25***	0.22***	-0.03	-0.09***	-0.05**	-0.10***	0.14***	0.02	0.11***	-0.11***	0.12***	1.00	
AGE	-0.06***	-0.02	-0.02	-0.02	-0.02	0.26***	0.12***	-0.01	0.04*	0.14***	-0.07***	-0.15***	1.00

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2.4 Variance inflation factor

	VIF	1/VIF
RDexpen	1.422	0.703
ROA	1.33	0.752
SIZE	1.307	0.765
AGE	1.164	0.859
DIV	1.163	0.86
LER	1.127	0.887
CAPEX	1.121	0.892
Post2012	1.119	0.894
SandyPost2012	1.106	0.904
SG	1.094	0.914
Mean VIF	1.195	.

Table 2.5 Impact of Hurricane Sandy on firm value

	OLS		PSM	
VARIABLES	Tobin's Q	Market to book	Tobin's Q	Market to book
Post2012	0.179***	0.305***	0.259***	0.292***
	(0.014)	(0.020)	(0.041)	(0.055)
Sandy*Post2012	0.042***	0.045**	0.069**	0.123***
	(0.014)	(0.020)	(0.031)	(0.040)
SIZE	-0.040***	-0.014***	-0.065***	-0.035***
	(0.004)	(0.005)	(0.009)	(0.012)
ROA	1.453***	1.883***	0.640***	0.741***
	(0.091)	(0.110)	(0.181)	(0.207)
SG	0.245***	0.270***	0.533***	0.500***
	(0.035)	(0.044)	(0.099)	(0.115)
RDexpen	2.951***	3.526***	0.000*	-0.000
	(0.152)	(0.188)	(0.000)	(0.000)
CAPEX	0.006	-0.206	-1.504***	-1.940***
	(0.122)	(0.182)	(0.382)	(0.555)
LER	-0.139***	0.569***	-0.059	0.685***
	(0.033)	(0.055)	(0.094)	(0.139)
DIV	-0.107	0.409	2.741***	4.768***
	(0.269)	(0.471)	(0.947)	(1.507)
Constant	0.687***	0.435**	0.981***	1.128**
	(0.125)	(0.181)	(0.317)	(0.439)
Observations	7,257	7,257	1,329	1,329
Adjusted R-squared	0.400	0.336	0.247	0.179
Industry fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes

This table reports the results of panel data regression to explore the relationship between Tobin's Q and Hurricane Sandy. The first Model investigate the inclusion of all firms in the sample. Sandy is a dummy variable based on the firms headquarter location with regard to the impacted areas. It is set equal to 1 if firms headquarter is located in impacted areas and equal to 0 if it is in unimpacted areas. The second model is based on a matched sample using 2011 values of the following variables: ROA, SIZE. We include industry and time fixed effects in all specifications and compute two-way clustered standard errors at the firm and year level.
***, ** and, * represents statistical significance at the 1%, 5%, and 10% level, respectively.

Table 2.6 Impact of Hurricane Sandy on determinants of firm value

	OLS				PSM			
VARIABLES	ROA	SG	DIV	CAPEX	ROA	SG	DIV	CAPEX
Post2012	-0.004	-0.024***	-0.000	0.003**	-0.003	-0.033***	-0.000	0.005**
	(0.003)	(0.007)	(0.000)	(0.001)	(0.005)	(0.011)	(0.001)	(0.002)
Sandy*Post2012	0.008**	0.025**	0.002***	-0.003**	0.006*	0.029**	0.001*	-0.003**
	(0.003)	(0.012)	(0.001)	(0.001)	(0.004)	(0.014)	(0.001)	(0.002)
SIZE	0.010***	-0.010***	0.001***	-0.002***	0.005***	-0.008***	0.001***	-0.001*
	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.000)	(0.000)
ROA		-0.188***	0.012***	0.072***		-0.081*	0.025***	0.079***
		(0.029)	(0.001)	(0.005)		(0.044)	(0.004)	(0.007)
SG	0.030***		-0.006***	0.015***	0.068***		-0.008***	0.014***
	(0.008)		(0.001)	(0.003)	(0.012)		(0.002)	(0.005)
RDexpen	-0.762***				-0.607***			
	(0.035)				(0.054)			
CAPEX	0.277***	0.296***	0.004		0.270***	0.210**	-0.007	
	(0.029)	(0.062)	(0.005)		(0.041)	(0.086)	(0.010)	
LER	-0.044***			0.016***	-0.000			0.013**
	(0.009)			(0.004)	(0.011)			(0.006)
DIV	0.270***			-0.020	0.434***			-0.052
	(0.063)			(0.038)	(0.089)			(0.050)
AGE	0.016***	-0.069***			0.015***	-0.045***		
	(0.003)	(0.005)			(0.004)	(0.007)		
Constant	-0.180***	1.912***	-0.002	0.037***	-0.165***	1.652***	0.002	0.015*
	(0.031)	(0.049)	(0.003)	(0.006)	(0.043)	(0.065)	(0.005)	(0.008)
Observations	7,574	7,800	7,505	7,268	2,968	2,990	2,883	2,859
Adjusted R-squared	0.363	0.105	0.285	0.364	0.331	0.062	0.265	0.473
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

This table presents the results of the direct impact of Hurricane Sandy on one of determinants of firm value (i.e return on assets, sales growth, dividend yield, and capital expenditure) using OLS regression and PSM matching. Sandy is a dummy variable based on the firms headquarter location with regard to the impacted areas. It is set equal to 1 if firms headquarter is located in impacted areas and equal to 0 if it is in unimpacted areas. We include industry and time fixed effects in all specifications and compute two-way clustered standard errors at the firm and year level.
***, ** and, * represents statistical significance at the 1%, 5%, and 10% level, respectively.

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