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Insurance companies and storms

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PREFACE AND ACKNOWLEDGEMENTS

This paper is written to graduate from the master Financial Economics at the Erasmus University of Rotterdam. After working at the insurance firm HDI Global I specifically chose to research insurance companies as I found it interesting to combine my work with my studies, increasing my ability to learn and better understand the structure within insurance companies. Completing this thesis was definitely not without its difficulties and I could not have finished the paper without a strong support group. Firstly, I would like to thank my supervisor dr. Jan Lemmen, who has always been available to help me with any problems I'm encountered during the research process. Secondly, my family, who have supported me throughout this process and have always been eager to help me with my questions.

ABSTRACT

The optimal investment strategy for property-casualty insurance companies is to invest in companies with a low book-to-market ratio. Over the period of 2005 to 2017, the book-to-market ratio had a negative influence on the stock prices from one day before (t = -1) until one day after (t = +1) the storms. This resulted in a return of 0.3%. Factors such as the storms, type of firm, days, firm characteristics and storm characterises provide no investment opportunity and are therefore not included in the investment strategy. The property-casualty insurance companies are stable investments, since the stock prices only fluctuate by a small proportion after surviving the most enormous storms. Because of this, the property-casualty insurance companies are an attractive investment for risk-averse investors.

Keywords: Property-Casualty Insurance Firms, Major Storms, Ordinary Least Squares, Event Study, Stock Prices.

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CHAPTER 1 Introduction

Between 2008 and 2018, the United States experienced more than 200 natural disasters that killed a total of 1 million people (EM-DAT, 2018). Not only is the number of total deaths extreme, but also the total financial losses caused by these natural disasters, namely: 527 billion US dollars. A lot of these losses are covered by the insurance companies in the United States (Angbazo and Narayanan, 1996) and because of this, the insurance companies are of great importance. The financial impact due to these losses on the insurance companies is enormous. However, the insurance companies have known about this impact for many years and have eliminated their risk with the use of premiums and other regulations. Nonetheless, several questions remain: to what extent is this risk eliminated? Are insurance companies a good investment strategy due to this risk elimination? In this research, I investigate what the best short term investment strategy has been for the property-casualty insurance industry regarding storms over the period of 2005 to 2017 in the United States.

A number of studies have examined the influence of one storm on the stock prices of the insurance firms. For example, Lamb (1995) investigated the influence of hurricane Andrew in 1992 on the property-liability insurance firms, which can be divided into two groups: firms that were exposed to the storm and firms that were not. The results showed that both firms experienced a negative significant influence of the storms. Also, Shelor, Anderson and Cross (1992) examined the influence of the degree of exposure to earthquake Loma Pierta in 1989 on property-liability firms in the United States. In contrast to Lamb (1995), Shelor et al. (1992) concluded that the unexposed insurance firms experienced a significant positive relationship to the stock prices, whereas exposed firms experienced a decrease in stock price.

A study of Blau, Van Ness and Wade (2008) examined the influence of two hurricanes, Katrina and Rita, and the differences between these storms in supply and demand of insurance stocks. They investigated whether the investors had learned from Katrina and adapted this learning curve on the next hurricane, Rita. The results illustrated that the investors had learned, as can be deducted from the increase in trade of insurance stocks even before the damage of the storm was known.

This study explores how the property-casualty insurance companies handle their short-term increase in risk caused by hurricanes in the United States over the period of 2005 to 2017. First, the influence of a storm on the stock prices of these insurers is examined, using the abnormal return, the market model and the Standardized Cross-Sectional Test by Boehmer, Masumeci and Poulsen (1991). Furthermore, influences on the stock prices are measured by characteristics of an insurance company, namely the degree of exposure of the firm to the storm and the amount of direct premium written. The cumulative abnormal return (CAR) is used to measure these influences. Third, the characteristic of the storm and the amount of losses, are investigated, also using the CAR. Finally, the structure of each firm is examined more closely in combination with the stock prices. The CAR, the degree of exposure and the amount of direct premium written are used for this.

This paper has the following research question:

"Is there an optimal short term investment strategy for the property-casualty insurance companies over the period of 2005 to 2017, regarding storms that have received at least a 3 on the Saffir Simpson Hurricane Index in the United States?"

The optimal investment strategy for property-casualty insurance companies is to invest in companies with a low book-to-market ratio. Over the period of 2005 to 2017 the book-to-market ratio had a negative influence on the stock prices from one day before (t = -1) until one day after (t = +1) the storms. This resulted in a return of 0.3%. Factors such as the storm, type of firm, day, firm characteristics and storm characteristics provide no investment opportunity and is therefore not included in the investment strategy. The property-casualty insurance companies are stable investments, since the stock prices only fluctuate by a small proportion after surviving the most enormous storms. Because of this, the property-casualty insurance companies are an attractive investment for risk-averse investors.

This paper is divided in the following sections: Chapter 2 describes earlier research. Chapter 3 discusses four hypotheses. Some background information is provided on the storms and the insurance companies in Chapter 4. Chapter 5 explains the data used and the methodology of this research is elaborated in Chapter 6. The results are shown in Chapter 7. The recommendations and limitations of this paper are discussed in Chapter 8 and finally the research question is answered in Chapter 9 Conclusion.

CHAPTER 2 Literature review

Several investigations were performed in relation to natural disasters, such as the short- and long-term influences of natural disasters on the stock prices, the different influences of natural disasters on emerging and developed countries or the influence of the natural disasters on different industry sectors within the market. In this review, articles that are related to this research are selected, such as literature concerning storms and literature concerning the cumulative abnormal return (CAR).

2.1 Literature concerning natural disasters

Table 1 shows the existing literature concerning the natural disasters. A few striking aspects can be obtained from the literature.

First, in most cases, the literature shows a specific investigation in one kind of natural disaster. Second, each of these studies are done on short-terms, except for the research of Bourdeau-Brien and Kryzanowski (2017). Third, an event study with a market model is used for each research on natural disasters. The estimation window for the different investigations differ, but in most cases the estimation window ends 11 days before the disaster. Fourth, the event window has a maximum of 30 days (t= +30) after the disaster. Although, these windows are suitable for these investigations, the article of Blau et al. (2008) showed that the authors learned from previous natural disasters, which means that the short selling of insurance stocks had already begun before the natural disaster occurred. Furthermore, the results of each investigation showed either negative significant results for the abnormal return (AR) and the CAR or insignificant results. The results of the AR are further investigated with the use of a regression with the CAR as dependent variable. Table 1 captures all these points, except for the CAR variables.

Table 1 Literature corresponding natural disasters, stock markets and premiums

Author(s) (publication year)	**Time period**	**Region**	**Method**	**Estimation and event window**	**Results AR (day) or CAR (day to day)**
Shelor et al. (1992)	1989	California, United States	Event study: Market model, GLS.	Estimation window: -200 to -1 days for expected daily return. Event window: AR/CAR: 0 to 15 days.	AR (1): +64.5% for all property-liability and multiline insurance companies. CAR: not significant.
Lamb (1995)	1992	Florida, United States	Event study: Market model.	Estimation window: -150 days to -11 for expected daily return. Event window: AR/CAR: -10 till +30 days.	Negative significant effect. Most negative AR (1): -0.0172 and AR (2): -0.035. CAR: not significant.
Angbazo and Narayanan (1996)	1992	Florida, United States	Event study: Market model, GLS	Estimation window: -120 to -11 for expected daily return. Event window: AR/CAR: -10 till + 21 days.	Negative significant effect. AR (-3): -0.0081 AR (0): -0.0068 AR (+1): -0.0120 CAR (-1; +1): -1.55%
Knight and Pretty (1999)	1998-1990	United States	Event study: Market model, regression	Estimation window: 12 months. Event window: CAR: over -6 to 0 and 1 to +7 months	Negative significant effect. Increased trading volume 4 times. No significant influence of the stock volatility.
Browne and Hoyt (2000)	1983-1993	United States	Logit model	Monthly data over 1978 to 1982. Demand model over 1983-1993.	Income has an elasticity of 1.56. Premium has an elasticity of 0.997.
Cummins, Doherty and Lo (2002)	1983-1997	United States	Regression	Yearly observations.	Insurers pay more after a natural disaster. 1991: 79.6% of the 100 billion losses. 1997: 92.8% of the 100 billion losses.
Yamori and Kobayashi (2002)	1995	Japan	Event study: Market model	Estimation window: -160 to -11 days return. Event window: AR/CAR: -10 to +9 abnormal return.	Negative significant effect. Equally weighted portfolio: CAR(0; +1): -2.7%. CAR (0; +9): 3.7% Value weighted portfolio: CAR (0; +1): -3.3%. AR not significant for both portfolios.
Worthington and Valadkhani (2004)	1982-2002	Australia	ARMA	ARMA: Price returns 0 to 5 days.	Cyclones (+2; +5): -0.98%. Bushfires (+2; +4): +0.79 to +0.86%. Earthquakes (0; +5): -0.38% to -0.47%. No significant effects of storms and floods.
Born and Viscusi (2006)	1984-2004	United States	Logit model, regression	2 years.	Lower premium due to the elasticity of 0.973 and firms exiting the sector.
Ewing, Hein and Kruse (2006)	1998-2000	United States	Event study: Market model, ARCH, GARCH	Estimation window: 1998 till 2000; daily Event window: CAR: 0 till 10 days	Hurricane Floyd CAR (0; +10): -0.022. After a negative media reaction a decrease of 1.97% of the stock market. Hurricane Andrew CAR

					(0; +10): -0.0272. After a negative media reaction a decrease of 2% of the stock market.
Blau et al. (2008)	2005	United States	Event study: Mean adjusted model, regression	Estimation window for short selling: 10 days. Pre disaster -5 till -1. Post disaster +1 till +5.	Negative price adjustment one week before Katrina. Increase short selling before Rita with maximum value of 4.59% at t=-2.
Gangopadhyay, Haley and Zhang (2010)	2002-2005	United States	Event study: Market model.	Estimation window: 2002-2004; daily. Event window: AR: -5 to +10 days. CAR: -1 to +1	Katrina: AR(0): -0.79. AR(1): -0.76. CAR(-1;+1): -1.73. Rita: AR(-5) to AR (-2): -1.75 to 0.53. CAR(-1; +1): 2,73
Born and Klimaszewski-Blettner (2013)	1984-2007	United States	Logit model	1 year.	Expected disasters: Around 30/40% exit the market. Unexpected: Homeowners are more likely to exit the market than commercial insurers.
Wang and Kutan (2013)	1989-2011	United States and Japan	GARCH	1 to 5-day lag.	Japan: Overall significant positive effect. Cyclone: 0.34% daily. Earthquake lag 3: 0.34%. Tsunami: 0.84% daily gain. United States: No significant effect, expect the volcanic eruption: -0.76%
Bourdeau-Brien and Kryzanowski (2017)	1990-2014	United States	ARMAX, ARMA, GARCH	Estimation window: 250 days. Event window: 1 to 125 days.	19 out of 39 countries show a negative effect on the stock market. The impact is spread over 2/3 months with 40 days as peak.

2.2 Literature concerning CAR

As shown in Table 1, most studies showed a significant negative reaction of the CAR. Several papers did a sub-analysis using a regression as seen in Table 2. Location of the firms and the amount of direct premiums written per state over the total amount were mostly used to investigate the reaction of the CAR. In most cases, this reaction was insignificant for both the location and the amount of direct premium written.

Table 2 Literature surrounding CAR

Author(s) (publication year)	**Dependent variable**	**Variables**	**Results (%)**
Shelor et al. (1992)	First regression: CAR (0; +1)	Dummy variable: Firms located in California or not. Dummy variable: Firms write earthquakes insurance or not.	The location did not have an effect on the market.
Shelor et al. (1992)	Second regression: CAR (0; +1)	Dummy variable: Dollar amount of the premium of the earthquake over the total amount of premiums written. Dummy variable: Dollar amount of net premium over the total written out premium.	The proportion of premiums impacted neither the market response nor the amount of earthquakes.

Lamb (1995)	First regression: CAR (0; +1)	Dummy variable: Direct premium written out in Florida or Louisiana.	Negative price response of 5.768 of direct premium on CAR (0; +1)
Lamb (1995)	Second regression: CAR (0; +1)	The amount of direct premium over total amount of direct premium of the firm in Florida or Louisiana.	Negative price response of 0.863 on CAR (0; +1)
Angbazo and Narayanan (1996)	Stock price impact	1. Direct premiums over total premiums in Florida and Louisiana. 2. Loss reserves as fraction of net premiums. 3. Total amount of reinsurance protection over total direct premiums.	There is no significant impact on the stock price due to the exposure in Florida and Louisiana. No significant impact of the differences in loss reserves and the amount of reinsurance protection.
Knight and Pretty (1999)	CAR (0; +30); (0; +60); (0; +90); (0; +120); (0; +150); (0; +180); (0; +210).	Size, impact, industry insurance, fatalities, country, responsible, class, publicity.	Only impact had a significant reaction on the CAR, which was positive for each post-event period. 0.0843; 0.1298; 0.1298; 0.1838; 0.1184; 0.2662; 0.1783.
Yamori and Kobayashi (2002)	CAR (0;+1)	1. Net premium income over total premium. 2. ROA for each firm. 3. Risk exposure for each firm.	Premium: -0.0020. ROA: +0.0339. Risk exposure: -0.0696.
Gangopadhyay et al. (2010)	First regression: CAR (-1; +1)	1. Dummy variable: Located in the affected countries 2. The size of the company. 3. Market to book ratio	Katrina: Located: -1.73. Not located: -1.26. Rita: Located: 2.73. Not located: 1.19. Size not significant. Market to book significant and positive; (Values not displayed)
Gangopadhyay et al. (2010)	Second regression: CAR (-1; +1)	1. The degree of exposure. 2. The size of the company. 3. Market to book ratio	Katrina: Located: -2.15. Rita: Located: 3.38. Size not significant. Market to book significant and positive; (Values not displayed)

2.3 Contribution

As the literature review showed, almost every research is done on only one storm. Only the studies of Blau et al. (2008) and Gangopadhyay et al. (2010) have compared two storms. No other study has performed a comparison of multiple storms to discover an optimal investment strategy. By comparing different storms, information can be obtained about the factors that influence the price fluctuations of the stock prices. Moreover, information on the structure within an insurance company, the protection mechanisms of insurance companies, but also the learning curve of the investors can be achieved. In this paper investigates what the best short term investment strategy is for the property-casualty insurance industry regarding to storms over the period of 2005 to 2017 in the United States.

CHAPTER 3 Research framework

In this chapter the hypotheses that help to answer the research question: *"Is there an optimal short term investment strategy for the property-casualty insurance companies over the period of 2005 to 2017, regarding storms that have received at least a 3 on the Saffir Simpson Hurricane Index in the United States?"* are discussed.

Each of the hypotheses in the next section provides more insight into the best investment strategy for the property-casualty insurance companies. Each hypothesis discusses factors that could be an influence on the price fluctuations of the stocks, namely: the influences of the storm, the firm characteristics, the storm characteristics and the firm specific conditions. Moreover, every hypothesis is investigated over the period of 2005 to 2017, although this is not mentioned in the hypothesis in order to provide more clarity.

3.1 Hypotheses

Storms that received at least a 3 on the Saffir Simpson Hurricane Index have a devastating effect, since they cause considerable damage and a high amount of financial losses. The property-casualty insurance companies have to cover these losses based on the insurance coverage of the policy holder. Insurance companies have learned from this and try to defend themselves against possible losses. The question remains: do insurance companies eliminate the risk enough (or over-eliminate it) and does the market believe this as well? The market beliefs are translated into a reaction on the stock prices of the property-casualty insurance companies. Moreover, there is a difference between the insurance firms, which is based on the degree of exposure caused by the storm. Although the literature showed different responses for the degree of exposure, the assumption was made in this paper that the exposed insurance companies have not totally eliminated the risk caused by the storms. Due to this, the storms have a negative influence on the stock prices of the exposed firms. Insurance firms that are not exposed to the storms do not experience the extra risk caused by the storms. These unexposed firms did, however, account for the possibility of this extra risk and therefore have a surplus. The market accounted for this and therefore increased the stock prices of the unexposed firms. Based on this information the first hypothesis is:

(1) "*A storm has a negative significant influence on the stock prices of the exposed property-casualty insurance companies, whereas a storm has a positive influence on the stock prices of the unexposed property-casualty insurance companies."*

This hypothesis is investigated for each storm that received at least a 3 on the Saffir Simpson Hurricane Index over the period of 2005 to 2017. This is researched for each storm to discover possible differences between or a trend in storms. Both the exposed firms and the unexposed firms are examined relative to the market.

The next hypotheses specify other factors that could have an effect on the price fluctuations of the stocks namely: the firm characteristics. The degree of exposure is also researched, however, now on the difference between the exposed and unexposed firms, since a lot of differences caused by the storm can exist between these variables. The same influence is expected on the stock prices by the exposed and unexposed firms, due to the same assumption.

The direct premium written is the following firm characteristic that is investigated. The direct premium written is an important tool for insurance companies since it determines the revenue of insurance companies. Moreover, the direct premium written also downgrades the degree of risk exposure. This leads to a positive influence on the stock prices.

Besides these variables, there are a lot of other firm characteristics that could provide investment opportunities, such as the market size of a company and the height of the book-to-market ratio (Fama and French, 1992, 1995). The market size could influence the stock prices, because, in general, the smaller firms outperform the larger firms due to the larger extent of growth opportunities. The question remains: is this also the case for insurance companies? Larger insurance companies could take on more risk, which is of great importance for these storms. Since no literature about this phenomenon exists, the second hypothesis is based on the theory of Fama and French (1992, 1995), which states that the smaller firms have a positive influence on the stock prices, but the larger companies have a negative influence.

Furthermore, the height of the book-to-market ratio determines whether a stock is a value stock or a growth stock. A value stock is a stock with a high book-to-market ratio that outperforms a growth stock with a low book-to-market ratio (Fama and French, 1992, 1995), which is caused by the valuation of a company. If this is also the case with insurance companies, the fifth hypothesis will show this. These firm characteristics in combination with the stock prices lead to the second to fifth hypothesis:

(2) "*For each storm, exposed firms have a negative significant short term influence on stock prices compared to unexposed firms.*"

(3) "For each storm, the amount of direct premium written has a positive significant short term influence on the stock prices of the property-casualty insurance companies."

(4) "For each storm, smaller firms have a positive significant short term influence on the stock prices of the property-casualty insurance companies, whereby the larger firms have a negative significant short term influence on the stock prices."

(5) *"For each storm, a high book-to-market ratio has a positive significant short term influence on the stock prices of the property-casualty insurance companies."*

These hypotheses are investigated for each storm that received a minimum of 3 on the Saffir Simpson Hurricane Index over the period of 2005 to 2017. Although the variables are examined for four different hypotheses, each variable is included in the same model to avoid possible biases.

In addition to the firm characteristics, the characteristic of the storm could be of influence on the price fluctuations of the stocks as well. An important characteristic is the amount of losses caused by the storm, since insurance companies have to cover most of these financial losses. In general, a higher amount of losses leads to a higher financial amount needed to be covered. This results in the sixth hypothesis:

(6) *"The amount of losses caused by the storms has a significant influence on the stock price of the insurance companies after checking for degree of exposure, the amount of direct premium written, size and book-to-market ratio."*

This hypothesis is examined for each storm that received at least a 3 on the Saffir Simpson Hurricane Index, combined over the period of 2005 to 2017, after checking for the earlier mentioned firm characteristics. The storms are thus examined with the sixth hypothesis collectively and with the earlier hypotheses the storms are researched individually.

The property-casualty firms are investigated collectively through the earlier hypotheses, but individually through the following hypothesis. This is done because one company could deviate from the other property-casualty firms. This is done with the degree of exposure, the direct premium written and the amount of losses, since deviations exist in this variables between the firms. The last hypothesis is stated as follows:

(7) *"On firm level, the amount of losses and the exposed firm compared to the unexposed firms have a negative significant short term influence, but the amount of direct premium written has a positive short term influence on the stock prices after checking for size and book-to-market ratio."*

The firms are investigated over the multiple storms that have occurred over the period 2005 to 2017.

CHAPTER 4 Background information on storms and insurance companies

4.1 Degrees tropical storms

A lot of differences exist between storms, such as the wind speed, the location where the storm strikes, the amount of damage that is done, etc. (National Hurricane Center). The Saffir Simpson Hurricane Wind Scale divided the various storms into groups based on their maximum wind speed on a scale from 1 till 5, and storms that have a score of 3 or more receive names (World Metrological Organization).

Storms occur in the United States at the Atlantic Coast and at the Eastern Pacific Coast (National Hurricane Center). In the United States the hurricane season lasted from the 15th of May till 30th of November in the period of 2004-2017. Every year, the National Hurricane Center (NHC) estimates the possible number of storms that may strike during the hurricane season that year and this estimation has been accurate over the last 15 years. Additionally, the NHC also estimates the “best track” for each storm. The “best track” date shows the exact date when the storm was seen until when the storm has ended. After recognizing a storm, the NHC provides an update on the intensity and direction of the storm every 6 hours.

4.2 Insurance company structure

Natural disasters have been happening for decades. The insurance companies therefore know that these disasters affect their profit and adapt to the risk of natural disasters. To prevent the losses, tools such as the direct premium, for example the height of the direct premium written and the insurance coverage, are used. Other insurance companies, such as a reinsurer, are also used. A reinsurer is a company where the insurance company can insure themselves against possible aspects (Choulli, Taksar and Zhou, 2001). The insurance company has to pay a premium to the reinsurer based on the type of risk and the financial characteristics of the firm (Taksar, 2000). The reinsurer helps to spread out the risk in times of natural disasters, so that the insurance company will stay solvent, since not only the amount of claims are high but the claims mostly come at the same time (Choulli et al., 2001). Due to the reinsurer the insurance company can survive these kinds of natural disasters and can even take on more claims.

4.2.1. Direct premium and earned premium

Natural disasters cause a lot of stress for the property-casualty insurance companies. The insurance firms therefore try to rebuild their capital after a major disaster with the use of higher premiums, which results in higher prices for the policy holder. These prices can increase to such a high level that for some policy holders, the insurance is not affordable anymore (Federal Insurance Office, 2013). This means that not everyone is (fully) insured against possible losses. There is no public data available on how many policy holders are insured, but there is data available containing information on the amount of premium collected for the insurance policy. The direct premium is the total amount of the premiums collected before costs are deducted (Epermanis and Harrington, 2006; Gangopadhyay et al., 2010). Thus the direct premium written shows the growth of revenue of an insurance company (Herweijer, Ranger and Ward, 2009).

The premiums are based on four different elements: the type of coverage, the amount of coverage, the competition between the insurance companies and personal information. Personal information, such as the residential location, has an influence on the height of the direct premium (Changnon, Changnon, Fosse, Hoganson, Roth and Totsch, 1997; Kron, 2002; Pompe and Rinehart, 2008). Figure 1 shows that the amount of direct premium written is higher for the damaged states than other states, especially for California (CA), Texas (TX) and Florida (FL). The legend of each state is shown in Table 13 of Appendix A.

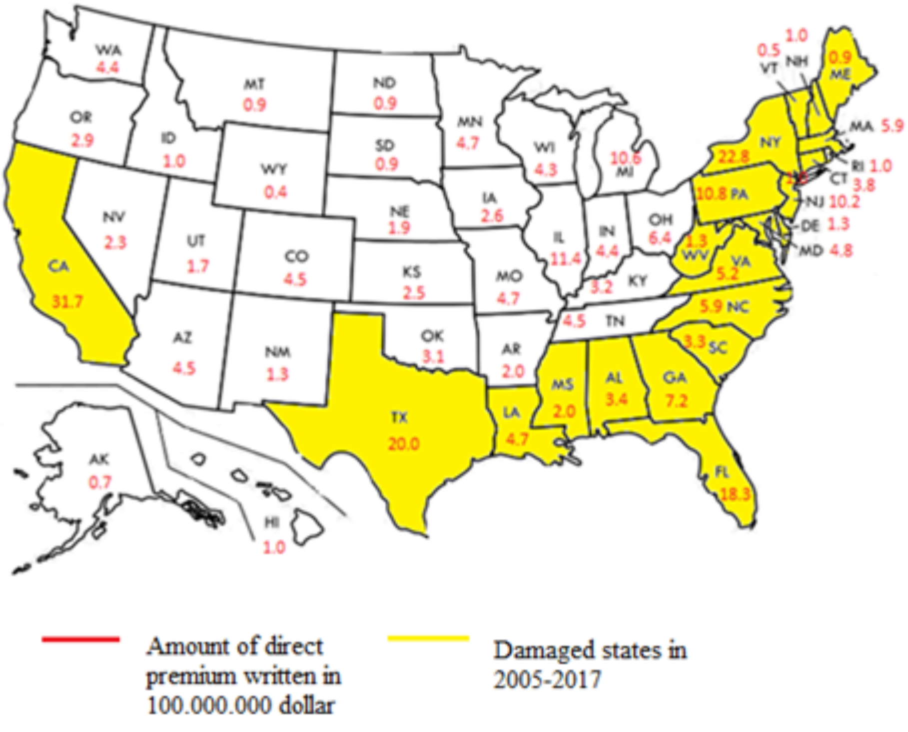

Figure 1 Damaged states and direct premium 2005-2017 in 100.000.000 dollar

Another important variable is the earned premium, which is the profit for the insurance companies. The earned premium is the amount of the direct premiums after deducting the costs. Figure 2 shows the amount of direct premiums written over the period of 2005 to 2017, based on the reports of the National Association of Insurance Commissioners (NAIC). Over the years, the amount of direct premium written has increased. After every catastrophe the insurance companies learn from this and adapt their premium (Federal Insurance Office, 2013).

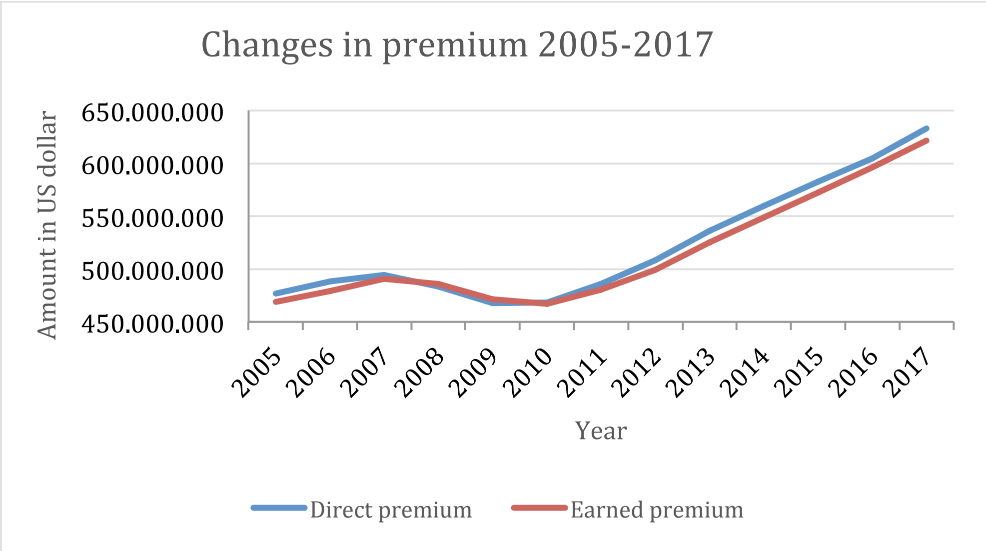

Figure 2 Changes in direct premium and earned premium

4.2.2. Insurance coverage

Besides the opportunities that insurance companies see to their gain with the height of the premium, the decrease of insurance coverage is also an opportunity to gain profit (Changnon et al., 1997; Kunreuther, 1996). This means that policy holders cannot totally insure themselves against natural disasters when living in exposed areas. The NAIC (2019) shows that 60% of the economic losses caused by natural disasters in 2018 were not insured by insurance companies. Flood insurance, which includes floods that are caused by hurricanes, is the source of this 60%, since this is mostly not covered by the standard insurance (Strum and Oh, 2010). The losses incurred correspond to the insurance coverage, since the holder can receive a payment for losses incurred based on the coverage during the year (Business Dictionary). It does, however, not say how the coverage has changed over the years. The losses incurred are therefore seen as costs for an insurance company.

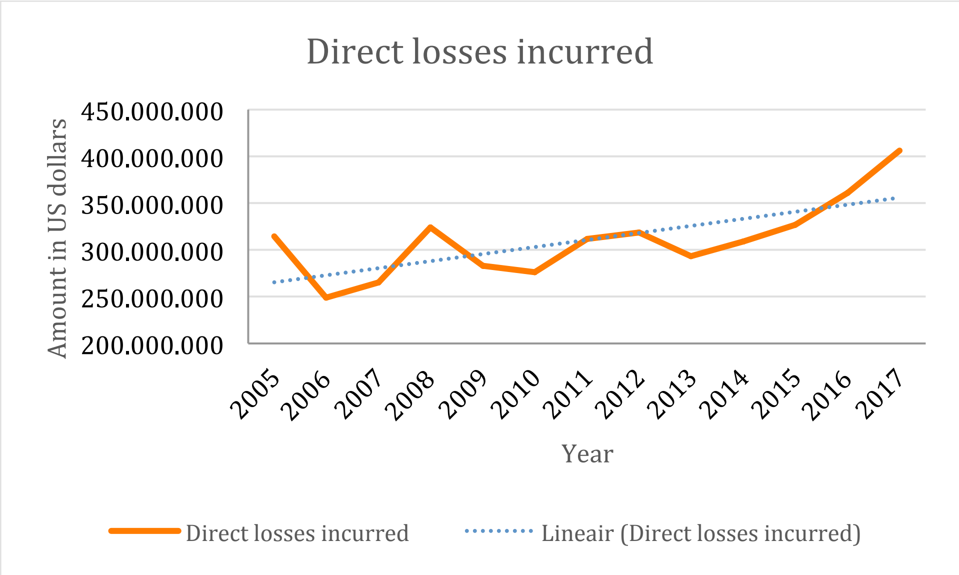

Figure 3 Direct losses incurred

CHAPTER 5 Data

In this chapter the data that is needed for this research is discussed. First, the data of the property-casualty insurance companies is collected. Then, the data of the storms is selected over the period of 2005 to 2017. Finally, the variables are discussed that are used in the CAR regressions are discussed.

5.1 Insurance companies

The type of publicly held insurance companies that is selected in this research is the property and casualty insurance in the United States. This particular group is selected because property and casualty insurance covers risks related to loss or damage of property (Statistica). This type of insurance focuses on two main subjects: protection of physical objects and protection against legal liability. The first part is especially important in this research, due to the damage caused by storms and the associated losses that need to be covered by the insurance.

Based on the reports of the NAIC, a selection is made of the property-casualty insurance companies in the United States. These reports showed the insurance companies in the United States, the business category of the insurance companies and the location of the companies. These reports are collected from 2005 till 2017 since earlier reports of the NAIC do not exist. Three main factors are of importance when selecting the sample: the business line (property-casualty), the existence of the company between 2005 and 2017 and the companies being public. Based on these factors, a selection is made from the reports of the NAIC. The insurance companies that are included in the sample had at least 50% of their business line in property-casualty, to obtain the largest possible sample and the most accurate results. This has led to the following sample of 54 publicly held insurance companies:

Table 3 Publicly held property-casualty insurance companies

The insurance companies included have at least 50% of their business line in property-casualty and were public between 2005 to 2017. * shows the largest companies over 2004 to 2017 according to the National Association of Insurance Commissioners in the United States.

Company	
Alleghany*	Horace Mann Educators*
Allianz*	Infinity Pr. & Clty.*
Allstate*	Kemper
American Financial GRP.*	Mbia GRP.
American International GRP.*	Mercury General*
American National IN.*	Markel*
Arch CAP.GP.*	Mgic GRP.
Aspen Insurance Holding GRP.	Navigators GRP.
Assurance America	Old Republic INTL.*
Assured Guaranty	Progressive*
Axis Capital HDG.*	Proassurance
Baldwin & Lyons	Protective Insurance
Berkshire Hathaway*	QBE Insurance GRP.*
Chubb LTD.*	Radian GRP.
Cincinnati Financial*	Reinsurance Group of AM.
Cna Financial	Rli*
Countrywide Insurance*	Safety Insurance GRP.*
Donegal GRP.	Seibels Bruce GRP.
Emc Insurance GRP.*	Selective Insurance GRP.*
Erie Indemnity*	State Auto Financial*
Everest RE GRP.*	Swiss RE*
Fairfax Financial HOLD.*	Travelers COS.*
Federated National HDG.*	United Fire GRP.
First acceptance	Universal Insurance HDG.
Hallmark Financial Services	W R Berkley*
Hanover Insurance GRP.	White Mountains Insurance GRP.
Hartford Financial SVS. GRP.	Zurich Insurance GRP.*

Aspen Insurance Holding GRP., First Acceptance, Kemper and Mbia GRP. changed their company name over the years, according to Bloomberg (2019) and Mbia (2019). Since the company itself remained the same, both companies are included in the sample. Moreover, Protective Insurance and Reinsurance Group of Amer. are part of a bigger insurance organization, namely Baldwin & Lyons and Kernan GRP (National Association of Insurance Commissioners, 2017). Most companies included in the sample are the parent company of different insurance companies. Protective Insurance and Reinsurance Group of Amer. are daughter companies and their results can therefore deviate from the mother company, which could provide some interesting results. Furthermore, these companies are included to obtain the largest possible sample.

Although Allianz, Swiss RE, QBE Insurance GRP. and Zurich Insurance GRP. are originally from another country, they are still included in the sample. The main reason is that the reports of the NAIC showed that these companies are among the biggest insurance companies in the United States. These companies are therefore included in the sample to obtain the largest possible sample.

5.1.1. Market index

The established sample has to be compared with the market index for the event study (MacKinlay, 1997). The market index used in this paper is the Standard & Poor's 500 index (S&P 500) because it contains 500 different types of companies that differentiate in size and sectors (Investopedia, 2019). This results in a real indicator of the market. The S&P 500 is selected instead of the Dow Jones Industrial Average (DJIA), Russell 2000 and Nasdaq Composite Index. The main disadvantage of these indexes is that each company contains only one kind of size or sector. Moreover, only five companies with a weight of 2.19 are included in the S&P 500 are also used in this paper. Since this is a relative small amount, the S&P 500 is considered a good indicator of the market for this research.

5.2 Storms

The data of the storms is collected from the EM-DAT (2018) database and the location of the damage is collected from the reports of the National Hurricane Center (2018), Blake, Rappaport and Landsea, (2007) and Blake, Landsea and Gibney (2011).The storms that are included stroke the United States after 2004. Storms are excluded from the sample when they had no clear start date, because this resulted in problems for the event study. Furthermore, only storms with names are included in the sample, due to the fact that a name is only given to the most dangerous storms (CNN, 2018). Moreover, the storms that had zero insurance losses are included because the market may react even before it knows what the actual insurance losses are, as is shown in the literature of Lamb (1995), Angbazo and Narayanan (1996) or Blau et al. (2008).

The states that are damaged by the storms are obtained from the National Hurricane Center (2018). Only for Irene, Sandy and Nate, the location could not be found in these reports and were left out of the sample. This resulted in the following sample of the natural disasters that caused damage in the United States:

Table 4 Natural disasters that damages the United States after 2004

Storms in this table are the storms that received at least a 3 on the Saffir Simpson Hurricane Index over the period of 2005 to 2017 and that had a clear location of damage and a clear start date. The total damage and insured losses are collected of EM-DAT (2018) database and are in US billion dollars.

Storm	**Location damage**	**Start date**	**Total damage ('000 US$)**	**Insured losses ('000 US$)**
Dennis	CA	10-07-05	2.230.000	1.115.000
Katrina	FL	29-08-05	125.000.000	60.000.000
Rita	SC	23-09-05	16.000.000	11.300.000
Wilma	FL	24-10-05	14.300.000	10.350.000
Ernesto	FL	02-08-06	32.860	0
Dolly	FL	23-07-08	1.200.000	600.000
Fay	FL	20-08-08	180.000	0
Hanna	CA, TX	28-08-08	160.000	0
Gustav	FL, CA, MS	01-09-08	7.000.000	3.500.000
Ike	FL	12-09-08	30.000.000	15.000.000
Ida	FL, NC, VA	09-11-09	600.000	0
Earl	TX	03-09-10	100.000	0
Lee	CA	04-09-11	750.000	560.000
Isaac	CA, TX	28-08-12	2.000.000	0
Iselle	CT, DE, MA, MD, ME, NC, NH, NJ, NY, PA, RI, VA, VT, WV	08-08-14	66.000	0
Hermine	CT, DE, MA, MD, ME, NC, NH, NJ, NY, PA, RI, VA, VT, WV	01-09-16	600.000	270.000
Matthew	AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, VA, WV	07-10-16	10.000.000	5.000.000
Harvey	TX, LA	25-08-17	95.000.000	30.000.000
Irma	FL	10-09-17	57.000.000	29.000.000

Source: EM-DAT (2018) and the reports of the National Hurricane Center.

5.3 Variables for the CAR regression

As can be seen from Section 2.2 several different variables are used. These variables are, for example, the location of the companies, the amount of direct premium written per state and several firm characteristics. In this paper the degree of exposure, the amount of direct premium written, the amount of losses and the firm characteristics are included as variables for the CAR regression. These variables are discussed in the next sections, except for the variable, losses caused by storms, which is mentioned below.

The losses caused by storms are shown in Table 4 in column "Total damage in US dollar". The insured losses are not used in the CAR regression. Nonetheless, it will be interesting to compare the results for each storm with the total insured losses, especially for the zero insured losses. For example, although a company did not lose any value due to the insurance, the market could still have an effect on the stock price of the company itself.

5.3.1. Degree of exposure

Looking at the different companies included in the sample, the first thing that is of importance is the location. As the investigation of Shelor et al. (1992) and Lamb (1995) suggests, a sample has to be made of exposed and unexposed firms for each storm. This is important because it is expected that the storms have a bigger influence on the exposed firms. As mentioned before, the reports of the NAIC also show the locations of where the companies are domiciled. A sample is made of each year for each company, because the locations of the companies could change over the years to either exposed or unexposed areas. Table 16 in Appendix C shows an example of this sample for the year 2017. Since most of the companies in the sample are a parent company, the location of the subsidiaries are also included. Each location of the subsidiary is included, as well as the ones from another business line. This is done because the stock prices are only the stock prices of the parent companies are known and therefore have to capture the total company information.

Although the locations where the company is domiciled are included, insurance companies still write out premiums in other states. This is not included in the data since this information is not available. Nevertheless, if this information is not available, the market does not know either and it is therefore not of any influence on the stock prices. Table 16 in Appendix C shows, for each storm, the state that has been damaged by the storms and the companies that are located in that state.

However, it has to be kept in mind that some companies are located in multiple states. As can be seen from the Table 15 in Appendix B, Berkshire Hathaway, Chubb LTD. and Zurich Insurance GRP., for example, are located in multiple states. Because of this, the effect of the storm may be smaller for these companies than for companies that are located in only one state. Companies located in only one state are Assurance America, Countrywide Insurance and Radian GRP., and the influence of the storm should therefore be more pronounced.

5.3.2. Direct premiums

Besides the degree of exposure, the direct premiums are also examined in this research as is done as well by Shelor et al. (1992), Lamb (1995), Angbazo and Narayanan (1996), Yamori and Kobayashi (2002) and Gangopadhyay et al. (2010). The direct premium written is an important factor in this research, since it is the gross revenue of the insurance company (Epermanis and Harrington, 2006; Gangopadhyay et al., 2010). Moreover, as explained in Chapter 4, an increase of the premium could indicate an increase in buffer to eliminate the risk by storms for insurance companies. Therefore, the premium is also an important variable to include.

The earned premium and losses incurred are not used in this analysis, since the variables are connected to the direct premium written and to each other. To avoid the potential risk of bias in this research, this variable was not included. I have specifically chosen for the direct premium written, since the earned premium is booked at the end of the year and the losses incurred are also fully known at the end of the year. In contrast, the direct premium is known at the beginning of the year. The direct premium written is therefore more accurate and known at the date of the storm.

The data of the direct premium is collected from the NAIC reports for each year per company. The data does not show how much direct premium is spent per state, only a total amount per company. After collecting the amount of direct premiums, the logarithm function is taken of this value to obtain a normal distribution (Walck, 1996). Only for the companies Countrywide and Reinsurance of America the direct premiums are not available for each year. Due to this, I have chosen to leave those companies out of the sample for the CAR regressions. Figure 4 shows the changes regarding the premium of the companies combined over the years. Figure 3 shows the same upwards trend as Figure 1.

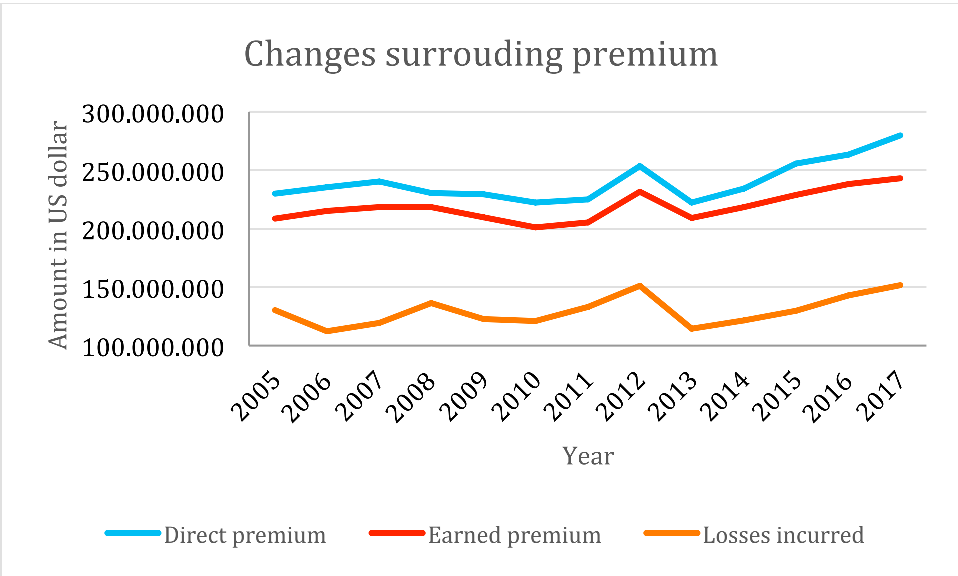

Figure 4 Changes direct premium, earned premium and losses incurred of selection companies

5.3.3. Market size and book-to-market ratio

Two important factors are the size of the company and the type of stock, since there are significant deviations between the companies and this could bias the results (Fama and French, 1992). The reports of NAIC show the 125 biggest insurance companies in the property-casualty business line in 2004-2017. A big difference exists between the companies in the sample, since 32 firms of the 54 firms in the sample belong to the biggest insurance firms in the United States throughout the years 2004-2017. Which companies belong to the biggest ones is shown in Table 4 with an asterisk (*). Due to this big difference, the market size is included as a (control) variable to control for the fact that small firms outperform big firms. Smaller firms outperform bigger firms, since smaller firms have a higher opportunity to grow than bigger firms and they receive a higher return (Fama and French, 1995). The market size of each company in the sample is collected from Datastream as the market value. The market value is the number of shares outstanding times the share price. The logarithm function is taken of this value, to obtain a normal distribution (Walck, 1996).

Another phenomenon that can create biases in the results is the type of stock (Fama and French, 1992, 1995). Each of the insurance stocks can be classified as either a value stock or a growth stock based on the firm conditions. Value stocks are traded under their fundamental value, which is not related to the company operations but to the irrational beliefs of the market. Moreover, value stocks typically have a lower risk than growth stocks (Bauman and Miller, 1997; Fama and French, 1992, 1995). A growth stock has a high growth expectation and grows faster than the overall market. Companies related to growth stocks invest their earnings in growth opportunities. These companies are thus more innovative and newer than companies related to value stocks (Fama and French, 1992, 1995).

Value stocks outperform growth stocks in an upturn of the economy, whereas growth stocks outperform value stocks in a downturn of the economy. For this reason a control variable has to be included into the regression to avoid biases. This is done using of the book-to-market ratio, which is collected per year from Datastream. A company with a book-to-market ratio above 1 is referred to as a value stock, whereas a company with a book-to-market ratio below 1 is referred to as a growth stock (Harris and Marston, 1994). The book-to-market ratio differs not only for each firm and for each storm, but also within a company. So, the insurance stocks cannot be classified as either a value or a growth stock.

CHAPTER 6 Methodology

In this section, the methods used for this investigation are discussed. Firstly, the time periods of the event window and the estimation window are determined. Secondly, the methodology of each hypothesis is discussed with the use of the market model, the abnormal return and the CAR. This is done to discover the best investment opportunity in the insurance companies in combination with the storms that received at least a 3 on the Saffir Simpson Hurricane Index over the period of 2005 to 2017.

6.1. Time periods

To investigate the relationship between the storms and the insurance companies, a difference has to be made between two periods, namely the period before the storm, the estimation window, and the period surrounding the storm, the event period. For both of these periods, the length has to be determined. This is not without difficulty because every choice has its advantages and disadvantages.

Before looking into both periods more closely, a sample is made of the storms that have occurred in 2004 to 2017 based on the report of the National Hurricane Center. These reports show the "best tracks" dates for each storm. The "best tracks" dates show the exact date when the storm was spotted until the storm has ended. Besides this, the National Hurricane Center also shows the possible direction of storms. The "best tracks" dates are collected of the storms that have obtained a name, since the reports of these storms provided records about the best tracks. This resulted in a sub-sample of 432 different kinds of storms in either the Atlantic Coast or the Eastern Pacific Coast. This information is public and therefore it may be assumed that the market has responded to this information. This sample is shown Table 16 of Appendix D.

6.1.1. Event window

Before determining the event window, the efficiency of the market has to be verified. The more efficient the market is, the faster the prices will change after an event has occurred. Since I investigate the stock market, it can be assumed that the market is most efficient. This is, due to the increase in technology, the stock prices can change instantly when an event occurs.

The period before and after the storm has occurred is of importance in this investigation. These two periods combined are called "the event period". The period before the storm is of importance because the formation and the possible direction of the storm will be on the news. Assumed is that the market will therefore already react on this news and change the stock prices of the insurance companies. The period after the storm is of importance, since the total damage caused by the storm is known during this period. A difficulty in this research is that each storm has its own length and therefore the event window differentiates for each storm. So, for example, Harvey was spotted 15 days before the storm had caused damage, but with Gaston or Agatha the storm was spotted only 1 day before damage was caused.

To be consistent, one period is chosen as event window. Earlier research, such as Lamb (1995), Angbazo and Narayanan (1996) and Yamori and Kobayashi (2002) showed that in these researches the period before is equal to 11 days (t = -11). However, these researches are based on one kind of storm and are relatively outdated. As mentioned, new technologies have been developed and the predictions regarding storms have become more precise. Due to this, an average is calculated based on the sample, explained above, of the 432 different kinds of storms. This resulted in an average of 5.43 days as “best track”. As Cowan (1992), Morck (1992), MacKinlay (1997) and Blinder (1998) mention, it is better to obtain a longer period surrounding the event, to really capture the event. Therefore, an event window of 6 days was chosen. This event window includes days before and after the occurrence of the storm, since the best track data illustrates the moment when the storm is discovered until its end. These 6 days are, therefore, combined with the begin date of each storm. Each storm with a clear beginning date is collected of the EM-DAT (2018) database and is combined with the 6 days, which is shown in Table 18 of Appendix E. This has led to an event window of t = -3 till t = +3.

6.1.2. Estimation window

The second choice that has to be made is over the period without a storm. It is of extreme importance that no other event has occurred in this period that could be of any influence on the insurance companies (MacKinlay, 1997). The longer this period without storm is, the more accurate the results will be. In general, the estimation window is directly connected to the event window. Earlier studies, such as Lamb (1995) and Angbazo and Narayanan (1996) have shown that the estimation window did not result in any problems, since these researches have chosen the first storm of the year. In this paper multiple storms are studied and these storms are directly following up to each other or even overlapping each other as is shown in Table 16 of Appendix D. Due to this, another period has to be chosen that is not directly before the event window.

The estimation window will cause some difficulties, since this period has to be a period in which no other event has occurred. As is mentioned in Chapter 4, the period in which no natural disaster occurs is for both the Atlantic Coast and the Eastern Pacific Coast between the end November until the beginning of May. Based on the reports of the National Hurricane Center over the period of 2004 to 2017, no storms have occurred earlier than the 6^{th} of May in this period and not later than 28^{th} of November, except for Alex and Arlene in 2016 and 2017. Because these are the only two and extreme rare cases, the estimation window is from 29th of November till the 2^{nd} of May. These exact dates are chosen since there is accounted for the event period of 3 days before the storm (t= -3). This will result in an estimation window of 156 days. In my opinion choosing an estimation window of 156 days will result in the best possible and unbiased results.

Between the periods of 2004 to 2017, four leap years occur. To be consistent with the data, the estimation window should be 156 days each year, also for the leap years of 2004, 2008, 2012 and 2016. The sample for these years will be from the 29th of November till 1st of May.

6.2. Influence of the storm on the stock prices per degree of exposure

After establishing the time periods, the methodology for the first hypothesis is discussed in this section. The first hypothesis touched upon the influence of the storm on the stock prices of the insurance companies in the period of 2005 to 2017, whereby the exposed firms experienced a negative influence and the unexposed firms a positive influence. The first step in researching this, is collecting the daily stock prices of the insurance companies from Datastream.

Next, these prices are transformed into the return with the use of the following formula (MacKinlay, 1997; Shelor et al., 1992; Lamb, 1995):

$$(1)\ R_t = (P_t - P_{t-1})/P_{t-1}$$

Where

R_t is the return at day t,

P_t is the price at day t,

and P_{t-1} is the price at day $t-1$.

Third, the parameters are calculated with the use of the market model. This model is chosen, because we can assume that there is a linear relationship between the market return and the securities return (MacKinlay, 1997). The market model illustrates how the supply and demand determine the price and the quantity (Campbell and MacKinlay, 1997), thus how the storms influences the stock prices of the public insurance companies. This results in the following formula:

$$(2)\ R_{sit} = \alpha_{si} + \beta_{si} R_{mt} + \varepsilon_{sit}$$

Where

R_{it} is the actual return given each storm s and period t for firm i,

R_{mt} the market return, which is illustrated with the S&P 500,

and α_{si}, β_{si} and ε_{sit} are the intercept, the slope and the error corresponding the relationship between the actual and the market return given each storm s and period t for firm i, respectively.

Regressions (1) and (2) are calculated with the use of Eventus, provided by Erasmus University Rotterdam.

Fourth, in combination with the formulas of (1) and (2) the abnormal return for each firm and for each storm is calculated. This leads to the following formula:

$$(3)\ AR_{sit} = R_{sit} - \left(\hat{\alpha}_{si} + \hat{\beta}_{si} R_{mt} \right)$$

Where

AR_{sit} is the abnormal return given each storm s and period t for firm i,
R_{sit} is the actual return surrounding given the storm s and period t for firm i,
R_{mt} the market return, which is illustrated with the S&P 500,
and $\hat{\alpha}_{si}$ and $\hat{\beta}_{si}$ are the intercept and the slope corresponding the relationship between the actual and the market return given period t for firm i for each storm s, respectively.

Since the influence of the storm on the stock prices is investigated per degree of exposure, two groups are made: exposed and unexposed firms. Which firms are exposed for each storm is shown in Table 15 of Appendix C. The AR_{sit} of each firm is combined based on the degree of exposure to calculate the average abnormal return, AAR. This leads to the following regression:

$$(4)\ AAR_{stex} = \frac{1}{N_{firms}} \sum AR_{sit}$$

The average abnormal return shows the abnormal return for each storm s and period t per status of exposure ex. After this, the Two-paired T-test is used for AAR_{stex} for each group, to discover if there is a significant influence of the storm on the stock prices of the insurance firms.

Next, with the use of the AAR, the CAAR will be calculated. The CAAR is the difference between the expected return of a stock and the actual return that is often used to discover the impact of news on the stock price taken over the average (Nasdaq, 2019). The CAAR is calculated as follows:

$$(5)\ CAAR_{(-t;t)} = AAR_{t-1} + AAR_t$$

Where

$CAAR_{(-t;t)}$ is the cumulative average abnormal return of the period of $-t$ and t of each AR company combined,
AAR_{sit} the average abnormal return given each storm s and period t for firm i.

After calculating the $CAAR_{(-t;t)}$ for each storm, the significance level is determined with Standardized Cross-Sectional Test by Boehmer et al. (1991). This is done with the following formula:

$$(6)\ t_{(-t;t)} = \frac{1}{N}\Sigma \frac{ACAAR_{(-t;t)}}{\sqrt{\frac{1}{N(N-1)} * \Sigma(CAR_{si(-t;t)} - ACAAR_{(-t;t)})^2}}$$

Where

$t_{(-t;t)}$ is the t statistic according to Boehmer et al. (1991) calculated for each storm and dived into two groups based on the degree of exposure,

$ACAAR_{(-t;t)}$ is the average $CAAR_{(-t;t)}$ for each company on the period $-t$ and t,

N is the number of companies in the sample based on the degree of exposure,

and $CAR_{si(-t;t)}$ is the cumulative abnormal return for storm s and company i over the period $-t$ and t.

The CAAR is specifically calculated with the Standardized Cross-Sectional Test, since this test accounts for event volatility. Event volatility is the additional variance that the storms bring into the stock prices of the insurance companies and the Standardized Cross-Sectional Test by Boehmer et al. (1991) accounts for changes in the volatility. This T-test is therefore stronger than the Two-paired T-test used by the AAR since the Two-paired T-test does not account for the event volatility. Standardized Cross-Sectional Test can, however, not be used on the AAR and therefore the highlight lies on the significant results of the CAAR. This does not mean that the t-statistic of the AAR can be neglected, since this can provide some extra support of the results. This is the methodology needed to either accept or reject the first hypothesis.

6.3. CAAR regressions

6.3.1. The degree of exposure and the amount of direct premium written

In this section the methodology for the second until fifth hypothesis is discussed. These hypotheses discuss the influences of the firm characteristics, namely the degree of exposure, the amount of direct premium written, the market size and the book-to-market ratio.

The CAAR variable calculated at regression (5) is used to investigate the second hypothesis. The CAAR is used and not the AAR, since the CAAR provides less biases in the results than the AAR. Besides this, a specific CAAR that provided significant results at regression (6), is researched further, since this provides more insight into the possible reasons of the influence on the abnormal return.

This leads to formula (7):

$$(7)\ CAAR_{st} = \alpha_s + D_1 * Exposed + \beta_1 * Amount\ of\ DPW + \beta_2 * Size + \beta_3 * \frac{B}{M} + \varepsilon_{st}$$

Where

$CAAR_{st}$ is the cumulative average abnormal return of period t from -3 to +3 for each storm,

$Exposed$ is the degree of exposure and D_1 is a dummy variable corresponding to this. D_1 is equal to 1 if the firm is located in the exposed area,

$Amount\ of\ DPW$ is the logarithm of amount direct premium written for each firm,

$Size$ is the logarithm of the market cap for each firm,

$\frac{B}{M}$ is the book-to-market ratio for each firm, which is an indicator for value or growth stock,

and α_s and ε_{st} are the intercept and error given period t for each storm s, respectively.

The variables that are of importance in answering the second hypothesis are $Exposed$ and $Amount\ of\ DPW$, whereby the relationship between the stock prices and these variables are shown with D_1 and β_1.

For the different CAR regressions the program Stata is used. The regression is based on the assumptions of Ordinary Least Squares (OLS). The assumptions of OLS are the following, namely: homogeneity of variance, normality, independence, errors in variables and linearity (Institute for Digital Research and Education, 2019). Only no homogeneity of variance or heteroscedasticity could provide problems in our sample. The White test is used to detect and solve this problem (Stata) and based on this I can say that the best results are provided for this investigation. For the following test the assumptions of OLS are accounted for as well.

6.3.2. The amount of losses

The methodology of the third hypothesis is discussed next. The third hypothesis investigates the influence of the amount of losses caused by the storm on the stock prices of the insurance companies after checking for the degree of exposure, the amount of direct premium written and the firm characteristics, size and the book-to-market ratio. These influence are also investigated on the CAAR, after transforming into a total CAAR, TCAAR. This is done to obtain multiple data about the amount of losses in the regression. This results in the following formula:

$$(8)\ TCAAR_t = \alpha + \beta_1 * Amount\ of\ losses + \beta_2 * Amount\ of\ DPW + \ D_1 * Exposed + \beta_3 * Size + \beta_4 * \frac{B}{M} + \ \varepsilon_t$$

Where

$TCAAR_t$ is the total cumulative average abnormal return of the period t from -3 to +3,

$Amount\ of\ losses$ is the logarithm based on the amount of losses for each storm in Table 4,

$Amount\ of\ DPW$ is the logarithm of amount direct premium written for each firm,

$Exposed$ is the degree of exposure and D_1 is a dummy variable corresponding to this. D_1 is equal to 1 if the firm is located in the exposed area,

$Size$ is the logarithm of the market cap for each firm,

$\frac{B}{M}$ is the book-to-market ratio for each firm, which is an indicator for value or growth stock,

and α and ε_t are the intercept and error given period t, respectively.

So, the relationship between the variable $Amount\ of\ losses$ and the $TCAAR$ is important in order to either reject or accept the third hypothesis. This relationship is shown with the direction and the significance of β_1.

6.3.3. Firms individually

Lastly, the regression that is used to determine the fourth hypothesis is discussed. The fourth hypothesis inspects the influence of the amount of losses, the degree of exposure and the amount of direct premium written per firm in more detail. This is done to discover differences between firms and thus between firm specific conditions. The CAR over the different days is used for each storm, whereby the amount of losses, amount of direct premium written and the degree of exposure are added. Size and the book-to-market ratio are included as control variables, since these differs over the period 2005 to 2017 in the company. This leads to the following formula:

$$(9)\ CAR_{it} = \alpha_i + \beta_1 * Amount\ of\ losses + \beta_2 * Amount\ of\ DPW_i + D_1 * Exposed_i + Size_i + \frac{B}{M_i} + \varepsilon_{it}$$

Where

CAR_{it} is the cumulative abnormal return for period t and for firm i,

$Amount\ of\ losses$ is the logarithm based on the amount of losses for each storm in Table 4,

$Amount\ of\ DPW_i$ is the logarithm of direct premium written for firm i,

$Exposed_i$ is a dummy variable. D_1 is equal to 1 if the firm is located in the exposed area,

$Size_i$ is the logarithm of the market cap for firm i,

$\frac{B}{M_i}$ is the book-to-market ratio for firm i, which is an indicator for value or growth stock,

and ε_{it} is the error corresponding to the variables of this regression given for period t and for firm i.

Each of these variables are equally important, since the relationship of all these variables with the CAR are investigated on firm individual level.

CHAPTER 7 Results

In this chapter the results that are based on the methods used earlier in this research are discussed. Each section in this chapter is related to one of the hypotheses mentioned in Chapter 3. The first hypothesis is discussed in Section 7.1., the second hypothesis in Section 7.2. etc. In each section the hypothesis is restated. The tables with the results are shown directly in the text or in the Appendix. When the tables are placed in the Appendix, this is mentioned in the text. The results of each hypothesis contribute to finding an answer to the research question. The research question is given in Chapter 1 is: *"Is there an optimal short term investment strategy for the property-casualty insurance companies over the period of 2005 to 2017, regarding storms that have received at least a 3 on the Saffir Simpson Hurricane Index in the United States?"*

7.1. The influence of storms on the stock prices

The first hypothesis is as follows: "*A storm has a negative significant influence on the stock prices of the exposed property-casualty insurance companies, whereas a storm has a positive influence on the stock prices of the unexposed property-casualty insurance companies."*

The results of the influence of each storm on the stock prices per degree of exposure are shown in Table 18 of the Appendix F, Table 5 and 6 in the text show a summary of Table 19. If the coefficient of the (C)AAR value is significant, then the storm had an influence on the stock prices. The direction of this influence is based on the sign before the coefficient. The results are first discussed for the CAAR values and then the AAR values.

7.1.1. CAAR values

The results show, overall, significant values for each storm per group, exposed and unexposed. Table 5, shown underneath, demonstrates for each storm which of the CAAR values are significant and in which direction after using the Standardized Cross-Sectional Test by Boehmer et al. (1991).

Table 5 Significant CAAR values of each storm

This Table is a summary of Table 15. Table 5 shows for which storm the cumulative average abnormal return (CAAR) has a significant value over the period of -3 up to and including +3. The CAAR is divided into two groups, namely exposed and unexposed. The CAAR (-t; t) receives a "-" if the influence of the storm was negative significant, "+" if the influence of the storm was positive significant and "0" if the influence of the storm was insignificant at a level of 95%, 97.5% or 99%. The T-test that is used to determine the significant level of the CAAR is the Standardized Cross-Sectional Test. The storms are in chronological order.

Storm	**Exposed CAAR (-t;t)**						**Unexposed CAAR (-t;t)**					
	(-3;-2)	**(-2;-1)**	**(-1;0)**	**(0;+1)**	**(+1;+2)**	**(+2;+3)**	**(-3;-2)**	**(-2;-1)**	**(-1;0)**	**(0;+1)**	**(+1;+2)**	**(+2;+3)**
Dennis	-	0	+	0	0	0	-	+	+	+	+	+
Katrina	0	0	0	-	-	-	+	+	+	-	-	-
Rita	+	+	0	0	0	0	0	0	0	0	0	0
Wilma	-	-	+	+	-	-	-	-	+	+	-	-
Ernesto	-	-	0	+	0	-	-	-	+	+	+	-
Dolly	0	-	-	-	-	-	+	-	0	-	-	-
Fay	0	0	0	0	0	0	-	-	+	+	+	-
Hanna	-	0	0	-	-	-	-	0	0	-	-	0
Gustav	+	0	-	-	-	-	+	0	-	0	-	-
Ike	-	+	+	0	0	0	-	+	+	-	-	-
Ida	+	+	+	+	+	-	+	+	+	+	+	-
Earl	+	+	-	+	-	0	-	+	+	-	-	-
Lee	-	-	+	0	-	+	0	-	+	+	-	+
Isaac	0	-	0	0	+	0	0	-	0	0	+	0
Iselle	-	-	0	-	+	0	+	-	0	-	0	0
Hermine	0	0	0	0	0	0	0	0	-	-	-	-
Matthew	0	-	-	-	-	-	-	-	-	-	-	-
Harvey	+	-	0	+	+	+	+	-	0	+	+	+
Irma	+	0	0	+	+	0	+	0	0	+	+	+

Table 5 shows the price fluctuations of the stocks by the CAAR for each storm, the directions of these prices fluctuations can be derived from the sign + or -. There are 114 CAAR values (19 storms times 6 days) for the exposed and the unexposed firms. The exposed firms have 28 significant positive values (+), 41 significant negative values (-) and 45 insignificant values (0). The unexposed firms have 40 significant positive values (+), 49 significant negative values (-) and 25 insignificant values (0).

Based on the results, information can be derived about the influence of the storm, the degree of exposure, the direction of the price fluctuations and the learning curve of the investor. Firstly, storms influence the stock prices of the property-casualty insurance companies for either the exposed and unexposed firms. The influence lies between -3.6% until +4.2% for the exposed firms and for the unexposed firms between

-4.2% until +4.4%, as is presented in Table 18. Secondly, it appears that there is no specific difference between the exposed and unexposed firms, because groups of firms show the same amount of influences (+/-/0). Third, the direction of the influences is not equal for each storm and even deviate per day. For example, Wilma showed for the exposed firms on the first two days a negative influence of the storm, but for the next two days positive influences and for the last days negative influences again. Based on this, it can be concluded that the investor does not know how to react on the storm. Lastly, there is no learning curve of the investor. Katrina and Harvey caused the highest amount of damage, as Table 4 shows. Because of this, it could be expected that the investors had learned from this by downgrading the stock prices of both groups even more. Table 5 shows, however, that Rita and Irma, the storms following up Katrina and Harvey, even had a positive or insignificant influence on the stock prices. This indicates that the investors did not learn from previous storms. Moreover, there is not a clear pattern in Table 5, which only supports that there is no learning curve of the investor even more.

So, this means for the hypothesis that there is no difference between the exposed and the unexposed firms. The possible causes of fluctuation of the values are further researched by testing the next hypotheses. The literature also shows different reactions of the CAAR values, as mentioned before. For example, the study of Lamb (1995) provided insignificant CAR results for hurricane Andrew, but research of Angbazo and Narayanan (1996) demonstrated a negative significant influence for CAR (-1; +1) for the same hurricane, Andrew. The differences between the studies of Lamb (1995), Angbazo and Narayanan (1996), but also this research are caused by the use of different T-tests and event windows. Every model is based on its own assumption, but the Standardized Cross-Sectional Test by Boehmer et al. (1991), used in this research, provides valid results, since it accounts for the event-volatility.

7.1.2. AAR values

The AAR values showed some significant results, however, in a much smaller amount than by the CAAR values. The results are presented in the Table below:

Table 6 Significant AAR values for each storm

This Table is a summary of Table 15. Table 6 shows for which storm the average abnormal return (AAR) has a significant value over the period of -3 up to and including +3. The AAR is divided into two groups, namely exposed and unexposed. The AAR (-t; t) receives a "-" if the influence of the storm was negative significant, "+" if the influence of the storm was positive significant and "0" if the influence of the storm was insignificant at a level of 95%, 97.5% or 99%. The T-test that is used to determine the significant level of the AAR is the Two-paired Test. These variables show the AAR of the companies that were exposed by the corresponding storm. The storms are in chronological order.

Storm	**Exposed AAR (t)**							**Unexposed AAR (t)**						
	-3	**-2**	**-1**	**0**	**1**	**2**	**3**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
Dennis	+	0	0	0	0	0	0	-	+	+	+	+	+	0
Katrina	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rita	0	0	0	0	0	0	0	0	+	0	0	0	0	0
Wilma	0	-	0	+	0	0	0	+	0	0	+	0	0	0
Ernesto	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dolly	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fay	0	0	0	0	0	0	-	0	0	0	0	0	0	0
Hanna	-	0	0	0	-	0	0	-	0	0	0	-	0	0
Gustav	0	0	0	0	0	0	-	0	0	0	0	0	0	0
Ike	0	0	0	0	0	0	0	-	0	+	0	-	0	-
Ida	0	0	0	+	0	0	0	0	+	0	+	0	0	0
Earl	0	+	-	0	0	-	0	0	+	0	-	0	-	+
Lee	0	0	-	0	0	-	+	0	-	-	0	-	-	+
Isaac	-	+	0	0	0	+	+	-	0	0	0	0	+	0
Iselle	+	0	0	+	0	0	-	0	0	0	-	0	0	0
Hermine	+	0	0	0	0	0	0	0	0	0	0	0	0	0
Matthew	0	0	0	0	0	-	0	0	0	0	0	0	-	0
Harvey	+	0	0	0	0	0	0	+	0	0	0	0	0	0
Irma	0	0	0	0	0	0	0	0	0	0	0	0	0	0

The AAR values are shown in Table 6. There are 133 CAAR values (19 storms times 7 days) for the exposed and the unexposed firms. The exposed firms have 12 significant positive values (+), 12 significant negative values and 109 insignificant values. The unexposed firms have 16 significant positive values (+), 15 significant negative values (-) and 102 insignificant values (0).

As explained in Chapter 6, the power of the Standardized Cross-Sectional Test by Boehmer et al. (1991). is higher than the Two-paired T-test, since it accounts for event volatility. Although the AAR values show more insignificant values than the CAAR values, the AAR values do, however, support the CAAR results since there is no clear direction of the influences on the exposed and unexposed firms.

7.2. Firm characteristics

This section researches the second until the fifth hypotheses based on the firm characteristics. The hypotheses and the corresponding results are presented per section in this sub chapter. The overall results are shown in Table 20 of Appendix G. Table 7 until 10 are a summary of Table 19.

7.2.1. The degree of exposure

The second hypothesis is: "*For each storm, exposed firms have a negative significant short term influence on stock prices compared to unexposed firms."* Table 7 presents the results corresponding to this hypothesis.

Table 7 Significant results of the degree of exposure

This Table is a summary of Table 15. * denotes significance at 95% level, two tailed test. This Table shows the influence of degree of exposure on the cumulative average abnormal return (CAAR) (-t; t). Influence is the coefficient of the dummy variable Exposure. Exposure is equal to 1 if the firm is exposed and equal to 0 is the firm is unexposed. Each regression is checked for the assumptions of Ordinary Least Squares (OLS).

Storm	**CAAR (-t;t)**	**Influence**
Katrina	(+1;+2)	-0.0074*

The degree of exposure is illustrated with the variable "Exposure". Based on this, there is no significant difference between the exposed and unexposed firms, accept for CAAR (+1; +2) of Katrina. Exposed firms have a negative significant influence on the CAAR of 0.7% compared to unexposed firms with everything else held equally for storm Katrina. This probably has to do with the fact that Katrina has caused the highest amount of damage ever (National Hurricane Center, 2018; Blake et al., 2007, 2011). Although Katrina has caused a high amount of damage, the influence is still small and only for one day. So based on these results the market does not react on the degree of exposure. This means that the market thinks that the insurance companies have eliminated their risk enough. It is interesting is that the earlier research on Katrina and Rita did show significant results of the exposed firms (Shelor et al., 1992; Lamb, 1995; Gangopadhyay et al., 2010) This difference could be, however, created by the difference in sample. In contrast to the mentioned studies, several firms that were also located anywhere else in the world beside the United States were used. These firms are more likely to be less affected by a storm in the United States and this could have an effect on the results, since these are combined into groups.

One important thing to notice is that "Exposure" is a dummy variable that compares the influence of exposed firms relative to unexposed firms. In Section 7.1. both the exposed firms and unexposed firms were compared to the market. So, these results do not deviate from the results of CAAR and AAR but they support these results.

7.2.2. The amount of direct premium written

The third hypothesis is: *"For each storm, the amount of direct premium written has a positive significant short term influence on the stock prices of the property-casualty insurance."* The results are shown in Table 8 below.

Table 8 Significant results of the amount of direct premium written

This Table is a summary of Table 15. *, **, *** denote significance at respectively 95%, 97.5% and 99% level, two tailed test. This Table shows the influence of amount of direct premium written (DPW) on the cumulative average abnormal return (CAAR) (-t; t). Influence is the coefficient of the DPW. The DPW is the logarithm function of the amount of direct premium written. Each regression is checked for the assumptions of Ordinary Least Squares (OLS). The storms are in chronological order.

Storm	**CAAR (-t;t)**	**Influence**
Ernesto	(-2;-1)	0.0003*
Ernesto	(-1;0)	0.0004*
Ida	(-3;-2)	0.0039***
Earl	(-3;-2)	-0.0019***
Hermine	(0;+1)	-0.0013**

There is no significant relationship between the CAAR values and the amount of direct premium written, except for the CAAR values of Ernesto, Ida, Earl and Hermine, as is shown in Table 8. Although these variables are significant, their influence is relatively small and are therefore not economically significant. This result is supported by the study of Shelor et al. (1992), since the proportion of the premium also had no impact on the stock prices. The studies of Lamb (1995) and Yamori and Kobayashi (2002) both found only one significant influence of the premiums on the stock prices of CAR (0; +1), however, the amount of direct premium written per state was used in their research. Moreover, they only researched one CAR value and this influence is relatively small (0.87% and -0.002%). The results of this research are, therefore, in line with earlier literature. More research into the amount of direct premium written per state could provide more support by earlier literature. However, due to data limitations this is not possible in this research.

As explained in Chapter 4 the amount of direct premium written is equal to the revenue of the insurance company. Even though the amount of direct premium written does not provide significant results, Figure 3 presented that the amount of direct premium has increased over the years. Although the revenue increased, the investors did not find it more to buy the insurance stocks.

7.2.3. Size

The fourth hypothesis is as follows: *"For each storm, smaller firms have a positive significant short term influence on the stock prices of the property-casualty insurance companies, whereby the larger firms have a negative significant short term influence on the stock prices."* An overview of the results corresponding to this hypothesis are presented in Table 9.

Table 9 Significant results of the size

This Table is a summary of Table 15. *, **, *** denote significance at respectively 95%, 97.5% and 99% level, two tailed test. This Table shows the influence of the market cap on the cumulative average abnormal return (CAAR) (-t; t). Influence is the coefficient of size. Size is the logarithm function of the market cap. Each regression is checked for the assumptions of Ordinary Least Squares (OLS). The storms are in chronological order.

Storm	**CAAR (-t;t)**	**Influence**
Rita	(+1;+2)	-0.0013*
Ernesto	(+1;+2)	-0.0002***
Fay	(-1;0)	-0.0155*
Earl	(-2;-1)	-0.0045***
Earl	(+2;+3)	-0.0029*
Lee	(-3;-2)	-0.0068*
Lee	(-1;0)	0.0077*
Lee	(0;+1)	0.0052*
Iselle	(0;+1)	0.0056***
Hermine	(+1;+2)	0.0041***
Irma	(+1;+2)	0.0014*
Irma	(+2;+3)	0.0028***

Size did show some significant effects for Rita, Ernesto, Fay, Earl, Lee, Iselle, Hermine and Irma, but is however, not economically significant. As Table 9 shows that until storm Lee, size presents a negative influence on the CAAR, but since the since CAAR (-1;0) of Lee a positive influence of size on the CAAR. This indicates that something has changed the beliefs of the market. The reason for this is, however, unknown. Knight and Pretty (1999) and Gangopadhyay et al. (2010) show the same insignificant influences of size on the stock prices of the researched firms and these results are thus in line with earlier research.

One important limitation to this investigation has to be kept in mind. Even though Table 3 presented differences in market size between the companies, the smaller companies are still relatively large. This is due to the fact that, mostly, large companies go public. The small local companies could provide more information in the difference between the companies, but due to data limitations it was not possible to obtain information from these companies.

7.2.3. Book-to-market ratio

The last hypothesis is*: "For each storm, a high book-to-market ratio has a positive significant short term influence on the stock prices of the property-casualty insurance companies."* Table 10 illustrates the results.

Table 10 Significant results of the book-to-market ratio

This Table is a summary of Table 15. *, **, *** denote significance at respectively 95%, 97.5% and 99% level, two tailed test. This Table shows the influence of book-to-market on the cumulative average abnormal return (CAAR) (-t; t). Influence is the coefficient of the book-to-market ratio. Each regression is checked for the assumptions of Ordinary Least Squares (OLS). The storms are in chronological order.

Storm	**CAAR (-t;t)**	**Influence**
Dennis	(-2;-1)	-0.0036***
Dennis	(0;+1)	-0.0056***
Rita	(-1;0)	-0.0035*
Rita	(0;+1)	-0.0032***
Wilma	(0;+1)	-0.0004***
Dolly	(-1;0)	-0.0061***
Dolly	(0;+1)	-0.0015***
Dolly	(+1;+2)	0.0015***
Gustav	(-2;-1)	-0.0063***
Gustav	(-1;0)	-0.0023*
Gustav	(0;+1)	-0.0046*
Gustav	(+1;+2)	-0.0108*
Hanna	(-2;-1)	0.1139***
Hanna	(-1;0)	0.0090***
Hanna	(0;+1)	-0.0202***
Hanna	(+1;+2)	-0.0069***
Hanna	(+2;+3)	-0.0121**
Ike	(-3;-2)	0..0035***
Ike	(-1;0)	-0.0092*
Earl	(+2;+3)	-0.0037**
Lee	(-3;-2)	0.0117***
Iselle	(0;+1)	0.0048*
Hermine	(+2;+3)	-0.0044***
Matthew	(0;+1)	0.0004*
Harvey	(+1;+2)	-0.0039***
Irma	(0;+1)	-0.0017*

The book-to-market ratio has no significant influence for each storm, since out of the 114 CAAR values only 26 values are significant. Although only 26 values are significant, 14 out of 19 storm showed at least one significant value. This significant influence of the book-to-market ratio shifted, however, over the different days as in direction. As shown in Table 10, 19 of the 26 significant values have a negative significant value on the CAAR, where 7 values have a positive significant value on the CAAR. What could offset these influences can only be guessed. The only thing that can be concluded of these results is that the investor is inconsistent.

The book-to-market ratio is only used by the study of Gangopadhyay et al. (2010). Both regressions presented a negative influence on the stock prices for the CAR (-1; +1) regarding to Katrina and Rita. Rita does provide a negative influence by these CAR values to our results as well. However, the height of the influence is not mentioned in the study of Gangopadhyay et al. (2010), so no conclusions can drawn from this. Katrina does, however, not display any significant values by either of the CAR values. What could be the cause of this difference is unknown, but because Gangopadhyay et al. (2010) used a significantly smaller amount of companies, which also differed from the companies used in this research.

7.3. The amount of losses

The sixth hypothesis is discussed in this sub chapter based on the storm characteristics, which is as follows: *"The amount of losses caused by the storms has a significant influence on the stock price of the insurance companies after checking for degree of exposure, the amount of direct premium written, size and book-to-market ratio."* The results corresponding to this hypothesis is shown in Table 11 below:

Table 11 TCAAR per period and losses

*, **, *** denote significance at respectively 95%, 97.5% and 99% level, two tailed test. This Table shows the influence of exposed, Losses, DPW, Size and Book-to-market on the total cumulative average abnormal return (TCAAR) (-t; t). Exposure is a dummy variable for the categories exposed by the storm and unexposed by the storm. The exposure dummy takes value 1 if a firm is exposed by the storm and 0 if it is unexposed by the storm. Losses is the logarithm of the damage done by the storms in US dollars as is shown in Table 4 of this report. DPW is the logarithm of the direct premium written. Size is the logarithm of the market value per company. The book-to-market is the book-to-market ratio. Both the variables size and the book-to-market ratio are obtained from Datastream. Each regression is checked for the assumptions of Ordinary Least Squares (OLS). ¬ shows where a correction is made for heteroscedasticity.

TCAAR (-3;-2)¬	**Exposed**	**Losses**	**DPW**	**Size**	**Book-to-market**
	0.0010	0.0004	0.0003	20.36e-06	0.0002
TCAAR (-2;-1)¬	**Exposed**	**Losses**	**DPW**	**Size**	**Book-to-market**
	0.0005	0.0003	0.0007	0.0000	0.0005
TCAAR (-1;0)	**Exposed**	**Losses**	**DPW**	**Size**	**Book-to-market**
	0.0011	-0.0010	0.0005	-0.0017*	-0.0036***
TCAAR (0;1)¬	**Exposed**	**Losses**	**DPW**	**Size**	**Book-to-market**
	0.0017	-0.0023***	-0.0003	-0.0006	-0.0028***
TCAAR (+1;+2)¬	**Exposed**	**Losses**	**DPW**	**Size**	**Book-to-market**
	-0.0032*	0.0005	-0.0003	0.0015	-0.0010
TCAAR (+2;+3)¬	**Exposed**	**Losses**	**DPW**	**Size**	**Book-to-market**
	0.0016	0.0008	0.0003	-0.00266	-0.0014

As Table 11 shows, there is no significant influence of the amount of losses after checking for the degree of exposure, amount of direct premium written, size and book-to-market ratio, except for TCAAR (0;-1) at a level of 1%. This influence is, however, not economically significant. No earlier studies have ever researched the influence of the amount of losses caused by a storm on the stock prices.

Although the results are insignificant, the structure in the insurance company still could have changed over the years. The insurance companies have protected themselves in such a way that the height of the damage does not have an influence on the stock price.

The book-to-market ratio does have a negative significant influence on the TCAAR (-1;0) and (0; +1) of 0.2 and 0.3%. This indicates that the market believes that overall a higher book-to-market ratio results in a lower TCAAR. The book-to-market ratio thus provides an investment opportunity. This means that growth stocks, in context of insurance firms, are younger insurance firms that still need to gain market share and may take more risks than older more established firms. Besides this, there could be an influence of the economy, since growth stock outperform value stocks in downturn of the economy. This is very important to keep in mind, since the period of 2005 to 2017 captures the financial crisis. No earlier research has researched the influence of the book-to-market ratio on the stock prices of insurance companies for every storm combined. Only the study of Gangopadhyay et al. (2010), as mentioned before, showed a significant negative influence for Katrina and Rita on CAR (-1; +1), which is in line with the results in Table 11.

The degree of exposure, the amount of direct premium written and size show also here some insignificant results.

7.4. Firm level

The last part of the results corresponds to the following hypothesis: *"On firm level, the amount of losses and the exposed firm compared to the unexposed firms have a negative significant short term influence, but the amount of direct premium written has a positive short term influence on the stock prices after checking for size and book-to-market ratio."*

First the results are shown by the degree of exposure and then the results of the amount of losses and the amount of direct premium written. The results of the amount of losses and the amount of direct premium written are combined, since both of these results are not economically significant and are therefore shown in Table 20 of Appendix H. These results are thus in line with the results found earlier. Only the degree of exposure provides some interesting results. Since the firms are examined on firm level, other factors corresponding to the firm could be of an influence on the stock price of that firm. Because of this, only the firms are discussed that showed some interesting results corresponding to the storms.

7.4.1. The degree of exposure

This sections discusses in more detail the degree of exposure on firm level. The results corresponding to the influence of the exposed firms compared to the unexposed firms on the stock prices are shown below:

Table 12 The degree of exposure on firm level

*, **, *** denote significance at 95%, 97.5% and 99% level, respectively. * and ** denote significance at 95% and 97.5% level, respectively. This Table shows the influence on the cumulative abnormal return (CAR) (-t; t) of Exposure, Losses and DPW after checking for the size and the book-to-market ratio. Exposure is a dummy variable for the categories exposed by the storm and unexposed by the storm. The exposure dummy takes value 1 if a firm is exposed by the storm and 0 if it is unexposed by a storm. Losses is the logarithm of the damage done by the storms in US dollars as is shown in Table 4 of this report. DPW is the logarithm of the amount direct premium written. The variable influence shows the coefficient of either the Losses or the DPW. Each regression is checked for the assumptions of Ordinary Least Squares (OLS).

Company	**CAR (-t;t)**	**Variable**	**Influence**
Assurance America	(0;+1)	Exposure	-0.0579**
Safety Insurance GRP.	(+1;+2)	Exposure	-0.0206*
State Auto Financial	(-3;-2)	Exposure	-0.0235*
Swiss RE	(-1;0)	Exposure	0.0151**
Universal Insurance HDG.	(+1;+2)	Exposure	-0.0535*

Five companies of the 54 companies show a significant relationship between the degree of exposure and the CAR values. Four companies present a negative significant influence between -5.8% to -2.1% on the

CAR of when these companies are exposed to the storm compared to when they are not exposed to the storm. Since these companies are the only companies that illustrate these results, it seems that there are some issues within the firm structure. These firms did not eliminate their risk enough according to the market, but only 1 day of the 6 days is significant. This influence is thus probably related to other conditions in the firms, but this is beyond the scope of this research.

Assurance America and Universal Insurance HDG. are discussed in more detail, since these firms are only located in one state over the period of 2005 to 2017, as mentioned in Chapter 5. Both firms show only one significant result over the 6 days. So, also for companies only located in one state, there is no difference between the exposed and unexposed firms. This only provides extra support for the results found earlier by hypothesis 1 and 3.

CHAPTER 8 Limitations and recommendations

8.1. Limitations

In this research the limitations are as follows: the sample, the data limitation on amount of direct premium written by each company per state and the data limitation on the insurance coverage.

First of all, the limitation in the sample. This limitation is due to the fact that only a small amount of the property-casualty insurance companies are public. This leads to a significantly smaller sample than first was expected and the conclusions are therefore less valid. Previous studies, for example the studies Shelor et al. (1992), Lamb (1995) and Gangopadhyay et al. (2010), also dealt with this problem. Furthermore, the companies included in the sample are relatively large companies since large companies mostly go public, and therefore data is publicly available. It could be interesting to research the influence of the storm on smaller companies to discover how these companies protect themselves against the extra risk.

Second, the data limitation on the amount of direct premium written per company in each state. With this information, the degree of exposure would established more precisely. The conclusion would have been more accurate, since nowadays the customer can reach the insurance companies that are located further away due to the increase of technology.

Third, the limitation on the data of the insurance coverage. If this data was available over the years and per company, this research could provide insight into the structure of the insurance companies. As is mentioned before, the insurance coverage did decrease, but it is not known by how much and in relation to the amount direct premium written and the losses incurred. Because of this missing information, only an estimation could be made.

8.2. Recommendations

Further research is needed into the variable book-to-market ratio. It was shown in Section 7.2.3. that the book-to-market ratio was of influence by 14 out of the 19 storms, however, this influence fluctuated per day and per direction. If the possible causes are discovered, a better investment strategy for the property-casualty insurance companies could be made. Moreover, the differences between the property-casualty insurance firms could provide a better strategy, since one firm could eliminate their risk better than the other firm. If this is the case, it would provide an extra investment opportunity. In addition to these factors, this research should also be performed on other kind of natural disasters, to examine if the same investment opportunities are provided as the ones by storms.

CHAPTER 9 Conclusion

In this chapter the research question and the sub questions are answered based on the results.

Hypothesis 1: "*A storm has a negative significant influence on the stock prices of the exposed property-casualty insurance companies, whereas a storm has a positive influence on the stock prices of the unexposed property-casualty insurance companies.*"

Storms have a significant influence on the stock prices of the property-casualty insurance companies for either the exposed and unexposed firms. This influence is, however, not consistent for each storm and per day and thus the beliefs of the market are not consistent. Moreover, there is no difference between the exposed firms and unexposed firms, since the price fluctuations have the same heights (between -4.4% until +4.2%), the same amount of significant influences and the same direction of these influences, namely: positive, negative or insignificant. Earlier studies, such as the study of Lamb (1995) and the study of Angbazo and Narayanan (1996), also differs in the direction of the price fluctuations. These differences exist due to different assumptions made in the model. This research account, however, for the event-volatility and therefore provides more valid results.

The return that can be expected on this investment is therefore ambiguous and depends on many factors corresponding to characteristics of the storm and of the company. Hypothesis 2 until hypothesis 5 discuss the firm characteristics that are of an influence for the price fluctuations of the stocks.

Hypothesis 2: "*For each storm, exposed firms have a negative significant short term influence on stock prices compared to unexposed firms.*"

There is no significant difference between the exposed firms and unexposed firms and their influences on the stock prices over the period of 2005 to 2017. Only for Katrina there was a significant difference between those groups of companies, where the exposed firms had a negative significant influence compared to the unexposed firms. This is probably due to the high amount of damage that was caused by Katrina. The studies of Shelor et al. (1992) and Lamb (1995) did, however, find some significant results regarding to the degree of exposure. These differences in results are probably offset by the differences in the selection of companies, since Shelor et al. (1992) and Lamb (1995) only selected companies located in the United States in contrast to this research that has also selected companies located outside of the United States.

Hypothesis 3: *"For each storm, the amount of direct premium written has a positive significant short term influence on the stock prices of the property-casualty insurance companies."*

The amount of direct premium written has no significant influence on the stock prices over the period of 2005 to 2017. Although that this factor does not influence the stock prices, the amount of direct premium and the revenue of the insurance companies increased over the years. The market still believes that this is not of any influence. This is in line with the literature, since Shelor et al. (1992), Lamb (1995) and Yamori and Kobayashi (2002) also found either no significant result or a significant result that could be neglected.

Hypothesis 4: *"For each storm, smaller firms have a positive significant short term influence on the stock prices of the property-casualty insurance companies, whereby the larger firms have a negative significant short term influence on the stock prices."*

Size has no influence on the stock prices of the property-casualty insurance companies over the period of 2005 to 2017, because neither of these values were economically significant. These results are in line with the earlier study of Gangopadhyay et al. (2010). One important limitation is that the property-casualty insurance companies that are included in this paper are relatively large. So, although the results present that there is no significant relationship, this could be different if smaller companies were included in the selection. This was, however, not possible due to data limitations.

Hypothesis 5: *"For each storm, a high book-to-market ratio has a positive significant short term influence on the stock prices of the property-casualty insurance companies."*

The book-to-market ratio has no influence on the stock prices of the property-casualty insurance companies. It is interesting that out of the 19 storms, 14 storms did provide at least one significant influence. This influence was, however, not consistent per day and fluctuated in the direction of the influence. The investors were thus not consistent and further investigation is needed into the cause. The research of Gangopadhyay et al. (2010) showed a negative significant influence on the stock prices. This difference is caused by the difference in sample.

Hypothesis 6: *"The amount of losses caused by the storms has a significant influence on the stock price of the insurance companies after checking for degree of exposure, the amount of direct premium written, size and book-to-market ratio."*

The amount of losses has, overall, no influence on the stock prices of the property-casualty insurance companies. Because the height of the damage caused by the storm is not of any influence, this indicates that the market believed that the insurance companies have created a buffer to protect themselves against the highest financial losses.

The book-to-market ratio has a negative influence on the stock prices for one day before (t= -1) until one day after the storm (t = +1). This influence is -0.2% to -0.3%. Although this influence is relatively small, it is an investment opportunity. It has to be kept in mind that the direction of this influence could be due to the downturn of the economy, since the period of 2005 to 2017 captures the financial crisis. No investigation is done on the influence of the book-to-market ratio on the stock prices of insurance companies. The only research that comes close is the research of Gangopadhyay et al. (2010), which shows a negative influence of the book-to-market ratio on the stock prices regarding Katrina and Rita for the CAR (-1; +1). This study, therefore, supports the results.

Hypothesis 7: *"On firm level, the amount of losses and the exposed firm compared to the unexposed firms have a negative significant short term influence, but the amount of direct premium written has a positive short term influence on the stock prices after checking for size and book-to-market ratio."*

On firm level, the variables: the degree of exposure, the amount of losses and the amount of direct premium written, have no influence on the stock prices of the firm. This only supports the findings of the other hypotheses, since not only have these variables no influences in the entire industry, but also not on firm level.

These hypotheses help to answer the research question: *"Is there an optimal short term investment strategy for the property-casualty insurance companies over the period of 2005 to 2017, regarding storms that have received at least a 3 on the Saffir Simpson Hurricane Index in the United States?"*

Based on this paper, there is an optimal short term investment strategy for the property-casualty insurance companies, since the variable book-to-market ratio provides an opportunity. Over the period of 2005 to 2017 a low book-to-market ratio caused an increase in stock prices of the property-casualty insurance industry. This only provided an opportunity one day before the storms (t= -1) until one day after the storms (t= +1). This opportunity does not exist for each storm. Although the influence of the book-to-market ratio occurs (sometimes) for some storms, it differs per day and per direction. Because of this, no investment strategy can be made for this.

Moreover, it does not matter whether property-casualty insurance stocks are bought or sold regarding to the storms. This is, because the stock prices move between -4.5% until +4.2%. Furthermore, it does not matter in what type of firm an investment is made, since either the exposed and unexposed firms show different reactions for each storm per day in the same kind of amount. Also, on what day on investment is made is not of any influence, since the return differs in amount and direction per day for each storm. Furthermore, firm characteristics and the storm characteristic do influence the stock prices and therefore these variables do not results in an investment opportunity.

Overall, the property-casualty insurance companies are a stable investment. The fluctuations of the stock prices are small or can even be neglected. This means that the insurance companies can exist throughout every major storm. Due to this, property-casualty insurance companies are an ideal investment for risk-averse investors. For risk-seeking investors, property-casualty insurance companies are not a good investment, since the risk and thereby the return is relatively small.

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APPENDIX A Legend

Table 13 Names states

State		State	
Alabama	AL	Montana	MT
Alaska	AK	Nebraska	NE
Arizona	AZ	Nevada	NV
Arkansas	AR	New Hampshire	NH
California	CA	New Jersey	NJ
Colorado	CO	New Mexico	NM
Connecticut	CT	New York	NY
Delaware	DE	North Carolina	NC
Dist.	DC	North Dakota	ND
Florida	FL	Ohio	OH
Georgia	GA	Oklahoma	OK
Hawaii	HI	Oregon	OR
Idaho	ID	Pennsylvania	PA
Illinois	IL	Rhode	RI
Indiana	IN	South	SC
Iowa	IA	South	SD
Kansas	KS	Tennessee	TN
Kentucky	KY	Texas	TX
Louisiana	LA	Utah	UT
Maine	ME	Vermont	VT
Maryland	MD	Virginia	VA
Massachusetts	MA	Washington	WA
Michigan	MI	West	WV
Minnesota	MN	Wisconsin	WI
Mississippi	MS	Wyoming	WY
Missouri	MO		

Source: National Association of Insurance Commissioners.

APPENDIX B Location companies 2017

Table 14 Location companies 2017

Company																	
Alleghany	NH	CA	NY	NE	DE	OK	WI										
Allianz	CA	HI	IL	MD	MN	MO	NJ	NY	OH								
Allstate	FL	IL	MA	NY	TX	WI											
American Financial GRP	CA	DE	FL	MO	NY	OH	TX										
American International GRP.	DE	IL	NY	PA	PR	TX											
American National IN.	CA	LA	MO	NY	TX												
Arch CAP GP.	DE	MO	NC	WO													
Aspen Insurance Holding GRP.	ND	TX															
Assurance America	NE																
Assured Guaranty	MD	NY															
Axis Capital HDG.	CT	IL	NY														
Baldwin & Lyons	IN																
Berkshire Hathaway	AZ	CA	CO	CT	DC	DC	DE	IA	IN	KS	MD	ND	NE	NJ	NY	PA	TX
Chubb LTD.	CT	DE	GA	IA	IL	IN	NJ	NY	PA	PR	TX	WI					
Cincinnati Financial	DE	OH															
CNA Financial	IL	NJ	PA	SD													
Countrywide Insurance	NY																
Donegal GRP.	IA	MD	MI	PA	VA	WI											
EMC Insurance GRP	IA	ND															
Erie Indemnity	PA	NY															
Everest RE GRP	DE	GA															
Fairfax Financial HOLD.	AR	CA	CT	DE	NJ	NY											

Federated National HDG.	MN	OK															
First Acceptance	GA	TN	TX														
Hallmark Financial Services	AZ	OK	TX														
Hanover Insurance GRP.	IL	IN	MI	NH	NY	OH	TX										
Hartford Financial SVS. GRP.	CT	IL	IN	TX													
Horace Mann Educators	IL	TX															
Infinity Pr. & Clty.	IN	OH	TX														
Kemper	AL	IL	LA	MO	NY	OK	TX	TX	WI								
Markel	CA	IL	MO	NE	TX	VA											
Mbia GRP.	NY																
Mercury General	CA	FL	GA	IL	OK	TX											
Mgic GRP.	WI																
Navigators GRP.	NY																
Old Republic INTL.	FL	IL	MS	NC	OK	PA	TX	WI									
Proassurance	AL	DC	IL	MI	PA	VT											
Progressive	CA	DE	FL	IL	IN	LA	MI	NY	OH	TX	WI	WI					
Protective Insurance	IN																
QBE Insurance GRP.	MN	ND	PA	PR	WI												
Radian GRP.	PA																
Reinsurance Group of AM.	IL																
Rli	IL																
Safety Insurance GRP.	MA																
Seibels Bruce GRP.	SC																
Selective Insurance GRP.	IN	NJ	NY														
State Auto Financial	AZ	CT	IA	IN	MN	OH	WI										

Swiss RE	MO	MO	NH	NY	TX	VT											
Travelers COS.	AZ	CT	DE	FL	IA	TX	WI										
United Fire GRP	CA	IA	LA	NJ	PA	TX											
Universal Insurance HDG.	FL																
W R Berkley	AZ	CA	DE	IA	ND	TX											
White Mountains Insurance GRP.	DE	NY	PA	TX													
Zurich Insurance GRP.	CA	DE	DE	FL	IL	MA	MD	MD	NE	NH	NY	OK	WA				

Source: National Association of Insurance Commissioners.

APPENDIX C Combination location damage and location company

Table 15 Storms and their exposed firms

Table 15 shows for each storm the companies that were located in that state. These companies are then classified as “exposed” and every other company not included as “unexposed”. The storms are in chronological order.

Dennis	**Los Angeles**
Allianz	Kemper
American Financial GRP.	Progressive
American International GRP.	United Fire GRP.
American National IN.	Mercury General
CNA Financial	White Mountains Insurance GRP.
Fairfax Financial HOLD.	Zurich Insurance GRP.
Horace Mann Educators	
Katrina	**Florida**
American Financial GRP.	State Auto Financial
Berkshire Hathaway	Travelers COS.
Hartford Financial SVS. GRP.	Universal Insurance HDG.
Mercury General	W R Berkley
Old Republic INTL.	Zurich Insurance GRP.
Progressive	
Rita	**South Carolina**
Allstate	Selective Insurance GRP.
Assurance America	Seibels Bruce GRP
CNA Financial	State Auto financial
Wilma	**Florida**
American Financial GRP.	State Auto Financial
Berkshire Hathaway	Travelers COS.
Hartford Financial SVS. GRP.	Universal Insurance HDG.
Mercury General	W R Berkley
Old Republic INTL.	Zurich Insurance GRP.
Progressive	
Ernesto	**Florida**
Allstate	Progressive
American International GRP.	Travelers COS.
Berkshire Hathaway	Universal Insurance HDG.
Mercury General	W R Berkley
Old Republic INTL.	Zurich Insurance GRP.
Dolly	**Florida**
Alleghany	Old Republic INTL.
Allstate	Progressive
American International GRP.	QBE Insurance GRP.
Berkshire Hathaway	Travelers COS.
Hanover Insurance GRP.	Universal Insurance HDG.
Mercury General	Zurich Insurance GRP.

Fay	**Florida**
Alleghany	Old Republic INTL.
Allstate	Progressive
American International GRP.	QBE Insurance GRP.
Berkshire Hathaway	Travelers COS.
Hanover Insurance GRP.	Universal Insurance HDG.
Mercury General	Zurich Insurance GRP.
Hanna	**Los Angeles, Texas**
Alleghany	Kemper
Allianz	Infinity Pr. & Clty
Allstate	Mercury General
American Financial	Old Republic INTL.
American International GRP.	Progressive
American National IN.	Radian GRP.
Aspen Insurance Holding GRP.	State Auto Financial
Berkshire Hathaway	Swiss RE
Chubb LTD.	Travelers COS.
Fairfax Financial HOLD.	United Fire GRP.
First Acceptance	Universal Insurance HDG.
Hallmark Financial Services	White Mountains Insurance GRP
Hanover Insurance GRP.	W R Berkley
Hartford Financial SVS. GRP.	Zurich Insurance GRP.
Horace Mann Educators	
Gustav	**Florida, Los Angeles, Mississippi**
Alleghany	Mercury General
Allianz	Old Republic INTL.
Allstate	Progressive
American Financial	QBE Insurance GRP.
American International GRP.	Travelers COS.
American National IN.	United fire GRP.
Berkshire Hathaway	Universal Insurance HDG.
Fairfax Financial HOLD.	W R Berkley
Hanover Insurance GRP.	White Mountains Insurance GRP.
Horace Mann Educators	Zurich Insurance GRP.
Kemper	
Ike	**Florida**
Alleghany	Old Republic INTL.
Allstate	Progressive
American International GRP.	QBE Insurance GRP.
Berkshire Hathaway	Travelers COS.
Hanover Insurance GRP. Insurance GRP.	Universal Insurance HDG.
Mercury General	Zurich Insurance GRP.
Ida	**Florida, North Carolina, Virginia**
Alleghany	Progressive

Allstate	QBE Insurance GRP.
American International GRP.	Seibels Bruce GRP.
Berkshire Hathaway	Travelers COS.
Donegal GRP.	Universal Insurance HDG.
Markel	W R Berkley
Mercury General	Zurich Insurance GRP.
Old Republic INTL.	
Earl	**Texas**
Allianz	Infinity Pr & Clty
Allstate	Kemper
American Financial	Mercury General
American International GRP.	Old Republic INTL.
American National IN.	Progressive
Aspen Insurance Holding GRP.	Radian GRP.
Berkshire Hathaway	State Auto Financial
Chubb	Swiss RE
Fairfax Financial HOLD.	Travelers COS.
First Acceptance	United Fire GRP.
Hallmark Financial Services	W R Berkley
Hanover Insurance GRP.	White Mountains Insurance GRP.
Hartford Financial SVS. GRP.	Zurich Insurance GRP.
Horace Mann Educators	
Lee	**Los Angeles**
Alleghany	Kemper
Allianz	Mercury General
Allstate	Progressive
American Financial GRP	United Fire GRP.
American National IN.	White Mountains Insurance GRP.
Berkshire Hathaway	W R Berkley
Fairfax Financial HOLD.	Zurich Insurance GRP.
Isaac	**Texas, Los Angeles**
Alleghany	Horace Mann Educators
Allianz	Kemper
Allstate	Infinity
American Financial GRP.	Mercury General
American International GRP.	Old Republic INTL.
American National IN.	Progressive
Aspen Insurance Holding GRP.	Qbe Insurance GRP.
Berkshire Hathaway	Radian GRP.
Chubb LTD.	State Auto Financial
Fairfax Financial HOLD.	United Fire GRP.
First Acceptance	W R Berkley
Hallmark Financial Services	White Mountains Insurance GRP.
Hanover Insurance GRP.	Zurich Insurance GRP.

Hartford Financial SVS. GRP.	
Iselle	**Mid Atlantic, North East United States**
Alleghany	Hartford Financial SVS. GRP.
Allianz	Markel
Allstate	Mbia GRP.
American Financial GRP.	Navigators
American International GRP.	Old Republic INTL.
American National IN.	Proassurance
Assured Guaranty	Radian GRP.
Axis Capital HDG.	Reinsurance Group of AM.
Berkshire Hathaway	Safety
Chubb LTD.	Selective Insurance GRP.
Cincinnati Financial	State Auto Financial
CNA Financial	Swiss RE
Countrywide Insurance	Travelers COS.
Donegal GRP.	United Fire GRP.
Erie Indemnity	White Mountains Insurance GRP.
Everest RE GRP.	W R Berkley
Fairfax Financial HOLD.	Zurich Insurance GRP.
Hanover Insurance GRP.	
Hermine	**Mid Atlantic, North East United States**
Alleghany	Hartford Financial SVS. GRP.
Allianz	Kemper
Allstate	Markel
American Financial GRP.	Mbia GRP.
American International GRP.	Navigators GRP.
American National IN.	Old Republic INTL.
Arch CAP.GP.	Proassurance
Assured Guaranty	Progressive
Axis Capital HDG.	QBE Insurance GRP.
Berkshire Hathaway	Radian GRP.
Chubb LTD.	Safety Insurance GRP.
Cincinnati Financial	Selective Insurance GRP.
CNA Financial	State Auto Financial
Countrywide Insurance	Swiss RE
Donegal GRP.	Travelers COS.
Erie Indemnity	United Fire GRP.
Everest RE GRP.	White Mountains Insurance GRP.
Fairfax Financial HOLD.	W R Berkley
Hanover Insurance GRP.	Zurich Insurance GRP.
Matthew	**South East United States**
Allstate	Kemper
American Financial GRP.	Markel
American International GRP.	Mercury General

Assurance America	Old Republic INTL.
Berkshire Hathaway	Proassurance
Chubb LTD.	Progressive
Donegal GRP.	Seibels Bruce GRP.
Everest RE GRP.	Travelers COS.
First Acceptance	Universal Insurance HDG.
Harvey	**Texas, Los Angeles**
Alleghany	Horance Mann Educators
Allstate	Infinity Pr. & Clty.
American Financial GRP.	Markel
American International GRP.	Mercury General
American National IN.	Old Republic INTL.
Aspen Insurance Holding GRP.	Progressive
Berkshire Hathaway	Swiss RE
Chubb LTD.	Travelers COS.
First Acceptance	United Fire GRP.
Hallmark Financial Services	White Mountains Insurance GRP.
Hanover Insurance GRP.	W R Berkley
Hartford Financial SVS. GRP.	Zurich Insurance GRP.
Irma	**Florida**
Allianz	Old Republic INTL.
Allstate	Progressive
American Financial GRP.	Travelers COS.
Fairfax Financial HOLD.	Universal Insurance HDG.
Mercury General	

APPENDIX D Best tracks storms 2004-2017

Table 16 Best tracks date

This Table shows the best track date for each storm in the United States over the period of 2004-2017. The best track date is the date when the storm was spotted (begin date) for the first time by the National Hurricane Center (NHC) until the storm disappeared (end date). The variable difference is the difference between the begin date and the end date in days. The storms are in chronological order per column.

Storm	Begin date	End date	Difference	Storm	Begin date	End date	Difference
Alex	31-7-2004	6-8-2004	6	Agatha	22-5-2004	24-5-2004	2
Bonnie	3-7-2004	13-7-2004	10	Blas	12-7-2004	15-7-2004	3
Charley	9-8-2004	14-8-2004	5	Celia	19-7-2004	25-7-2004	6
Danielle	9-8-2004	14-8-2004	5	Darby	26-7-2004	1-8-2004	6
Earl	13-8-2004	15-8-2004	2	Estelle	19-8-2004	24-8-2004	5
Frances	25-8-2004	8-9-2004	14	Frank	23-8-2004	26-8-2004	3
Gaston	27-8-2004	4-9-2004	8	Georgette	26-8-2004	30-8-2004	4
Hermine	27-8-2004	31-8-2004	4	Howard	30-8-2004	5-9-2004	6
Ivan	2-9-2004	24-9-2004	22	Isis	8-9-2004	16-9-2004	8
Jeanne	13-9-2004	28-9-2004	15	Javier	10-9-2004	19-9-2004	9
Kari	16-9-2004	24-9-2004	8	Kay	4-10-2004	6-10-2004	2
Lisa	19-9-2004	3-10-2004	14	Lester	11-10-2004	13-10-2004	2
Matthew	8-10-2004	10-10-2004	2	Adrian	17-5-2005	21-5-2005	4
Nicole	10-11-2004	11-11-2004	1	Beatrix	21-6-2005	24-6-2005	3
Otto	29-11-2004	3-12-2004	4	Calvin	26-6-2005	29-6-2005	3
Arlene	8-6-2005	13-6-2005	5	Dora	4-7-2005	6-7-2005	2
Bret	28-6-2005	30-6-2005	2	Eugene	18-6-2005	20-6-2005	2
Cindy	3-7-2005	7-7-2005	4	Fernanda	9-8-2005	16-8-2005	7
Dennis	4-7-2005	13-7-2005	9	Greg	11-8-2005	15-8-2005	4
Emily	11-7-2005	21-7-2005	10	Hilary	19-8-2005	25-8-2005	6
Franklin	21-7-2005	29-7-2005	8	Irwin	25-8-2005	28-8-2005	3
Gert	23-7-2005	25-7-2005	2	Jova	12-9-2005	25-9-2005	13
Harvey	2-8-2005	8-8-2005	6	Kenneth	14-9-2005	30-9-2005	16
Irene	4-8-2005	18-8-2005	14	Lidia	17-9-2005	19-9-2005	2
Jose	22-8-2005	23-8-2005	1	Max	17-9-2005	22-9-2005	5
Katrina	23-8-2005	30-8-2005	7	Norma	23-9-2005	27-9-2005	4
Lee	28-8-2005	2-9-2005	5	Otis	28-9-2005	3-10-2005	5
Maria	1-9-2005	10-9-2005	9	Aletta	27-5-2006	30-5-2006	3
Nate	5-9-2005	10-9-2005	5	Bud	11-7-2006	16-7-2006	5
Ophelia	6-9-2005	17-9-2005	11	Carlotta	12-7-2006	16-7-2006	4
Philippe	17-9-2005	23-9-2005	6	Daniel	16-7-2006	26-7-2006	10
Rita	18-9-2005	26-9-2005	8	Emilia	21-7-2006	28-7-2006	7
Stan	1-10-2005	5-10-2005	4	Fabio	31-7-2006	3-8-2006	3
Tammy	5-10-2005	6-10-2005	1	Gilma	1-8-2006	3-8-2006	2
Vince	8-10-2005	11-10-2005	3	Hector	15-8-2006	23-8-2006	8
Wilma	15-10-2005	25-10-2005	10	Ileana	21-8-2006	27-8-2006	6
Alpha	22-10-2005	24-10-2005	2	John	28-8-2006	4-9-2006	7
Beta	26-10-2005	31-10-2005	5	Kristy	30-8-2006	8-9-2006	9

Gamma	14-11-2005	21-11-2005	7	Lane	13-9-2006	17-9-2006	4
Delta	22-11-2005	28-11-2005	6	Miriam	16-9-2006	18-9-2006	2
Epsilon	29-11-2005	8-12-2005	9	Norman	9-10-2006	15-10-2006	6
Zeta	30-12-2005	6-1-2006	7	Olivia	9-10-2006	12-10-2006	3
Alberto	10-6-2006	14-6-2006	4	Paul	8-11-2006	10-11-2006	2
Beryl	18-7-2006	21-7-2006	3	Rosa	8-11-2006	10-11-2006	2
Chris	1-8-2006	4-8-2006	3	Sergio	13-11-2006	20-11-2006	7
Debby	21-8-2006	26-8-2006	5	Alvin	27-5-2007	31-5-2007	4
Ernesto	24-8-2006	1-9-2006	8	Barbara	29-5-2007	2-6-2007	4
Florence	3-9-2006	12-9-2006	9	Cosme	14-7-2007	22-7-2007	8
Gordon	10-9-2006	20-9-2006	10	Dalilia	22-7-2007	27-7-2007	5
Helene	12-9-2006	24-9-2006	12	Erick	31-7-2007	2-8-2007	2
Isaac	27-9-2006	2-10-2006	5	Flossie	8-8-2007	16-8-2007	8
Andrea	6-5-2007	8-5-2007	2	Gil	29-8-2007	2-9-2007	4
Bary	1-6-2007	2-6-2007	1	Henriette	30-8-2007	6-9-2007	7
Chantal	31-7-2007	1-8-2007	1	Ivo	18-9-2007	23-9-2007	5
Dean	13-8-2007	23-8-2007	10	Juliette	29-9-2007	2-10-2007	3
Erin	15-8-2007	17-8-2007	2	Kiko	15-10-2007	23-10-2007	8
Felix	31-8-2007	5-9-2007	5	Alma	29-5-2008	30-5-2008	1
Gabrielle	8-9-2007	11-9-2007	3	Boris	27-6-2008	4-7-2008	7
Humberto	12-9-2007	14-9-2007	2	Cristina	27-6-2008	30-6-2008	3
Ingrid	12-9-2007	17-9-2007	5	Douglas	1-7-2008	4-7-2008	3
Jerry	23-9-2007	24-9-2007	1	Elida	11-7-2008	19-7-2008	8
Karen	25-9-2007	29-9-2007	4	Fausto	16-7-2008	22-7-2008	6
Lorenzo	25-9-2007	28-9-2007	3	Genevieve	21-7-2008	27-7-2008	6
Melissa	28-9-2007	30-9-2007	2	Hernan	6-8-2008	12-8-2008	6
Noel	28-10-2007	2-11-2007	5	Iselle	13-8-2008	16-8-2008	3
Olga	11-12-2007	12-12-2007	1	Julio	23-8-2008	26-8-2008	3
Arthur	31-5-2008	1-6-2008	1	Karina	2-9-2008	3-9-2008	1
Bertha	3-6-2008	20-6-2008	17	Lowell	6-9-2008	11-9-2008	5
Cristobal	19-6-2008	23-6-2008	4	Marie	6-10-2008	11-10-2008	5
Dolly	20-6-2008	25-6-2008	5	Norbert	4-10-2008	12-10-2008	8
Eduoard	3-8-2008	6-8-2008	3	Odile	8-10-2008	12-10-2008	4
Fay	15-8-2008	26-8-2008	11	Polo	2-11-2008	5-11-2008	3
Gustav	25-8-2008	4-9-2008	10	Andres	21-6-2009	24-6-2009	3
Hanna	28-8-2008	7-9-2008	10	Blanca	6-7-2009	9-7-2009	3
Ike	1-9-2008	14-9-2008	13	Carlos	10-7-2009	16-7-2009	6
Josephine	2-9-2008	6-9-2008	4	Dolores	15-7-2009	16-7-2009	1
Kyle	25-9-2008	29-9-2008	4	Lana	30-7-2009	2-8-2009	3
Laura	29-9-2008	1-10-2008	2	Enrique	3-8-2009	7-8-2009	4
Marco	6-10-2008	7-10-2008	1	Felicia	3-8-2008	11-8-2008	8
Nana	12-10-2008	14-10-2008	2	Guillermo	12-8-2009	19-8-2009	7
Omar	13-10-2008	18-10-2008	5	Hilda	22-8-2009	28-8-2009	6
Paloma	5-11-2008	9-11-2008	4	Ignacio	24-8-2009	27-8-2009	3
Ana	11-8-2009	16-8-2009	5	Jimena	28-8-2009	4-9-2009	7
Bill	15-8-2009	24-8-2009	9	Kevin	29-8-2009	1-9-2009	3

Claudette	16-8-2009	17-8-2009	1	Linda	7-9-2009	11-9-2009	4
Danny	26-8-2009	29-8-2009	3	Marty	16-9-2009	19-9-2009	3
Erika	1-9-2009	3-9-2009	2	Nora	23-9-2009	25-9-2009	2
Fred	7-9-2009	12-9-2009	5	Olaf	1-10-2009	3-10-2009	2
Grace	4-10-2009	6-10-2009	2	Patricia	11-10-2009	14-10-2009	3
Henri	6-10-2009	8-10-2009	2	Rick	15-10-2009	21-10-2009	6
Ida	4-11-2009	10-11-2009	6	Agatha	29-5-2010	30-5-2010	1
Alex	25-6-2010	3-7-2010	8	Blas	17-6-2010	21-6-2010	4
Bonnie	22-7-2010	26-7-2010	4	Celia	18-6-2010	28-6-2010	10
Colin	2-08-2010	8-8-2010	6	Darby	23-6-2010	28-6-2010	5
Danielle	21-08-2010	30-8-2010	9	Estelle	6-8-2010	10-8-2010	4
Earl	25-08-2010	4-9-2010	10	Frank	21-8-2010	28-8-2010	7
Fiona	30-08-2010	3-9-2010	4	Georgette	20-9-2010	23-9-2010	3
Gaston	1-09-2010	2-9-2010	1	Adrian	7-6-2011	12-6-2011	5
Hermine	5-09-2010	9-9-2010	4	Beatriz	19-6-2011	22-6-2011	3
Igor	8-09-2010	21-9-2010	13	Calvin	7-7-2011	10-7-2011	3
Julia	12-09-2010	20-9-2010	8	Dora	18-7-2011	24-7-2011	6
Karl	14-09-2010	18-9-2010	4	Eugene	31-7-2011	6-8-2011	6
Lisa	30-09-2010	6-10-2010	6	Fernanda	15-8-2011	19-8-2011	4
Matthew	23-09-2010	26-9-2010	3	Greg	16-8-2011	21-8-2011	5
Nicole	28-09-2010	29-9-2010	1	Hilary	21-8-2011	28-8-2011	7
Otto	6-10-2010	10-10-2010	4	Irwin	6-10-2011	16-10-2011	10
Paula	11-10-2010	15-10-2010	4	Jova	6-10-2011	12-10-2011	6
Richard	20-10-2010	25-10-2010	5	Kenneth	19-11-2011	25-11-2011	6
Shary	28-10-2010	30-10-2010	2	Aletta	14-5-2012	19-5-2012	5
Tomas	29-10-2010	7-11-2010	9	Bud	20-5-2012	26-5-2012	6
Arlene	28-6-2011	2-7-2011	4	Carlotta	14-6-2012	16-6-2012	2
Bret	17-7-2011	22-7-2011	5	Daniel	4-7-2012	12-7-2012	8
Cindy	20-7-2011	22-7-2011	2	Emilia	12-7-2012	20-7-2012	8
Don	27-7-2011	30-7-2011	3	Fabio	7-8-2012	13-8-2012	6
Emily	2-8-2011	7-8-2011	5	Gilma	11-8-2012	15-8-2012	4
Franklin	12-8-2011	13-8-2011	1	Hector	11-8-2012	16-8-2012	5
Gert	13-8-2011	16-8-2011	3	Ileana	27-8-2012	2-9-2012	6
Harvey	19-8-2011	22-8-2011	3	John	2-9-2012	4-9-2012	2
Irene	21-8-2011	28-8-2011	7	Kristy	12-9-2012	17-9-2012	5
Jose	27-8-2011	28-8-2011	1	Lane	15-9-2012	19-9-2012	4
Katia	29-8-2011	10-9-2011	12	Miriam	22-9-2012	27-9-2012	5
Lee	2-9-2011	5-9-2011	3	Norman	28-9-2012	29-9-2012	1
Maria	6-9-2011	16-9-2011	10	Olivia	6-10-2012	8-10-2012	2
Nate	7-9-2011	11-9-2011	4	Paul	13-10-2012	17-10-2012	4
Ophelia	20-9-2011	3-10-2011	13	Rosa	30-10-2012	3-11-2012	4
Philippe	24-9-2011	8-10-2011	14	Alvin	15-5-2013	17-5-2013	2
Rina	23-10-2011	28-10-2011	5	Barbara	28-5-2013	30-5-2013	2
Sean	8-11-2010	11-11-2010	3	Cosme	23-6-2013	27-6-2013	4
Alberto	19-5-2012	22-5-2012	3	Dalilia	29-6-2013	7-7-2013	8
Beryl	26-5-2012	30-5-2012	4	Erick	4-7-2013	9-7-2013	5

Chris	18-6-2012	22-6-2012	4	Flossie	25-7-2013	30-7-2013	5
Debby	23-6-2012	27-6-2012	4	Gil	30-7-2013	6-8-2013	7
Ernesto	1-8-2012	10-8-2012	9	Henriette	3-8-2013	11-8-2013	8
Florence	3-8-2012	6-8-2012	3	Ivo	22-8-2013	25-8-2013	3
Gordon	15-8-2012	20-8-2012	5	Juliette	28-8-2013	29-8-2013	1
Helene	9-8-2012	18-8-2012	9	Kiko	30-8-2013	2-9-2013	3
Isaac	21-8-2012	1-9-2012	11	Lorena	5-9-2013	7-9-2013	2
Joyce	22-8-2012	24-8-2012	2	Manuel	13-9-2013	19-9-2013	6
Kirk	28-2-2012	4-3-2012	5	Narda	6-10-2013	10-10-2013	4
Leslie	30-8-2012	11-9-2012	12	Octave	12-10-2013	15-10-2013	3
Michael	3-9-2012	11-9-2012	8	Priscilla	14-10-2013	16-10-2013	2
Nadine	10-9-2012	3-10-2012	23	Raymond	20-10-2013	30-10-2013	10
Oscar	3-10-2012	5-10-2012	2	Sonia	1-11-2013	4-11-2013	3
Patty	11-10-2012	13-10-2012	2	Amanda	22-5-2014	29-5-2014	7
Rafael	12-10-2012	17-10-2012	5	Boris	2-6-2014	4-6-2014	2
Sandy	22-10-2012	29-10-2012	7	Cristina	9-6-2014	15-6-2014	6
Tony	22-10-2012	25-10-2012	3	Douglas	28-6-2014	5-7-2014	7
Andrea	5-6-2013	7-6-2013	2	Elida	30-6-2014	2-7-2014	2
Bary	17-6-2013	20-6-2013	3	Fausto	7-7-2014	9-7-2014	2
Chantal	7-7-2013	10-7-2013	3	Genevieve	25-7-2014	13-8-2014	19
Dorian	23-7-2013	3-8-2013	11	Hernan	26-7-2014	29-7-2014	3
Erin	15-8-2013	18-8-2013	3	Iselle	31-7-2014	9-8-2014	9
Fernand	25-8-2013	26-8-2013	1	Julio	4-8-2014	15-8-2014	11
Gabrielle	4-9-2013	13-9-2013	9	Karina	13-8-2014	26-8-2014	13
Humberto	8-9-2013	19-9-2013	11	Lowell	17-8-2014	24-8-2014	7
Ingrid	12-9-2013	17-9-2013	5	Marie	22-8-2014	28-8-2014	6
Jerry	29-9-2013	3-10-2013	4	Norbert	2-9-2014	8-9-2014	6
Karen	3-10-2013	6-10-2013	3	Odile	10-9-2014	18-9-2014	8
Lorenzo	21-10-2013	24-10-2013	3	Polo	16-9-2014	22-9-2014	6
Melissa	18-11-2013	21-11-2013	3	Rachel	24-9-2014	30-9-2014	6
Arthur	1-7-2014	5-7-2014	4	Simon	1-10-2014	7-10-2014	6
Bertha	1-8-2014	6-8-2014	5	Trudy	17-10-2014	19-10-2014	2
Cristobal	23-8-2014	29-8-2014	6	Vance	30-10-2014	5-11-2014	6
Dolly	1-9-2014	3-9-2014	2	Andres	28-5-2015	4-6-2015	7
Edouard	11-8-2014	19-8-2014	8	Blanca	31-5-2015	9-6-2015	9
Fay	10-10-2014	13-10-2014	3	Carlos	10-6-2015	17-6-2015	7
Gonzalo	12-10-2014	18-10-2014	6	Ela	8-7-2015	16-7-2015	8
Hanna	22-10-2014	29-10-2014	7	Dolores	11-7-2015	18-7-2015	7
Ana	8-5-2015	11-5-2015	3	Enrique	12-5-2015	18-5-2015	6
Bill	16-6-2015	18-6-2015	2	Felicia	23-7-2015	24-7-2015	1
Claudette	13-6-2015	14-6-2015	1	Guillermo	29-7-2015	7-8-2015	9
Danny	18-8-2015	24-8-2015	6	Hilda	6-8-2015	13-8-2015	7
Erika	24-8-2015	28-8-2015	4	Ignacio	25-8-2015	5-9-2015	11
Fred	30-8-2015	6-9-2015	7	Jimena	26-8-2015	9-9-2015	14
Grace	5-9-2015	9-9-2015	4	Kevin	31-8-2015	5-9-2015	5
Henri	8-9-2015	11-9-2015	3	Linda	5-9-2015	10-9-2015	5

Ida	18-9-2015	27-9-2015	9	Marty	26-9-2015	1-10-2015	5
Joaquin	28-9-2015	7-10-2015	9	Nora	9-10-2015	15-10-2015	6
Kate	8-11-2015	11-11-2015	3	Olaf	15-10-2015	26-10-2015	11
Alex	12-1-2016	15-1-2016	3	Patricia	20-10-2015	24-10-2015	4
Bonnie	27-5-2016	4-6-2016	8	Rick	18-10-2015	19-10-2015	1
Colin	5-6-2016	7-6-2016	2	Sandra	23-11-2015	28-11-2015	5
Danielle	19-6-2016	22-6-2016	3	Agatha	2-7-2016	5-7-2016	3
Earl	2-8-2016	6-8-2016	4	Blas	2-7-2016	10-7-2016	8
Fiona	16-8-2016	23-8-2016	7	Celia	6-7-2016	15-7-2016	9
Gaston	22-8-2016	2-9-2016	11	Darby	11-7-2016	25-7-2016	14
Hermine	28-8-2016	3-9-2016	6	Estelle	15-7-2016	21-7-2016	6
Ian	12-9-2016	16-9-2016	4	Frank	21-7-2016	28-7-2016	7
Julia	13-9-2016	18-9-2016	5	Georgette	21-7-2016	27-7-2016	6
Karl	14-9-2016	23-9-2016	9	Howard	31-7-2016	3-8-2016	3
Lisa	19-9-2016	25-9-2016	6	Ivette	3-8-2016	8-8-2016	5
Matthew	28-9-2016	9-10-2016	11	Javier	7-8-2016	9-8-2016	2
Nicole	4-10-2016	18-10-2016	14	Kay	18-8-2016	23-8-2016	5
Otto	20-11-2016	26-11-2016	6	Lester	24-8-2016	7-9-2016	14
Arlene	19-4-2017	22-4-2017	3	Madeline	26-8-2016	2-9-2016	7
Bret	19-6-2017	20-6-2017	1	Newton	4-9-2016	7-9-2016	3
Cindy	20-6-2017	23-6-2017	3	Orlene	18-9-2016	23-9-2016	5
Don	17-7-2017	18-7-2017	1	Paine	25-9-2016	27-9-2016	2
Emily	30-7-2017	1-8-2017	2	Rosyln	28-9-2016	2-10-2016	4
Franklin	7-8-2017	10-8-2017	3	Ulika	28-9-2016	30-9-2016	2
Gert	13-8-2017	17-8-2017	4	Seymour	23-10-2016	28-10-2016	5
Harvey	17-8-2017	1-9-2017	15	Tina	13-11-2016	14-11-2016	1
Irma	30-8-2017	12-9-2017	13	Otto	20-11-2016	26-11-2016	6
Jose	5-9-2017	22-9-2017	17	Adrian	9-5-2017	10-5-2017	1
Katia	5-9-2017	9-9-2017	4	Beatriz	31-5-2017	2-6-2017	2
Lee	14-9-2017	30-9-2017	16	Calvin	11-6-2017	13-6-2017	2
Maria	16-9-2017	30-9-2017	14	Dora	24-6-2017	28-6-2017	4
Nate	4-10-2017	8-10-2017	4	Eugene	7-7-2017	12-7-2017	5
Ophelia	9-10-2017	13-10-2017	4	Fernanda	11-7-2017	22-7-2017	11
Philippe	26-10-2017	27-10-2017	1	Greg	17-7-2017	26-7-2017	9
Rina	5-11-2017	9-11-2017	4	Hilary	21-7-2017	30-7-2017	9
Lidia	30-8-2017	3-9-2017	4	Irwin	22-7-2017	1-8-2017	10
Max	13-9-2017	15-9-2017	2	Jova	11-8-2017	13-8-2017	2
Norman	14-9-2017	19-9-2017	5	Kenneth	18-8-2017	23-8-2017	5
Otis	11-9-2017	19-9-2017	8	Ramon	3-10-2014	4-10-2014	1
Pilar	23-7-2017	25-7-2017	2	Selma	27-10-2017	28-10-2017	1

APPENDIX E Event window with best tracks combined: 2000-2017

Table 17 Event window and best tracks date

This Table shows the begin date of each storm and the best track date for each storm. The begin date of the storm is the date when the storm appeared for the first time EM-DAT (2018). The best track date is the date when the storm was spotted (begin date) for the first time by the National Hurricane Center (NHC) until the storm disappeared (end date). The storms are in chronological order per column.

Storm	Begin date storm	Begin date best track	End date best track
Leslie	4-10-2000	4-10-2000	7-10-2000
Allison	5-6-2001	5-6-2001	17-6-2001
Isidore	26-9-2002	14-9-2002	27-9-2002
Lili	3-10-2002	21-9-2002	4-10-2002
Bill	30-6-2003	29-6-2003	2-7-2003
Isabel	18-9-2003	6-9-2003	19-9-2003
Charley	13-8-2004	9-8-2004	14-8-2004
Gaston	29-8-2004	27-8-2004	4-9-2004
Frances	5-9-2004	25-8-2004	8-9-2004
Ivan	15-9-2004	2-9-2004	24-9-2004
Jeanne	25-9-2004	13-9-2004	28-9-2004
Dennis	10-7-2005	4-7-2005	13-7-2005
Katrina	29-8-2005	23-8-2005	30-8-2005
Rita	23-9-2005	18-9-2005	26-9-2005
Wilma	24-10-2005	15-10-2005	25-10-2005
Ernesto	2-8-2006	24-8-2006	1-9-2006
Dolly	23-7-2008	20-6-2008	25-6-2008
Fay	20-8-2008	15-8-2008	26-8-2008
Hanna	28-8-2008	28-8-2008	7-9-2008
Gustav	1-9-2008	25-8-2008	4-9-2008
Ike	12-9-2008	1-9-2008	14-9-2008
Ida	9-11-2009	4-11-2009	10-11-2009
Earl	3-9-2010	25-8-2010	4-9-2010
Irene	27-8-2011	21-8-2011	28-8-2011
Lee	4-9-2011	2-9-2011	5-9-2011
Isaac	28-8-2012	21-8-2012	1-9-2012
Isaac	28-8-2012	21-8-2012	1-9-2012
Sandy	28-10-2012	22-10-2012	29-10-2012
Iselle	8-8-2014	31-7-2014	9-8-2014
Joaquin	1-10-2015	28-9-2015	7-10-2015
Hermine	1-9-2016	28-8-2016	3-9-2016
Matthew	7-10-2016	28-9-2016	9-10-2016
Harvey	25-8-2017	17-8-2017	1-9-2017
Irma	10-9-2017	30-8-2017	12-9-2017
Nate	7-10-2017	4-10-2017	8-10-2017

APPENDIX F AAR Results

Table 18 AAR and CAAR results

*, **, *** denote significance at 95%, 97.5% and 99% level, respectively. The AAR is the average abnormal return for t, which is divided into subgroups of exposed and unexposed. A Two-paired T-test is used for the AAR. The CAAR is the cumulative average abnormal return for (-t; t). The t-test that is used for the CAAR is the Standardized Cross-Sectional Test by Boehmer et al. (1991). The CAAR is also divided into exposed and unexposed firms. The storms are in chronological order.

Dennis	**AAR (t)**	**Exposed**	**CAAR (-t;t)**	**Exposed**	**AAR (t)**	**Unexposed**	**CAAR (-t;t)**	**Unexposed**
	AAR -3	0.01345***	CAAR	-0.0135	AAR -3	-0.0105***	CAAR	-0.0105
	AAR -2	0.0012	CAAR(-3;-2)	-0.0122***	AAR -2	0.0041***	CAAR(-3;-2)	-0.0064***
	AAR -1	0.0057	CAAR(-2;-1)	0.0069	AAR -1	0.0129***	CAAR(-2;-1)	0.0170***
	AAR 0	0.0057	CAAR(-1;0)	0.0113**	AAR 0	0.0051***	CAAR(-1;0)	0.0180***
	AAR +1	0.0053	CAAR(0;+1)	0.0110	AAR +1	0.0058***	CAAR(0;+1)	0.0109***
	AAR +2	-0.0147	CAAR(+1;+2)	-0.0094	AAR +2	0.0040***	CAAR(+1;+2)	0.0098***
	AAR +3	0.0361	CAAR(+2;+3)	0.0214	AAR +3	0.0039	CAAR(+2;+3)	0.0079***
Katrina	**AAR (t)**	**Exposed**	**CAAR (-t;t)**	**Exposed**	**AAR (t)**	**Unexposed**	**CAAR (-t;t)**	**Unexposed**
	AAR -3	0.0037	CAAR	0.0037	AAR -3	0.0006	CAAR	0.0006
	AAR -2	0.0030	CAAR(-3;-2)	0.0068	AAR -2	0.0023	CAAR(-3;-2)	0.0028***
	AAR -1	0.0071	CAAR(-2;-1)	0.0101	AAR -1	0.0133	CAAR(-2;-1)	0.0155**
	AAR 0	-0.0078	CAAR(-1;0)	-0.0008	AAR 0	0.0015	CAAR(-1;0)	0.0148***
	AAR +1	-0.0277	CAAR(0;+1)	-0.0355***	AAR +1	-0.0188	CAAR(0;+1)	-0.0173***
	AAR +2	0.0067	CAAR(+1;+2)	-0.0210***	AAR +2	0.0090	CAAR(+1;+2)	-0.0098***
	AAR +3	-0.0143	CAAR(+2;+3)	-0.0077*	AAR +3	-0.0133	CAAR(+2;+3)	-0.0043***
Rita	**AAR (t)**	**Exposed**	**CAAR (-t;t)**	**Exposed**	**AAR (t)**	**Unexposed**	**CAAR (-t;t)**	**Unexposed**
	AAR -3	-0.0026	CAAR	-0.0026	AAR -3	-0.0047	CAAR	-0.0047
	AAR -2	0.0247	CAAR(-3;-2)	0.0221***	AAR -2	0.0302*	CAAR(-3;-2)	0.0256
	AAR -1	0.0169	CAAR(-2;-1)	0.0415***	AAR -1	0.0139	CAAR(-2;-1)	0.0441
	AAR 0	0.0099	CAAR(-1;0)	0.0268	AAR 0	0.0118	CAAR(-1;0)	0.0257
	AAR +1	-0.0001	CAAR(0;+1)	0.0098	AAR +1	-0.0003	CAAR(0;+1)	0.0115
	AAR +2	-0.0105	CAAR(+1;+2)	-0.0106	AAR +2	-0.0069	CAAR(+1;+2)	-0.0072
	AAR +3	0.0058	CAAR(+2;+3)	-0.0048	AAR +3	0.0045	CAAR(+2;+3)	-0.0024
Wilma	**AAR (t)**	**Exposed**	**CAAR (-t;t)**	**Exposed**	**AAR (t)**	**Unexposed**	**CAAR (-t;t)**	**Unexposed**
	AAR -3	0.1437	CAAR	0.1437	AAR -3	0.5769***	CAAR	0.5769
	AAR -2	-0.1846***	CAAR(-3;-2)	-0.0410***	AAR -2	-0.7357	CAAR(-3;-2)	-0.1588***
	AAR -1	-0.0080	CAAR(-2;-1)	-0.1926***	AAR -1	-0.0078	CAAR(-2;-1)	-0.7435***
	AAR 0	0.1647***	CAAR(-1;0)	0.1567***	AAR 0	0.6617***	CAAR(-1;0)	0.6539***
	AAR +1	-0.0423	CAAR(0;+1)	0.1224***	AAR +1	-0.1838	CAAR(0;+1)	0.4779***
	AAR +2	-0.0685	CAAR(+1;+2)	-0.1108***	AAR +2	-0.2667	CAAR(+1;+2)	-0.4505***
	AAR +3	-0.1321	CAAR(+2;+3)	-0.2006***	AAR +3	-0.5421	CAAR(+2;+3)	-0.8088***
Ernesto	**AAR (t)**	**Exposed**	**CAAR (-t;t)**	**Exposed**	**AAR (t)**	**Unexposed**	**CAAR (-t;t)**	**Unexposed**
	AAR -3	0.0011	CAAR	0.0011	AAR -3	-0.0070	CAAR	-0.0070
	AAR -2	-0.0143	CAAR(-3;-2)	-0.0132***	AAR -2	-0.0161	CAAR(-3;-2)	-0.0231***

	AAR -1	-0.0059	CAAR(-2;-1)	-0.0202***	AAR -1	-0.0022	CAAR(-2;-1)	-0.0182***
	AAR 0	0.0110	CAAR(-1;0)	0.0051	AAR 0	0.0173	CAAR(-1;0)	0.0151***
	AAR +1	0.0108	CAAR(0;+1)	0.0218***	AAR +1	0.0097	CAAR(0;+1)	0.0270***
	AAR +2	0.0043	CAAR(+1;+2)	0.0151	AAR +2	0.0035	CAAR(+1;+2)	0.0132**
	AAR +3	-0.0202	CAAR(+2;+3)	-0.0158*	AAR +3	-0.0241	CAAR(+2;+3)	-0.0207***
Dolly	**AAR (t)**	**Exposed**	**CAAR (-t;t)**	**Exposed**	**AAR (t)**	**Unexposed**	**CAAR (-t;t)**	**Unexposed**
	AAR -3	0.0085	CAAR	0.0085	AAR -3	0.0082	CAAR	0.0082
	AAR -2	0.0132	CAAR(-3;-2)	0.0216	AAR -2	0.0116	CAAR(-3;-2)	0.0198***
	AAR -1	-0.0145	CAAR(-2;-1)	-0.0013***	AAR -1	-0.0154	CAAR(-2;-1)	-0.0038***
	AAR 0	0.0025	CAAR(-1;0)	-0.0120**	AAR 0	0.0017	CAAR(-1;0)	-0.0137
	AAR +1	-0.0069	CAAR(0;+1)	-0.0044***	AAR +1	-0.0033	CAAR(0;+1)	-0.0016***
	AAR +2	-0.0015	CAAR(+1;+2)	-0.0084**	AAR +2	-0.0062	CAAR(+1;+2)	-0.0095***
	AAR +3	-0.0282	CAAR(+2;+3)	-0.0298***	AAR +3	-0.0310	CAAR(+2;+3)	-0.0372***
Fay	**AAR (t)**	**Exposed**	**CAAR (-t;t)**	**Exposed**	**AAR (t)**	**Unexposed**	**CAAR (-t;t)**	**Unexposed**
	AAR -3	-0.0026	CAAR	-0.0026	AAR -3	-0.0064	CAAR	-0.0064
	AAR -2	-0.0115	CAAR(-3;-2)	-0.0141	AAR -2	-0.0169	CAAR(-3;-2)	-0.0233***
	AAR -1	-0.0029	CAAR(-2;-1)	-0.0144	AAR -1	-0.0028	CAAR(-2;-1)	-0.0197***
	AAR 0	0.0068	CAAR(-1;0)	0.0039	AAR 0	0.0187	CAAR(-1;0)	0.0159***
	AAR +1	0.0057	CAAR(0;+1)	0.0125	AAR +1	0.0111	CAAR(0;+1)	0.0298***
	AAR +2	0.0041	CAAR(+1;+2)	0.0098	AAR +2	0.0035	CAAR(+1;+2)	0.0146***
	AAR +3	-0.0199***	CAAR(+2;+3)	-0.0158	AAR +3	-0.0244	CAAR(+2;+3)	-0.0209***
Hanna	**AAR (t)**	**Exposed**	**CAAR (-t;t)**	**Exposed**	**AAR (t)**	**Unexposed**	**CAAR (-t;t)**	**Unexposed**
	AAR -3	-0.0222***	CAAR	-0.0222	AAR -3	-0.0281***	CAAR	-0.0281
	AAR -2	0.00072437	CAAR(-3;-2)	-0.0234***	AAR -2	0.0026	CAAR(-3;-2)	-0.0255***
	AAR -1	0.00612909	CAAR(-2;-1)	0.0074	AAR -1	-0.0003	CAAR(-2;-1)	-0.0006
	AAR 0	0.00205406	CAAR(-1;0)	0.0054	AAR 0	-0.0024	CAAR(-1;0)	-0.0057
	AAR +1	-0.0027***	CAAR(0;+1)	-0.0244***	AAR +1	-0.0267***	CAAR(0;+1)	-0.0303*
	AAR +2	-0.0010	CAAR(+1;+2)	-0.0263***	AAR +2	-0.0011	CAAR(+1;+2)	-0.0273***
	AAR +3	-0.0159	CAAR(+2;+3)	-0.0167***	AAR +3	-0.0093	CAAR(+2;+3)	-0.0072
Gustav	**AAR (t)**	**Exposed**	**CAAR (-t;t)**	**Exposed**	**AAR (t)**	**Unexposed**	**CAAR (-t;t)**	**Unexposed**
	AAR -3	0.0085	CAAR	0.0085	AAR -3	0.0081	CAAR	0.0081
	AAR -2	0.0136	CAAR(-3;-2)	0.0221***	AAR -2	0.0109	CAAR(-3;-2)	0.0190***
	AAR -1	-0.0147	CAAR(-2;-1)	-0.0011	AAR -1	-0.0155	CAAR(-2;-1)	-0.0047
	AAR 0	0.0022	CAAR(-1;0)	-0.0125***	AAR 0	0.0017	CAAR(-1;0)	-0.0138***
	AAR +1	-0.0052	CAAR(0;+1)	-0.0030***	AAR +1	-0.0034	CAAR(0;+1)	-0.0017
	AAR +2	-0.0020	CAAR(+1;+2)	-0.0072***	AAR +2	-0.0071	CAAR(+1;+2)	-0.0105***
	AAR +3	-0.0294***	CAAR(+2;+3)	-0.0314***	AAR +3	-0.0311	CAAR(+2;+3)	-0.0381***
Ike	**AAR (t)**	**Exposed**	**CAAR (-t;t)**	**Exposed**	**AAR (t)**	**Unexposed**	**CAAR (-t;t)**	**Unexposed**
	AAR -3	-0.0304	CAAR	-0.0304	AAR -3	-0.0333***	CAAR	-0.0334
	AAR -2	0.0085	CAAR(-3;-2)	-0.0219***	AAR -2	0.0074	CAAR(-3;-2)	-0.0260***
	AAR -1	0.0200	CAAR(-2;-1)	0.0284***	AAR -1	0.0213***	CAAR(-2;-1)	0.0287***

	AAR 0	0.0117	CAAR(-1;0)	0.0317***	AAR 0	0.0084	CAAR(-1;0)	0.0297***
	AAR +1	-0.0327	CAAR(0;+1)	-0.0209	AAR +1	-0.0487***	CAAR(0;+1)	-0.0402***
	AAR +2	0.0203	CAAR(+1;+2)	-0.0123	AAR +2	0.0161	CAAR(+1;+2)	-0.0326***
	AAR +3	-0.0364	CAAR(+2;+3)	-0.0161	AAR +3	-0.0418***	CAAR(+2;+3)	-0.0257***
Ida	**AAR (t)**	**Exposed**	**CAAR (-t;t)**	**Exposed**	**AAR (t)**	**Unexposed**	**CAAR (-t;t)**	**Unexposed**
	AAR -3	0.0005	CAAR	0.0005	AAR -3	0.0009	CAAR	0.0009
	AAR -2	0.0175	CAAR(-3;-2)	0.0180***	AAR -2	0.0191***	CAAR(-3;-2)	0.0200***
	AAR -1	0.0026	CAAR(-2;-1)	0.0201***	AAR -1	0.0016	CAAR(-2;-1)	0.0207***
	AAR 0	0.0215***	CAAR(-1;0)	0.0242***	AAR 0	0.0218***	CAAR(-1;0)	0.0234***
	AAR +1	-0.0012	CAAR(0;+1)	0.0203***	AAR +1	0.0002	CAAR(0;+1)	0.0220***
	AAR +2	0.0038	CAAR(+1;+2)	0.0026***	AAR +2	0.0037	CAAR(+1;+2)	0.0040***
	AAR +3	-0.0108	CAAR(+2;+3)	-0.0070***	AAR +3	-0.0102	CAAR(+2;+3)	-0.0064***
Earl	**AAR (t)**	**Exposed**	**CAAR (-t;t)**	**Exposed**	**AAR (t)**	**Unexposed**	**CAAR (-t;t)**	**Unexposed**
	AAR -3	-0.0078	CAAR	-0.0078	AAR -3	-0.0073	CAAR	-0.0073
	AAR -2	0.0091***	CAAR(-3;-2)	0.0013***	AAR -2	0.0026***	CAAR(-3;-2)	-0.0047***
	AAR -1	-0.0003***	CAAR(-2;-1)	0.0087***	AAR -1	0.0049	CAAR(-2;-1)	0.0075***
	AAR 0	-0.0001	CAAR(-1;0)	-0.0005***	AAR 0	-0.0021***	CAAR(-1;0)	0.0029***
	AAR +1	0.0010	CAAR(0;+1)	0.0009***	AAR +1	0.0014	CAAR(0;+1)	-0.0007***
	AAR +2	-0.0085***	CAAR(+1;+2)	-0.0075***	AAR +2	-0.0076*	CAAR(+1;+2)	-0.0062***
	AAR +3	0.0073	CAAR(+2;+3)	-0.0012	AAR +3	0.0058**	CAAR(+2;+3)	-0.0017***
Lee	**AAR (t)**	**Exposed**	**CAAR (-t;t)**	**Exposed**	**AAR (t)**	**Unexposed**	**CAAR (-t;t)**	**Unexposed**
	AAR -3	-0.0151	CAAR	-0.0151	AAR -3	-0.0206	CAAR	-0.0206
	AAR -2	-0.0024	CAAR(-3;-2)	-0.0175***	AAR -2	-0.0086***	CAAR(-3;-2)	-0.0292
	AAR -1	-0.0079***	CAAR(-2;-1)	-0.0104***	AAR -1	-0.0147***	CAAR(-2;-1)	-0.0234***
	AAR 0	0.0134	CAAR(-1;0)	0.0055*	AAR 0	0.0165	CAAR(-1;0)	0.0018***
	AAR +1	0.0009	CAAR(0;+1)	0.0143	AAR +1	-0.0047**	CAAR(0;+1)	0.0118***
	AAR +2	-0.0068***	CAAR(+1;+2)	-0.0058***	AAR +2	-0.0023***	CAAR(+1;+2)	-0.0070*
	AAR +3	0.0072**	CAAR(+2;+3)	0.0005***	AAR +3	0.00578***	CAAR(+2;+3)	0.0035***
Isaac	**AAR (t)**	**Exposed**	**CAAR**	**Exposed**	**AAR (t)**	**Unexposed**	**CAAR (-t;t)**	**Unexposed**
	AAR -3	-0.0087***	CAAR	-0.0087	AAR -3	-0.00534***	CAAR	-0.0053
	AAR -2	0.0020***	CAAR(-3;-2)	-0.0067	AAR -2	0.0018	CAAR(-3;-2)	-0.0036
	AAR -1	-0.0047	CAAR(-2;-1)	-0.0027***	AAR -1	-0.0056	CAAR(-2;-1)	-0.0039***
	AAR 0	0.0107	CAAR(-1;0)	0.0060	AAR 0	0.0070	CAAR(-1;0)	0.0013
	AAR +1	-0.0008	CAAR(0;+1)	0.0099	AAR +1	-0.0026	CAAR(0;+1)	0.0043
	AAR +2	0.0098***	CAAR(+1;+2)	0.0090***	AAR +2	0.0137***	CAAR(+1;+2)	0.0111***
	AAR +3	0.0032***	CAAR(+2;+3)	0.0130	AAR +3	0.0002	CAAR(+2;+3)	0.0139
Iselle	**AAR (t)**	**Exposed**	**CAAR (-t;t)**	**Exposed**	**AAR (t)**	**Unexposed**	**CAAR (-t;t)**	**Unexposed**
	AAR -3	0.0049***	CAAR	0.0049	AAR -3	0.0140	CAAR	0.0140
	AAR -2	-0.0109	CAAR(-3;-2)	-0.0060***	AAR -2	-0.0023	CAAR(-3;-2)	0.0118***
	AAR -1	-0.0243	CAAR(-2;-1)	-0.0352***	AAR -1	-0.0259	CAAR(-2;-1)	-0.0282***
	AAR 0	0.0043***	CAAR(-1;0)	-0.0200	AAR 0	-0.0005***	CAAR(-1;0)	-0.0264

	AAR +1	-0.0078	CAAR(0;+1)	-0.0035***	AAR +1	-0.0116	CAAR(0;+1)	-0.0121***
	AAR +2	0.0216	CAAR(+1;+2)	0.0138***	AAR +2	0.0160	CAAR(+1;+2)	0.0044
	AAR +3	-0.0077***	CAAR(+2;+3)	0.0139	AAR +3	-0.0059	CAAR(+2;+3)	0.0101
Hermine	**AAR (t)**	**Exposed**	**CAAR (-t;t)**	**Exposed**	**AAR (t)**	**Unexposed**	**CAAR (-t;t)**	**Unexposed**
	AAR -3	0.0047***	CAAR	0.0047	AAR -3	-0.0003	CAAR	-0.0003
	AAR -2	-0.0002	CAAR(-3;-2)	0.0045	AAR -2	-0.0001	CAAR(-3;-2)	-0.0005
	AAR -1	-0.0009	CAAR(-2;-1)	-0.0010	AAR -1	-0.0041	CAAR(-2;-1)	-0.0042
	AAR 0	0.0000	CAAR(-1;0)	-0.0008	AAR 0	0.0012	CAAR(-1;0)	-0.0029***
	AAR +1	0.0038	CAAR(0;+1)	0.0038	AAR +1	-0.0021	CAAR(0;+1)	-0.0009***
	AAR +2	0.0002	CAAR(+1;+2)	0.0040	AAR +2	-0.0023	CAAR(+1;+2)	-0.0043***
	AAR +3	0.0018	CAAR(+2;+3)	0.0019	AAR +3	-0.0013	CAAR(+2;+3)	-0.0036***
Matthew	**AAR (t)**	**Exposed**	**CAAR (-t;t)**	**Exposed**	**AAR (t)**	**Unexposed**	**CAAR (-t;t)**	**Unexposed**
	AAR -3	-0.0101	CAAR	-0.0101	AAR -3	-0.0098	CAAR	-0.0098
	AAR -2	-0.0077	CAAR(-3;-2)	-0.0178	AAR -2	-0.0094	CAAR(-3;-2)	-0.0192***
	AAR -1	0.0038	CAAR(-2;-1)	-0.0039*	AAR -1	0.0029	CAAR(-2;-1)	-0.0065***
	AAR 0	-0.0039	CAAR(-1;0)	-0.0001***	AAR 0	-0.0030	CAAR(-1;0)	-0.0002***
	AAR +1	-0.0023	CAAR(0;+1)	-0.0062**	AAR +1	-0.0008	CAAR(0;+1)	-0.0038***
	AAR +2	-0.0011***	CAAR(+1;+2)	-0.0034***	AAR +2	-0.0013***	CAAR(+1;+2)	-0.0021***
	AAR +3	-0.0003	CAAR(+2;+3)	-0.0014***	AAR +3	0.0008	CAAR(+2;+3)	-0.0005***
Harvey	**AAR (t)**	**Exposed**	**CAAR (-t;t)**	**Exposed**	**AAR (t)**	**Unexposed**	**CAAR (-t;t)**	**Unexposed**
	AAR -3	0.01152***	CAAR	0.0115	AAR -3	0.0109***	CAAR	0.0109
	AAR -2	-0.0048	CAAR(-3;-2)	0.0067***	AAR -2	-0.0038	CAAR(-3;-2)	0.0071**
	AAR -1	-0.0005	CAAR(-2;-1)	-0.0053**	AAR -1	-0.0026	CAAR(-2;-1)	-0.0065**
	AAR 0	-0.0009	CAAR(-1;0)	-0.0014	AAR 0	0.0006	CAAR(-1;0)	-0.0021
	AAR +1	0.0100	CAAR(0;+1)	0.0090***	AAR +1	0.0068	CAAR(0;+1)	0.0073***
	AAR +2	0.0018	CAAR(+1;+2)	0.0117**	AAR +2	0.0027	CAAR(+1;+2)	0.0094***
	AAR +3	0.0122	CAAR(+2;+3)	0.0140***	AAR +3	0.0052	CAAR(+2;+3)	0.0079***
Irma	**AAR (t)**	**Exposed**	**CAAR (-t;t)**	**Exposed**	**AAR (t)**	**Unexposed**	**CAAR (-t;t)**	**Unexposed**
	AAR -3	0.0019	CAAR	0.0019	AAR -3	0.0047	CAAR	0.0047
	AAR -2	0.0087	CAAR(-3;-2)	0.0106***	AAR -2	0.0068	CAAR(-3;-2)	0.0116***
	AAR -1	-0.0093	CAAR(-2;-1)	-0.0005	AAR -1	-0.0080	CAAR(-2;-1)	-0.0012
	AAR 0	0.0065	CAAR(-1;0)	-0.0028	AAR 0	0.0084	CAAR(-1;0)	0.0003
	AAR +1	0.0037	CAAR(0;+1)	0.0102***	AAR +1	0.0035	CAAR(0;+1)	0.0119***
	AAR +2	0.0013	CAAR(+1;+2)	0.0051*	AAR +2	0.0015	CAAR(+1;+2)	0.0051***
	AAR +3	0.0011	CAAR(+2;+3)	0.0024	AAR +3	0.0014	CAAR(+2;+3)	0.0029***

APPENDIX G CAAR Results

Table 19 CAAR results for each storm and firm characteristics

*, **, *** denote significance at respectively 95%, 97.5% and 99% level, two tailed test. This Table shows the influence of the degree of exposure, amount of direct premium written, market cap and book-to-market on the cumulative average abnormal return (CAAR) (-t; t). Exposure is a dummy variable for the categories exposed by the storm and unexposed by the storm. The exposure dummy takes value 1 if a firm is exposed by the storm and 0 if it is unexposed by the storm. DPW is the logarithm of the direct premium written. Size is the logarithm of the market value per company. The book-to-market is the book-to-market ratio. Both variables size and the book-to-market ratio are obtained from Datastream. Each regression is checked for the assumptions of Ordinary Least Squares (OLS). ¬ shows where a correction is made for heteroscedasticity. The storms are in chronological order.

Dennis	**CAAR (-t;t)**	**Exposure**	**DPW**	**Size**	**Book-to-market**
	CAAR(-3;-2)	-0.0046	0.0006	-0.0008	-0.0028
	CAAR(-2;-1)¬	-0.0064	-0.0015	0.0010	-0.0036***
	CAAR(-1;0)¬	-0.0043	-0.0041	0.0078	-0.0063
	CAAR(0;+1)¬	-0.0033	-0.0077	0.0000	-0.0056**
	CAAR(+1;+2)¬	-0.0222	-0.0214	0.0145	-0.0197
	CAAR(+2;+3)¬	0.0152	0.0219	-0.0185	0.0168
Katrina	**CAAR (-t;t)**	**Exposure**	**DPW**	**Size**	**Book-to-market**
	CAAR (-3;-2)	-0.0020	0.0051	-0.0031	0.0062
	CAAR (-2;-1)	-0.0040	0.0007	-0.0006	-0.0005
	CAAR(-1;0)¬	-0.0005	0.0007	-0.0033	-0.0050
	CAAR (0;+1)¬	-0.0008	0.0016	-0.0040	-0.0042
	CAAR(+1;+2)¬	-0.0074*	0.0051	0.0037	0.0055
	CAAR(+2;+3)	-0.0076	0.0024	0.0023	0.0028
Rita	**CAAR (-t;t)**	**Exposure**	**DPW**	**Size**	**Book-to-market**
	CAAR(-3;-2)	0.0017	0.0006	0.0007	0.0000
	CAAR(-2;-1)	0.0004	-0.0005	0.0006	-0.0011
	CAAR(-1;0)	-0.0015	-0.0015	0.0004	-0.0035*
	CAAR(0;+1)¬	0.0003	-0.0005	-0.0010	-0.0032***
	CAAR(+1;+2)	0.0023	0.0007	-0.0016*	-0.0004
	CAAR(+2;+3)¬	0.0012	-0.0014	-0.0007	0.0047
Wilma	**CAAR (-t;t)**	**Exposure**	**DPW**	**Size**	**Book-to-market**
	CAAR(-3;-2)	0.0001	0.0000	0.0000	0.0001
	CAAR(-2;-1)¬	0.0004	-0.0003	0.0003	-0.0006
	CAAR(-1;0)¬	0.0004	-0.0005	0.0004	-0.0006
	CAAR(0;+1)	-0.0004	-0.0003	-0.0001	0.0004***
	CAAR(+1;+2)	-0.0003	-0.0003	0.0001	0.0002
	CAAR(+2;+3)	0.0000	0.0002	0.0002	-0.0002
Ernesto	**CAAR (-t;t)**	**Exposure**	**DPW**	**Size**	**Book-to-market**
	CAAR(-3;-2)¬	-0.0006	0.0003	0.0000	0.0000
	CAAR(-2;-1)¬	-0.0007	0.0003*	-0.0001	0.0000

	CAAR(-1;0)	-0.0009	0.0004*	0.0000	-0.0001
	CAAR(0;+1)	-0.0005	0.0000	0.0001	-0.0002
	CAAR(+1;+2)	-0.0002	-0.0003	0.0003***	-0.0001
	CAAR(+2;+3)	-0.0003	0.0002	0.0001	0.0001
Dolly	**CAAR (-t;t)**	**Exposure**	**DPW**	**Size**	**Book-to-market**
	CAAR(-3;-2)	-0.0013	0.0000	0.0002	-0.0001
	CAAR(-2;-1)	0.0129	-0.0009	-0.0020	-0.0002
	CAAR(-1;0)	0.0001	-0.0019	-0.0020	-0.0061***
	CAAR(0;+1)	0.0001	-0.0005	0.0017	-0.0015***
	CAAR(+1;+2)	0.0016	0.0019	0.0011	0.00148***
	CAAR(+2;+3)	0.0083	0.0019	-0.0054	0.0005
Fay	**CAAR (-t;t)**	**Exposure**	**DPW**	**Size**	**Book-to-market**
	CAAR(-3;-2)	-0.0024	0.0018	0.0074	-0.0075
	CAAR(-2;-1)	0.0035	0.0037	-0.0022	-0.0018
	CAAR(-1;0)	-0.0017	0.0068	-0.0154*	0.0038
	CAAR(0;+1)	-0.0096	0.0030	-0.0090	0.0041
	CAAR(+1;+2)	-0.0083	0.0034	0.0009	0.0003
	CAAR(+2;+3)	0.0026	0.0056	-0.0044	-0.0038
Gustav	**CAAR (-t;t)**	**Exposure**	**DPW**	**Size**	**Book-to-market**
	CAAR(-3;-2)	0.0064	0.0012	-0.0053	-0.0024
	CAAR(-2;-1)	0.0072	-0.0013	-0.0054	-0.0063***
	CAAR(-1;0)	0.0022	-0.0012	-0.0009	-0.0023*
	CAAR(0;+1)	0.0036	0.0002	-0.0076	-0.0046*
	CAAR(+1;+2)	0.0073	-0.0021	-0.0069	-0.0109*
	CAAR(+2;+3)	0.0055	-0.0036	0.0017	-0.0076
Hanna	**CAAR (-t;t)**	**Exposure**	**DPW**	**Size**	**Book-to-market**
	CAAR(-3;-2)	0.0042	-0.0006	-0.0009	-0.0017
	CAAR(-2;-1)	0.0091	0.0041	-0.0025	0.0114***
	CAAR(-1;0)	0.0239	0.0064	-0.0185	-0.0090***
	CAAR(0;+1)	0.0212	-0.0010	-0.0183	-0.0202***
	CAAR(+1;+2)	0.0045	-0.0027	-0.0028	-0.00685***
	CAAR(+2;+3)	0.0091	0.0020	-0.0234	-0.0132**
Ike	**CAAR (-t;t)**	**Exposure**	**DPW**	**Size**	**Book-to-market**
	CAAR(-3;-2)	0.0008	0.0054	-0.0003	0.0035***
	CAAR(-2;-1)	-0.0054	0.0023	0.0008	-0.0054
	CAAR(-1;0)	0.0001	-0.0001	-0.0020	-0.0092*
	CAAR(0;+1)	0.0167	0.0047	-0.0026	-0.0026
	CAAR(+1;+2)	0.0241	0.0081	-0.0100	0.0035

	CAAR(+2;+3)	0.0161	0.0061	-0.0124	0.0007
Ida	**CAAR (-t;t)**	**Exposure**	**DPW**	**Size**	**Book-to-market**
	CAAR(-3;-2)	-0.0023	0.0039***	-0.0014	0.0010
	CAAR(-2;-1)	-0.0007	0.0021	-0.0007	0.0006
	CAAR(-1;0)	0.0006	-0.0002	-0.0006	-0.0008
	CAAR(0;+1)	-0.0005	0.0010	-0.0007	0.0017
	CAAR(+1;+2)	-0.0004	0.0002	0.0003	0.0018
	CAAR(+2;+3)	0.0001	0.0002	-0.0017	-0.0003
Earl	**CAAR (-t;t)**	**Exposure**	**DPW**	**Size**	**Book-to-market**
	CAAR(-3;-2)	0.0019	-0.0019***	0.0014	0.0005
	CAAR(-2;-1)	0.0041	0.0008	-0.0045***	-0.0026
	CAAR(-1;0)	0.0007	0.0003	-0.0014	-0.0013
	CAAR(0;+1)	0.0008	-0.0005	-0.0006	-0.0004
	CAAR(+1;+2)	0.0058	0.0006	-0.0022	-0.0028
	CAAR(+2;+3)	0.0055	0.0005	-0.0029*	-0.0037**
Lee	**CAAR (-t;t)**	**Exposure**	**DPW**	**Size**	**Book-to-market**
	CAAR(-3;-2)	-0.0084	0.0018	-0.0068*	0.01165***
	CAAR(-2;-1)	0.0010	0.0016	0.0007	0.0056
	CAAR(-1;0)	0.0014	-0.0004	0.0077*	-0.0008
	CAAR(0;+1)	0.0036	-0.0007	0.0052*	-0.0027
	CAAR(+1;+2)	0.0038	-0.0031	0.0017	-0.0096
	CAAR(+2;+3)	0.0005	-0.0008	-0.0052	-0.0048
Isaac	**CAAR (-t;t)**	**Exposure**	**DPW**	**Size**	**Book-to-market**
	CAAR(-3;-2)	0.0016	-0.0023	0.0089	0.0044
	CAAR(-2;-1)	-0.0008	-0.0006	0.0033	0.0017
	CAAR(-1;0)	-0.0008	0.0017	-0.0058	-0.0040
	CAAR(0;+1)	0.0010	0.0001	0.0009	-0.0018
	CAAR(+1;+2)	-0.0022	-0.0001	0.0012	-0.0004
	CAAR(+2;+3)	-0.0003	-0.0005	0.0013	0.0011
Iselle	**CAAR (-t;t)**	**Exposure**	**DPW**	**Size**	**Book-to-market**
	CAAR(-3;-2)	0.0104	-0.0021	0.0002	-0.0051
	CAAR(-2;-1)	0.0046	-0.0001	0.0048	0.0046
	CAAR(-1;0)	0.0025	0.0027	0.0004	0.0040
	CAAR(0;+1)	-0.0041	-0.0012	0.0056***	0.0048*
	CAAR(+1;+2)	-0.0029	-0.0021	0.0021	0.0037
	CAAR(+2;+3)	-0.0020	-0.0002	-0.0024	-0.0001
Hermine	**CAAR (-t;t)**	**Exposure**	**DPW**	**Size**	**Book-to-market**

	CAAR(-3;-2)⌟	0.0048	-0.0004	0.0009	0.0049
	CAAR(-2;-1)⌟	0.0023	-0.0004	0.0012	0.0037
	CAAR(-1;0)	0.0034	-0.0001	0.0007	-0.0007
	CAAR(0;+1)⌟	0.0068	-0.0013**	0.0029	0.0020
	CAAR(+1;+2)⌟	0.0009	-0.0012	0.0041***	-0.0034
	CAAR(+2;+3)	0.0018	-0.0001	0.0006	-0.0044***
Matthew	**CAAR (-t;t)**	**Exposure**	**DPW**	**Size**	**Book-to-market**
	CAAR(-3;-2)	0.0001	0.0000	0.0000	0.0001
	CAAR(-2;-1)⌟	0.0004	-0.0003	0.0003	-0.0006
	CAAR(-1;0)⌟	0.0004	-0.0005	0.0004	-0.0006
	CAAR(0;+1)	-0.0004	-0.0003	-0.0001	0.0004*
	CAAR(+1;+2)	-0.0003	-0.0003	0.0001	0.0002
	CAAR(+2;+3)	0.0000	0.0002	0.0002	-0.0002
Harvey	**CAAR (-t;t)**	**Exposure**	**DPW**	**Size**	**Book-to-market**
	CAAR(-3;-2)	-0.0002	0.0008	-0.0005	0.0005
	CAAR(-2;-1)	-0.0012	0.0001	0.0034	-0.0010
	CAAR(-1;0)	0.0002	0.0001	0.0009	0.0021
	CAAR(0;+1)	-0.0004	0.0003	0.0023	-0.0041
	CAAR(+1;+2)⌟	-0.0040	-0.0006	0.0098	-0.0039***
	CAAR(+2;+3)	0.0056	0.0006	0.0007	0.0015
Irma	**CAAR (-t;t)**	**Exposure**	**DPW**	**Size**	**Book-to-market**
	CAAR(-3;-2)⌟	-0.0003	0.0013	-0.0042	-0.0025
	CAAR(-2;-1)	0.0012	-0.0003	0.0001	0.0009
	CAAR(-1;0)⌟	-0.0039	-0.0019	0.0061	0.0035
	CAAR(0;+1)⌟	-0.0022	-0.0003	0.0005	-0.0017*
	CAAR(+1;+2)	-0.0009	-0.0002	0.0014*	-0.0006
	CAAR(+2;+3)	-0.0018	-0.0002	0.0028***	0.0013

APPENDIX H Amount of direct premium written and the amount of losses

Table 20 Amount of direct premium written and amount of losses

*, **, *** denote significance at 95%, 97.5% and 99% level, respectively. This Table shows the influence on the CAR (-t; t) causes of Exposure, Losses and DPW after checking for the size and the book-to-market ratio. The CAR (-t;t) is the cumulative abnormal return over the period of -3 up and including +3. Exposure is a dummy variable for the categories exposed by the storm and unexposed by the storm. The exposure dummy takes value 1 if a firm is exposed by the storm and 0 if it is unexposed by a storm. Losses is the logarithm of the damage done by the storms in US dollars as is shown in Table 4 of this report. DPW is the logarithm of the direct premium written. The variable influence show the coefficient of either the Losses or the DPW. Each regression is checked for the assumptions of Ordinary Least Squares (OLS).

Company	**CAR (-t;t)**	**Variable**	**Influence**
Alleghany	(+2;+3)	DPW	0.0316***
Allianz	(+2;+3)	Losses	2.74e-13***
American National IN.	(+2;+3)	Losses	2.60e-13*
American National IN.	(+1;+2)	Losses	2.46e-13*
Aspen Insurance Holding GRP.	(+1;+2)	Losses	3.00e-13*
Assurance America	(0;+1)	DPW	-0.1953**
Cna Financial	(+2;+3)	Losses	2.38e-13*
First acceptance	(+1;+2)	Losses	-4.86e-13**
Hallmark Financial Services	(+2;+3)	Losses	4.05e-13***
Kemper	(+2;+3)	DPW	-0.3725**
Kemper	(0;+1)	DPW	-0.3322**
Mbia GRP.	(+2;+3)	Losses	3.88e-13*
Proassurance	(+2;+3)	DPW	0.1524*
Proassurance	(0;+1)	DPW	0.1891*
Progressive	(-1;0)	DPW	-.0859*
QBE Insurance GRP.	(0;+1)	DPW	0.0904**
Radian GRP.	(-3;-2)	DPW	-0.4400*
Safety Insurance GRP.	(+2;+3)	DPW	0.3922***
Safety Insurance GRP.	(+1;+2)	DPW	0.2329**
Swiss RE.	(+2;+3)	Losses	2.38e-13*
Zurich Insurance GRP.	(+2;+3)	Losses	2.14e-13**