

Impact of Catastrophe Events on Insurance Companies' Market Valuation

An Event Study Analysis

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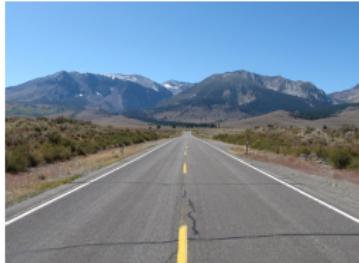
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Introduction

- Purposes:
 - Examine the impact of selected shocks and its significance on the stock valuation of insurance companies
 - Investigate the relation of companies characteristics and the effect caused by such events
 - Compare different test statistic on same events / firms
- Approach: event study analysis
- Application:
 - For academics: add to the understanding of the market stock valuation behavior
 - For practitioners: improve companies in their risk, investment and crisis management strategies

How to approach?

Calm period



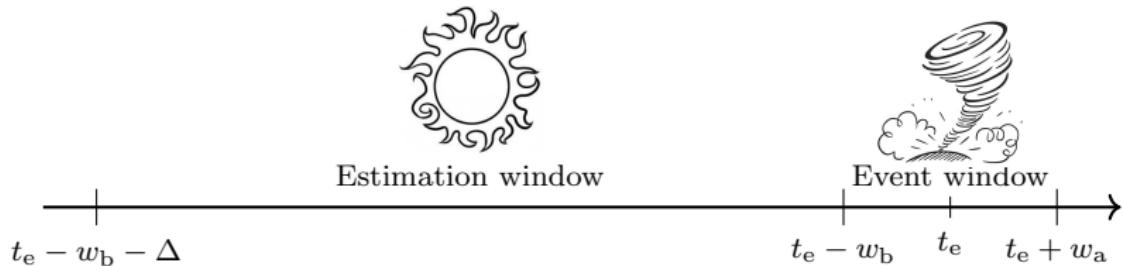
Event period



Methodology

Starting point:

- N securities (stocks of insurance companies)
- t_e : the day of the event
- Parameters: Δ, w_b, w_a



Methodology (cont.)

Market models:

- Adjusted mean-returns model:

$$R_{i,t} = \bar{R}_i + \epsilon_{i,t}$$

$$A_{i,t} = R_{i,t} - \bar{R}_i$$

- Adjusted market-returns model:

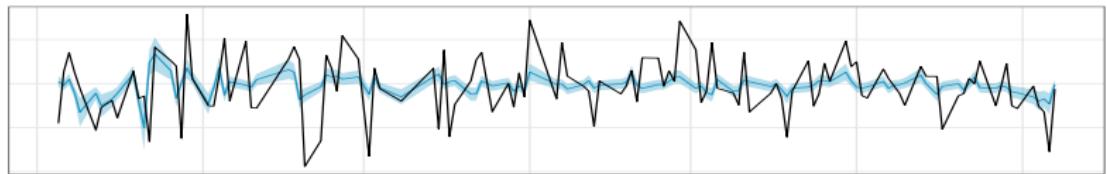
$$R_{i,t} = R_{M,t} + \epsilon_{i,t}$$

$$A_{i,t} = R_{i,t} - R_{M,t}$$

- Single-index market model:

$$R_{i,t} = \alpha_i + \beta_i \cdot R_{M,t} + \epsilon_{i,t}$$

$$A_{i,t} = R_{i,t} - \hat{\alpha}_i - \hat{\beta}_i \cdot R_{M,t}$$



Methodology (cont.)

Parametric tests:

- Student's t -test

$$\frac{\bar{A}_t}{S_{t\text{-test}}} \quad \hat{S}_{t\text{-test}} = \sqrt{\frac{1}{N(N-1)} \sum_{i=1}^N (A_{i,t} - \bar{A}_t)^2}$$

- Brown and Warner (1980)

$$\frac{\bar{A}_t}{S_{\text{BW1980}}} \quad \hat{S}_{\text{BW1980}} = \frac{1}{N} \sqrt{\sum_{i=1}^N \left[\frac{1}{\Delta-1} \sum_{t=t_e-w_b-\Delta}^{t_e-w_b-1} (A_{i,t} - \bar{A}_i)^2 \right]}$$

- Brown and Warner (1985)

$$\frac{\bar{A}_t}{S_{\text{BW1985}}} \quad \hat{S}_{\text{BW1985}} = \sqrt{\frac{1}{\Delta-1} \sum_{t=t_e-w_b-\Delta}^{t_e-w_b-1} (\bar{A}_t - \bar{\bar{A}})^2}$$

- Patell (1976)

$$\sum_{i=1}^N \text{SA}_{i,t} \Big/ \sqrt{N \cdot \frac{\Delta-2}{\Delta-4}} \quad \text{SA}_{i,t} = A_{i,t} \Big/ \hat{s}_i \cdot \sqrt{1 + \frac{1}{\Delta} + \frac{(R_{M,t} - \bar{R}_M)^2}{\sum_{k=t_e-w_b-1}^{t_e-w_b-1} (R_{M,k} - \bar{R}_M)^2}}$$

- Boehmer et al. (1991)

$$\frac{\overline{\text{SA}}_t}{S_{\text{BMP}}} \quad \hat{S}_{\text{BMP}} = \sqrt{\frac{1}{N(N-1)} \sum_{i=1}^N (\text{SA}_{i,t} - \overline{\text{SA}}_t)^2}$$

- Lamb (1995)

$$\frac{\bar{A}_t}{S_{\text{Lamb}}} \quad \hat{S}_{\text{Lamb}} = \sigma \cdot \sqrt{1 + \frac{1}{\Delta} + \frac{(R_{M,t} - \bar{R}_M)^2}{\sum_{k=t_e-w_b-1}^{t_e-w_b-1} (R_{M,k} - \bar{R}_M)^2}}$$

$$\sigma = \sqrt{\frac{1}{\Delta-1} \sum_{t=t_e-w_b-\Delta}^{t_e-w_b-1} (\bar{A}_t - \bar{\bar{A}})^2}$$

Methodology (cont.)

Non-parametric tests:

- Sign test

$$\frac{\left| \frac{\sum_{i=1}^N 1\{A_{i,t}>0\}}{N} - \frac{1}{2} \right|}{\sqrt{(\frac{1}{2})^2/N}}$$

- Generalized sign test

$$\frac{\left| \frac{\sum_{i=1}^N 1\{A_{i,t}>0\}}{N} - \hat{p} \right|}{\sqrt{\hat{p}(1-\hat{p})/N}}$$

- Corrado and Zivney (1992)

$$\frac{\bar{G}_t}{\sqrt{N} \hat{S}_{\text{sign}}}$$

$$G_{i,t} = \text{sign}(A_{i,t} - m_i)$$

$$\hat{S}_{\text{sign}} = \sqrt{\frac{1}{\Delta+w_b+w_a+1} \sum_{t=t_e-w_b-\Delta}^{t_e+w_a} \left(\frac{1}{N} \sum_{i=1}^N G_{i,t} \right)^2}$$

- Rank test

$$\frac{\frac{1}{N} \sum_{i=1}^N (K_{i,t} - \bar{K})}{\hat{S}_{\text{rank}}}$$

$$\hat{S}_{\text{rank}} = \sqrt{\frac{1}{\Delta+w_b+w_a+1} \sum_{t=t_e-w_b-\Delta}^{t_e+w_a} \left(\frac{1}{N} \sum_{i=1}^N (K_{i,t} - \bar{K}) \right)^2}$$

- Modified rank test

$$\frac{\frac{1}{\sqrt{N}} \sum_{i=1}^N (\text{SK}_{i,t} - \frac{1}{2})}{\hat{S}_{\text{mrknt}}}$$

$$\text{SK}_{i,t} = \frac{K_{i,t}}{1+\text{NM}_i}$$

$$\hat{S}_{\text{mrknt}} = \sqrt{\frac{1}{\Delta+w_b+w_a+1} \sum_{t=t_e-w_b-\Delta}^{t_e+w_a} \left(\frac{1}{\sqrt{N_t}} \sum_{i=1}^{N_t} (\text{SK}_{i,t} - \frac{1}{2}) \right)^2}$$

- Wilcoxon signed-rank test

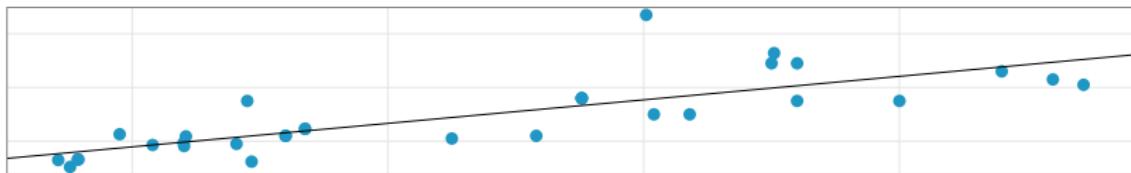
$$\sum_{i=1}^{N_r} [\text{sign}(A_{i,t}) \cdot \tilde{K}_{i,t}]$$

Methodology (cont.)

Cross-sectional regression analysis:

$$\text{CAR}_i(t_1, t_2) = \sum_{t=t_1}^{t_2} A_{i,t}$$

$$\begin{aligned}\widetilde{\text{CAR}}_i(t_1, t_2) = & \gamma_0 + \gamma_1 \cdot \widetilde{\text{MC}}_i + \gamma_2 \cdot \text{SUB}_i + \gamma_3 \cdot \widetilde{\text{GPWL}}_i \\ & + \gamma_4 \cdot \widetilde{\text{GPWNL}}_i + \gamma_5 \cdot \text{GEO}_i + \epsilon_i\end{aligned}$$



Data

The list of the events

Name	Type	Date	Insured loss in mUSD	Country
Hurricane Sandy	Hurricane	2012-10-24	36 079	US, Caribbean
Hurricane Irene	Hurricane	2011-08-22	6 134	US, Canada, Bahamas et al.
Hurricane Ike	Hurricane	2008-09-06	22 258	US, Gulf of Mexico, Caribbean et al.
Hurricane Katrina	Hurricane	2005-08-25	78 638	US, Gulf of Mexico, Bahamas
Hurricane Rita	Hurricane	2005-09-20	12 240	US, Gulf of Mexico, Cuba
Hurricane Wilma	Hurricane	2005-10-19	15 234	US, Mexico, Jamaica, Haiti et. al.
Tōhoku earthquake	Earthquake	2011-03-11	36 828	Japan
Christchurch earthquake	Earthquake	2011-02-22	16 836	New Zealand
Earthquake in Chile	Earthquake	2010-02-27	8 682	Chile
Winter Storm Kyrill	Storm	2007-01-18	6 959	Germany, UK, et al.
Hailstorms in July 2013	Storm	2013-07-27	3 899	Germany, France
Winter Storm Klaus	Storm	2009-01-24	3 501	France, Spain
Malaysia Airlines Flight	Man-made	2014-07-17	—	Ukraine
Germanwings Flight	Man-made	2015-03-24	—	France

Data (cont.)

665 publicly-traded companies with ICB supersector number
8500 (Insurance)



177 P&C, Full line insurer, and reinsurance (exclude Life
insurer and Insurance Brokers)



79 Western Europe and North America companies with more
than 60% of observations

Reference case of 9/11 Terrorist Attacks

Parametric tests: statistics and significance for 9/11 Terrorist Attacks

Date	W.day	$A_t, \%$	BW1980	BW1985	t-test	Patell	BMP	Lamb
09-11	Tues	-5.624	-15.090 ***	-11.229 ***	-4.961 ***	-19.424 ***	-4.855 ***	-10.942 ***
09-12	Wed	-3.664	-9.829 ***	-7.314 ***	-2.674 **	-11.190 ***	-1.934 *	-7.280 ***
09-13	Thurs	-0.286	-0.767	-0.571	-0.282	-1.344	-0.353	-0.568
09-14	Fri	-3.097	-8.310 ***	-6.184 ***	-4.081 ***	-10.881 ***	-4.061 ***	-6.111 ***
09-17	Mon	0.673	1.806 *	1.344	0.763	2.767 ***	0.993	1.302
09-18	Tues	-0.512	-1.373	-1.022	-0.722	-1.266	-0.487	-1.016
09-19	Wed	-1.061	-2.846 ***	-2.118 **	-1.022	-1.560	-0.603	-2.101 **
09-20	Thurs	-5.064	-13.587 ***	-10.111 ***	-5.516 ***	-15.608 ***	-4.686 ***	-9.814 ***
09-21	Fri	-4.292	-11.515 ***	-8.568 ***	-4.401 ***	-16.331 ***	-4.829 ***	-8.505 ***
09-24	Mon	3.496	9.381 ***	6.981 ***	3.418 ***	10.527 ***	3.491 ***	6.750 ***
09-25	Tues	1.573	4.221 ***	3.141 ***	1.820 *	4.479 ***	1.531	3.126 ***
09-26	Wed	2.475	6.641 ***	4.942 ***	3.691 ***	8.779 ***	3.361 ***	4.921 ***
09-27	Thurs	0.400	1.074	0.799	0.396	1.905 *	0.525	0.792
09-28	Fri	1.437	3.855 ***	2.869 ***	1.918 *	6.270 ***	2.211 **	2.788 ***

Negative signs in the (significant) statistics for dates in the first two weeks after the event are observed. The third week, in contrast, shows only positive signs.

Reference case of 9/11 Terrorist Attacks (cont.)

Non-parametric tests: statistics and significance for 9/11 Terrorist Attacks

Date	W.day	Sign	G.sign	C.sign	Rank	M.rank	Wlcx
09-11	Tues	-3.413 ***	-3.628 ***	-2.019 **	-2.828 ***	-2.907 ***	48.000 ***
09-12	Wed	-3.413 ***	-3.628 ***	-2.131 **	-2.242 **	-2.331 **	98.000 ***
09-13	Thurs	-0.180	-0.392	0.336	-0.187	-0.199	240.000
09-14	Fri	-3.413 ***	-3.628 ***	-2.131 **	-2.693 ***	-2.789 ***	52.000 ***
09-17	Mon	0.180	-0.033	0.112	0.134	0.110	268.000
09-18	Tues	-0.539	-0.752	-0.112	-0.568	-0.579	207.000
09-19	Wed	-0.898	-1.111	-0.561	-0.510	-0.532	207.000
09-20	Thurs	-3.413 ***	-3.628 ***	-2.131 **	-3.054 ***	-3.152 ***	33.000 ***
09-21	Fri	-3.413 ***	-3.628 ***	-1.906 *	-2.873 ***	-2.943 ***	57.000 ***
09-24	Mon	3.053 ***	2.843 ***	1.906 *	2.537 **	2.611 ***	403.000 ***
09-25	Tues	1.976 **	1.764 *	1.234	1.407	1.446	348.000 **
09-26	Wed	3.772 ***	3.562 ***	1.906 *	2.570 **	2.642 ***	430.000 ***
09-27	Thurs	-0.180	-0.392	-0.336	-0.071	-0.099	253.000
09-28	Fri	1.616	1.405	1.009	1.244	1.286	347.000 **

The significant dates of found through nonparametric tests correspond to the dates with extreme values of the parametric statistics.

Reference case of 9/11 Terrorist Attacks (cont.)

Brown and Warner 1985 test statistics and significance for 9/11 Terrorist Attacks for companies, **grouped by subsector**

		Overall			FL			P&C			Re		
Date	W.day	A_t , %	Stat	Signif	A_t , %	Stat	Signif	A_t , %	Stat	Signif	A_t , %	Stat	Signif
09-11	Tues	-5.624	-11.229	***	-4.915	-8.425	***	-2.394	-2.375	**	-16.715	-20.209	***
09-12	Wed	-3.664	-7.314	***	-1.852	-3.175	***	-8.641	-8.573	***	1.080	1.306	
09-13	Thurs	-0.286	-0.571		1.073	1.839	*	-3.256	-3.231	***	1.367	1.653	
09-14	Fri	-3.097	-6.184	***	-2.367	-4.058	***	-2.951	-2.928	***	-6.567	-7.939	***
09-17	Mon	0.673	1.344		0.828	1.419		-2.284	-2.266	**	7.409	8.958	***
09-18	Tues	-0.512	-1.022		-0.537	-0.921		0.312	0.310		-2.465	-2.980	***
09-19	Wed	-1.061	-2.118	**	-1.086	-1.862	*	-1.418	-1.406		-0.062	-0.075	
09-20	Thurs	-5.064	-10.111	***	-4.675	-8.013	***	-4.265	-4.232	***	-8.717	-10.539	***
09-21	Fri	-4.292	-8.568	***	-4.854	-8.321	***	-2.690	-2.669	***	-5.906	-7.141	***
09-24	Mon	3.496	6.981	***	4.409	7.558	***	0.794	0.788		6.374	7.706	***
09-25	Tues	1.573	3.141	***	1.324	2.270	**	1.820	1.806	*	2.014	2.435	**
09-26	Wed	2.475	4.942	***	1.697	2.908	***	2.178	2.161	**	6.528	7.893	***
09-27	Thurs	0.400	0.799		0.448	0.768		-0.373	-0.370		2.132	2.577	**
09-28	Fri	1.437	2.869	***	0.586	1.004		1.995	1.979	*	3.658	4.423	***

Reference case of 9/11 Terrorist Attacks (cont.)

Brown and Warner 1985 test statistics and significance for 9/11 Terrorist Attacks for companies, **grouped by the size of the market capitalization**

Date	W.day	Overall			Small			Middle			Large		
		\bar{A}_t , %	Stat	Signif	\bar{A}_t , %	Stat	Signif	\bar{A}_t , %	Stat	Signif	\bar{A}_t , %	Stat	Signif
09-11	Tues	-5.624	-11.229	***	-1.905	-2.857	***	-7.691	-9.678	***	-11.254	-13.169	***
09-12	Wed	-3.664	-7.314	***	-5.549	-8.321	***	-1.815	-2.284	**	-1.511	-1.768	*
09-13	Thurs	-0.286	-0.571		-2.719	-4.077	***	-0.474	-0.596		4.745	5.552	***
09-14	Fri	-3.097	-6.184	***	-1.999	-2.997	***	-4.359	-5.484	***	-4.191	-4.904	***
09-17	Mon	0.673	1.344		-2.335	-3.502	***	2.726	3.429	***	4.894	5.726	***
09-18	Tues	-0.512	-1.022		0.550	0.825		-4.254	-5.353	***	0.639	0.748	
09-19	Wed	-1.061	-2.118	**	-1.458	-2.186	**	1.261	1.587		-2.299	-2.691	***
09-20	Thurs	-5.064	-10.111	***	-4.175	-6.261	***	-4.876	-6.136	***	-7.006	-8.198	***
09-21	Fri	-4.292	-8.568	***	-3.055	-4.582	***	-7.660	-9.638	***	-3.817	-4.467	***
09-24	Mon	3.496	6.981	***	1.707	2.559	**	5.192	6.532	***	5.593	6.544	***
09-25	Tues	1.573	3.141	***	1.552	2.327	**	0.355	0.447		2.683	3.140	***
09-26	Wed	2.475	4.942	***	1.459	2.188	**	3.747	4.715	***	3.396	3.973	***
09-27	Thurs	0.400	0.799		0.189	0.283		-0.432	-0.543		1.552	1.816	*
09-28	Fri	1.437	2.869	***	2.362	3.541	***	0.553	0.695		0.361	0.423	

Sensitivity to the estimation period length changes

Results of Brown and Warner 1985 test for the different lengths of the estimation windows

		$\Delta = 50$			$\Delta = 100$			$\Delta = 150$			$\Delta = 200$		
Date	W.day	$A_t, \%$	Stat	Signif	$A_t, \%$	Stat	Signif	$A_t, \%$	Stat	Signif	$A_t, \%$	Stat	Signif
09-11	Tues	-5.750	-10.742	***	-5.724	-11.984	***	-5.692	-9.317	***	-5.907	-9.932	***
09-12	Wed	-3.446	-6.438	***	-3.611	-7.560	***	-3.611	-5.911	***	-3.617	-6.081	***
09-13	Thurs	-0.103	-0.192		-0.248	-0.520		-0.245	-0.402		-0.272	-0.457	
09-14	Fri	-3.098	-5.787	***	-3.141	-6.576	***	-3.121	-5.109	***	-3.259	-5.481	***
09-17	Mon	0.510	0.952		0.557	1.166		0.593	0.970		0.354	0.596	
09-18	Tues	-0.410	-0.765		-0.510	-1.068		-0.500	-0.818		-0.576	-0.968	
09-19	Wed	-1.007	-1.880	*	-1.080	-2.262	**	-1.065	-1.744	*	-1.171	-1.968	*
09-20	Thurs	-5.218	-9.747	***	-5.176	-10.836	***	-5.141	-8.416	***	-5.373	-9.035	***
09-21	Fri	-4.229	-7.900	***	-4.307	-9.018	***	-4.293	-7.028	***	-4.393	-7.387	***
09-24	Mon	4.026	7.521	***	3.688	7.721	***	3.657	5.987	***	3.843	6.462	***
09-25	Tues	1.804	3.370	***	1.632	3.417	***	1.630	2.669	***	1.633	2.746	***
09-26	Wed	2.642	4.936	***	2.506	5.247	***	2.510	4.109	***	2.474	4.159	***
09-27	Thurs	0.721	1.347		0.499	1.045		0.489	0.800		0.546	0.919	
09-28	Fri	1.934	3.612	***	1.614	3.378	***	1.586	2.597	**	1.752	2.945	***

The statistics and the obtained significances are the same for all values of Δ

Sensitivity to the market model changes

Results of Brown and Warner 1985 test for SIMM,
market-adjusted and mean-adjusted return market model

Date	W.day	SIMM			Market-adjusted			Mean-adjusted		
		A_t , %	Stat.	Signif.	A_t , %	Stat.	Signif.	A_t , %	Stat.	Signif.
09-11	Tues	-5.624	-11.229	***	-3.639	-3.610	***	-6.502	-10.267	***
09-12	Wed	-3.664	-7.314	***	-3.963	-3.931	***	-3.539	-5.589	***
09-13	Thurs	-0.286	-0.571		-0.355	-0.353		-0.262	-0.414	
09-14	Fri	-3.097	-6.184	***	-1.948	-1.932	*	-3.608	-5.698	***
09-17	Mon	0.673	1.344		2.907	2.884	***	-0.314	-0.495	
09-18	Tues	-0.512	-1.022		-0.046	-0.045		-0.723	-1.142	
09-19	Wed	-1.061	-2.118	**	-0.275	-0.273		-1.413	-2.230	**
09-20	Thurs	-5.064	-10.111	***	-2.896	-2.873	***	-6.022	-9.509	***
09-21	Fri	-4.292	-8.568	***	-3.562	-3.533	***	-4.619	-7.293	***
09-24	Mon	3.496	6.981	***	1.119	1.110		4.532	7.156	***
09-25	Tues	1.573	3.141	***	1.185	1.175		1.737	2.742	***
09-26	Wed	2.475	4.942	***	2.512	2.492	**	2.452	3.872	***
09-27	Thurs	0.400	0.799		-0.587	-0.582		0.826	1.305	
09-28	Fri	1.437	2.869	***	-0.721	-0.715		2.376	3.752	***

SIMM and mean-adjusted return model produce similar result,
while market-adjusted one differs

*We also investigate the sensitivity to the market index changes

Cross-sectional regression analysis

Estimated coefficients, their significance, and R^2 of the regression models for dates September 11 and September 17

Variable	Modality	September 11		September 17	
		Coef.	Signif.	Coef.	Signif.
Intercept		0.27939		-0.4275	.
\widetilde{MC}		0.61292	*	-0.6476	*
SUB	Full-line	-0.06829		0.2949	
SUB	Reinsurance	-2.04886	***	1.8401	***
\widetilde{GPWL}		-0.21973		0.4154	*
\widetilde{GPWNL}		-0.87502	**	0.8561	**
		$R^2 = 0.7429$		$R^2 = 0.7339$	

Brief summary

- The event study is validated as a proper method for this research
- The significance of 9/11 is approved, the results coincide with previous research (Chen et al. (2008), Cummins and Lewis (2003), Doherty et al. (2003), Wang and Corbett (2008), and Yanase and Yasuda (2010))
- The choice of the market model, the length of the estimation window, and the index is substantiated

Hurricanes: first notable results

- Hurricane Sandy:
 - Strong negative result for American reinsurance companies and weaker for European ones
 - Negative and significant day after the landfall for the full set of American companies
- Hurricane Irene:
 - Firstly positive and then negative significance dates for American firms
 - The opposite effect for European firms: firstly negative and then positive
- Hurricane Ike:
 - Almost no impact on American companies
 - Negative statistics for European ones after the landfall
- Hurricane Katrina: the weak negative influence for both samples (Gangopadhyay et al. (2010), Blau et al. (2008))
- Hurricane Rita: for both samples the same pattern can be observed – firstly negative then positive
- Hurricane Wilma:
 - For American firms the negative and significant day before the landfall
 - For European companies the result is positive and significant

Ongoing research

First comments:

- In several events, the significance of selected dates is in line with results found in other research
- Current difficulties: often only small sets of companies with available data during events (dates missing due to stock exchange closings)
- Separation of the isolate impact of the studied event (often other events happen in the same period)

Outlook:

- Finish analysis and description of all events
- Consolidate findings
- Discuss characteristics of companies input on abnormal returns

Thank you!