Lost in Transmission?

Stock Market Impacts of the 2006 European Gas Crisis

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Abstract: Around the turn of the year 2005/2006, the Russian freezing of natural gas exports to the Ukraine led to a European gas crisis. Using event study technique, we first investigate whether the Russian announcement of suspension of gas deliveries, this suspension itself as well as its withdrawal had an effect on *unsystematic volatility* of European energy stocks. Secondly, we measure event effects on *stock returns*, taking volatility (GARCH-effects) and especially possible firm-specific event-induced volatility into account. We get – at a first glance – counterintuitive results suggesting that the definite announcement of the crisis and therefore a rise of Western Europe's energy cost and risk tended to increase market expectations with respect to energy-related firms. In contrast, market uncertainty increased the day when Russia reopened its valves. One reason for these findings could be windfall profits of energy-related companies due to increasing resource and electricity prices. The existence of event-induced volatility at a between-firm level confirms the choice of a flexible methodology in order to test for abnormal returns.

Keywords: energy security, event study, gas crisis

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1. Introduction

Recently, energy security in Western Europe seems to be at risk. Around the turn of the year 2005/2006, the Russian freezing of natural gas exports to the Ukraine led to a European gas crisis. This triggered off intensive debates about energy security all over Europe (cp. e.g. Economist, 2006).[1]

Apart from this singular gas transmission crisis, ongoing political interventions in the Russian energy sector and general political instability in the Ukraine constantly give reason for serious concerns about energy security in Western Europe (Helm, 2005). The relevance of this issue for Europe is apparent in the light of the striking energy dependence on Russian resources.

In 2005, 20 per cent of the gas consumed in Western Europe stemmed from Russia *and* was transmitted via Ukrainian soil. Additionally, the global rise in energy demand due to the fast economic growth in Asia makes energy security an essential challenge for Western Europe (Correljé and van der Linde, 2006). What is more, the current period is shaped by the rise in importance of gas as the main source of new electricity-generation capacity (cp. Foss, 2005).

In the past decades, the scientific debate about energy security focused on possible implications for competitiveness at an economy-wide level as well as for politics (cp. e.g. Toman, 1993, LaCasse and Plourde, 1995, and Helm, 2005). Less discussed in academic contributions, however, is the question whether energy security has an impact on single sectors or companies that depend on a stable and secure resource supply. In this respect, it is straightforward to ask how utilities and companies operating or trading with natural gas are affected by changes in the environment of energy security. For this group, effects are not yet empirically analyzed. As the natural resource is the foundation of energy-related companies'

[1] Relatively similar to the gas crisis 2006, concerns about a stable oil supply were especially put forward by the Russian suspension of oil deliveries to Western Europe via Belarus in early 2007.

business, supply crises could, on the one hand, induce insecurity and have a negative effect on their business prospects. On the other hand, however, it seems to be possible that those companies would profit from such supply crises if they could realize windfall profits, e.g. due to rising resource prices.

Using an event study approach, we assess whether or not the Russian announcement of suspension of gas deliveries, this suspension itself as well as its withdrawal implied (a) uncertainty for and (b) generally abnormal returns of West European utilities' as well as oil and gas companies' stocks. The contribution of this paper is twofold: Besides putting the phenomenon of energy security on the agenda of economists dealing with financial markets, it should contribute to the methodological enhancements of event studies in the field of resource, energy and environmental economics. To our knowledge, this is the first paper in the field that assesses event impacts on *return volatility*. However, it is obvious that volatility is an important issue in financial markets and, to be precise, in stock attractiveness for potential investors (cp. e.g. Engle, 2004). Given a certain return level, risk-averse investors will prefer the equity with the lowest volatility. Furthermore, we are not familiar with any event study in this field that generally considers autoregressive conditional heteroskedasticity – although the GARCH-class has become standard in financial econometrics subsequent to Bollerslev's (1986) seminal paper. Consequently, event-induced volatility and security-specific volatility effects have been ignored here for the calculation and significance testing of *abnormal returns*. This analysis aims at starting to fill this gap.

The remainder of this paper is structured as follows: Section 2 gives an overview of the 2006 European gas crisis, the event to be analysed in this study. In Section 3 we review the related literature while Section 4introduces the methodological approach chosen. Our data basis and important features of our analysis are presented in Section 5. Section 6 reports the results, section 7 concludes.

2. The 2006 European Gas Crisis – An Overview

The Russian gas monopoly Gazprom[2] is an all-important supplier, owning 17 per cent of the world-wide gas resources. In 2005, it provided for about 50 per cent of Ukrainian gas consumption. Moreover, 25 per cent of the West European gas demand is supported by the supplier. 80 per cent of these imports (have to) be transmitted via the Ukraine.[3] As other former member states of the USSR, the Ukraine received Russian gas deliveries for a price that was well below the price level of the world market. While the world market level was about 230 dollars per 1000 cubic meters of gas in December 2005, the price the Ukraine had to pay was even below 50 dollars.

In a situation of deteriorated Russo-Ukrainian relations and rising oil and gas (world market) prices in late 2005, Gazprom – together with the Russian government – announced to withdraw this discount on gas deliveries. Gazprom consequently indicated a price increase of more than 350 per cent starting January 1, 2006.[4] As the Ukraine rejected this claim, a gas supply crisis was initiated on December 27, 2005, when Gazprom decisively announced a suspension of gas transmissions in case that the Ukraine would not accept the Russian price increase.[5] This suspension was scheduled for January 1, 2006. In the following days, no agreement between the Russian and the Ukrainian side was reached, even though international and especially European politicians had appealed for a negotiated resolution of the problem. The announcement on December 27 probably came too late in order to react on financial markets. We therefore consider the trading days starting from December 28, until January 1, as the period of announcement of the crisis. December 27 is analyzed as well, but separately.

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[2] The official company name of the corporation is OAO Gasprom.

[3] Von Hirschhausen et al. (2005) develop an interesting model (subsequently, they calibrate numerical results and run simulations) that takes into account different options of transporting Russian gas to Western Europe.

[4] Alternatively to this price increase, Gazprom demanded the licence for an equity stake in the Ukrainian transit pipeline network (Stern, 2006b).

[5] Already before December 27, 2005, there were threats of Gazprom to cut gas supply as well as Ukrainian claims that such steps would violate past contracts. The crisis came into reach and became more concrete only in late December, however.

Gazprom followed through with its threat and suspended gas deliveries on New Year's Day, 2006. The same day, the Ukrainian utility MOT declared that Russian deliveries had decreased by 25 per cent. In Central and West European countries, gas deliveries declined consequently, emphasizing the overall European dimension of the gas crisis. On January 2, 11 European countries reported a cutback of gas deliveries due to reduced feeding-in from Russia. The drop was not negligible, e.g. reaching losses of about one third of usual deliveries in Austria, 25 per cent in France and Italy, as well as of unknown size in Germany, the largest European economy (Stern, 2006b). At the APX, London, gas prices rose by more than 10 per cent. Even in the daytime of January 3, a normalization of Russian gas deliveries was not reached. While the gas price at the APX did not stop rising, the cutback of gas supply had consequences for the trading of resources other than gas, for example oil, and electricity at West European exchanges as well: The price of WTI rose by about 3 per cent; Brent prices reached their 3-month peak. Furthermore, German electricity prices at the EEX, Leipzig, were about 50 per cent higher than at the turn of the year. Moreover, the Gazprom share reached a record high when the Russian stock market reopened, indicating that Gazprom-investors appreciated the crisis (Stern, 2006a). Consequently, we label the trading days between January 1, and January 3, i.e. January 2, as the crisis period (day).

However, in the course of January 3, Russia turned the supply to the Ukraine back on. Consequently, the gas shortages in Western Europe were removed. A legal (preliminary) compromise in the conflict was reached on January 4. The agreement set the price for Russian gas deliveries that the Ukraine had to face from 2006 on at 95 dollars, the transit price for Russian gas through the Ukraine rose from 1.09 to 1.65 dollars. Resource prices at the international exchanges, as well as European electricity prices remained at a high level. In the empirical analysis of this paper, trading days from January 3, to January 5 are taken as the period when the crisis was resolved and withdrawn.

3. Literature Review

Event studies are particularly applied in finance and accounting, for example, to examine the effects of mergers and acquisitions, earnings announcements, or issues of new debt or equity (MacKinley, 1997, Kothari and Warner, 2006). However, they are increasingly used to analyze news related to resource, energy, and environmental economics. Those studies can roughly be subdivided into three different groups: Event studies considering (1) disclosures of information regarding positive or negative corporate environmental performance (Dasgupta et al., 2001, Gupta and Goldar, 2005, Capelle-Blancard and Laguna, 2007), (2) environmental news related to regulations concerning energy and the environment (Lanoie et al., 1998, Karpoff et al., 2005, Dasgupta et al., 2006), and (3) direct effects of regulation.

There are relatively few event studies which form this third group. This is due to the fact that regulation generally rather refers to a process than to a surprising event that may be analysed using the event study technique. If information has been available before the event, which is often the case, abnormal returns should not occur as the news is already priced in by the financial markets. Many of those studies have important features in common with our own analysis: Often, electric utility stocks are analysed (Butler and McNertney, 1991, Diltz, 2002, Kahn and Knittel, 2003, Oberndorfer and Ziegler, 2006). Besides that, those papers have in common with the assessment conducted here that they assess the influence of a general shock related to resource, energy, or environmental economics on stock returns. Results from those papers remain inconclusive, indicating that regulation does not affect financial markets as a rule. To our knowledge, there is no event study available that assesses the impact of energy supply shortages on stock returns. However, the study of Hayo and Kutan (2005) somehow relates to our paper: They analyze Russian financial markets with one focus on energy news. They receive mixed evidence for the impact of energy news.

Methodologically, to our knowledge, all event studies in the field of resource, energy, or environmental economics focus on the impacts of the respective event on *stock returns*. Against this background, this is the first paper in this field that, besides looking at stock returns, assesses event impacts on *unsystematic return volatility*. It is obvious that volatility is an important issue in financial markets and, to be precise, in stock attractiveness for potential investors. Given a certain return level, risk-averse investors will prefer the equity with lowest volatility (cp. e.g. Engle, 2004). Furthermore, we are not familiar with any event study in our field that generally considers autoregressive conditional heteroskedasticity – although the GARCH-class has become standard in financial econometrics – or even event-induced volatility (and, what is more, security-specific volatility effects) for the calculation and significance testing of abnormal returns. Using simulation technique, Savickas (2003) shows that traditional tests are misspecified in the presence of event-induced volatility.

4. Methodology

In this article, we want to analyze the impact of the 2006 European gas crisis on West European utilities from a stock market perspective using event study techniques. This is a very reliable approach for measuring impacts on their business prospects since, given the existence of efficient financial markets, stock prices constitute the best possible estimate of the net present value of discounted cash flows (Fama, 1970). Furthermore, measuring the impact of such a short-dated crisis is very difficult if the analysis is not based on daily data. For indicators of business prospects other than stock prices or returns, such as exports, sales, Tobin’s Q, or return on assets, daily data are not available. The methodological approach of this event study analysis is twofold: First, we want to analyse if the Russian suspension of gas deliveries, the announcement of this suspension as well as its withdrawal had an effect on *unsystematic volatility* of European energy stocks. Secondly, we want to measure event effects on *stock returns*, taking volatility and especially possible event-induced volatility into account.

First, we employ the approach formulated by Hilliard and Savickas (2003) in order to test for event-induced abnormal unsystematic volatility in the stock returns. The authors use a standard GARCH(1,1) (one-factor) model as a baseline. Models of the GARCH-class (Bollerslev, 1986) are very appealing approaches for the analysis of high-frequent time series in financial markets. Reason to this is the fact that they, in contrast to linear estimation techniques, address the so-called volatility clustering, the tendency that current volatility of asset prices tends to be positively correlated with its past values. Amongst those approaches, the use of the GARCH(1,1) model is widespread as it generally sufficiently explains systematic variation of asset price volatility (Akgiray, 1989, Andersen and Bollerslev, 1998, Engle, 2001), although meanwhile numerous modifications have been proposed. The one-factor model (inspired by the so-called market model) in the GARCH(1,1) form can be formulated as

(1) $r_{i,t} = \alpha_i + \beta_i r_{m,t} + \varepsilon_{i,t}$ with $\varepsilon_{i,t} \sim N(0, h_{i,t})$,

(2) $h_{i,t} = a_i + b_i h_{i,t-1} + c_i \varepsilon_{i,t-1}^2$,

where $r_{i,t}$ is the stock return for firm *i* in the period *t*, and $r_{m,t}$ is the return of the market portfolio, respectively. The error term $\varepsilon_{i,t}$ is assumed to be conditionally normally distributed with zero mean and variance $h_{i,t}$. α_i and β_i are the parameters of the mean equation, a_i, b_i, and c_i are the parameters of the variance equation.

At an event day *t*, two different types of factors may determine the level of unsystematic volatility: Security-specific factors are captured by the model formulated above (e.g. correlation with the market, volatility dynamics). Event-specific factors, however, form part of $\varepsilon_{i,t}$, but are ignored in the conditional variance $h_{i,t}$. The impact of event-specific factors can not adequately be captured by simply looking at the respective error terms as in such a setting; they can not be separated from security-specific factors.

Those event-specific factors, however, can be measured by the ratio λ_t of the cross-sectional variance of the estimated residuals from the one-factor model (1) and its conditional variance implied by the GARCH process. The parameter λ_t that is positive as a rule measures the event effect at time t on volatility in a manner that it indicates the multiple by which the unsystematic volatility increases from its no-event level, i.e. $\lambda_t = 1$ indicates that the event has no effect while for $\lambda_t = 2$, unsystematic volatility has doubled. If the volatility of the event day significantly exceeds the one implied by the model dynamics, an event impact on unsystematic volatility is observed. The parameter is estimated as follows,

$$(3)\ \hat{\lambda}_t = \frac{1}{N-1}\sum_{i=1}^{N}\frac{\left(\hat{\varepsilon}_{i,t} - \frac{1}{N}\sum_{j=1}^{N}\hat{\varepsilon}_{j,t}\right)^2}{\frac{N-2}{N}\hat{h}_{i,t} + \frac{1}{N^2}\sum_{j=1}^{N}\hat{h}_{i,t}},$$

with N denominating the number of assets analysed. The $\hat{\varepsilon}_{i,t}$ s and the $\hat{h}_{i,t}$ s are taken from the estimation of equation (1) and (2) for the respective firm i. The estimator of the cumulative abnormal return volatility for an event window between the days k and m is the sum of the individual estimators:

$$(4)\ C\hat{\lambda}_{k,m} = \sum_{t=k}^{m}\hat{\lambda}_t .$$

The null hypothesis of $\lambda_t = 1$ or of $C\lambda_{k,m} = m - k + 1$, respectively, can then be tested using

$$(5)\ s_t = (N-1)\hat{\lambda}_t \text{ or}$$

$$(6)\ Cs_{k,m} = (N-1)C\hat{\lambda}_{k,m},$$

where under H_0, the test statistic is χ^2-distributed with $N-1$ or $(N-1)(m-k+1)$ degrees of freedom, respectively.

In order to assess whether the gas crisis had an impact on stock returns, i.e. if abnormal returns occurred due to this event, we use the approach suggested by Savickas (2003). Given the fact that it addresses both conditionally heteroskedastic behaviour of volatility as well as possible event-induced variance increases it is a very robust method. Furthermore, it does not require the conditional volatility to be the same across firms analysed. These are very appealing features making Savickas' approach superior to well-established methods (e.g. Brown and Warner, 1980 and 1985, and Boehmer et al., 1991). The advantages of Savickas' approach are emphasized by the results obtained by Babalan and Constantinou (2005). In the existing event studies in energy and environmental economics, however, this approach has not been employed, yet. Moreover, to our knowledge, there is no event study available in this discipline that takes conditional heteroskedasticity into account although approaches of the GARCH-class have become standard in financial economics.

Savickas' (2003) test is based on an estimation framework with

(7) $r_{i,t} = \alpha_i + \beta_i r_{m,t} + \gamma_i D_t + \varepsilon_{i,t}$ with $\varepsilon_{i,t} \sim N(0, h_{i,t})$,

(8) $h_{i,t} = a_i + b_i h_{i,t-1} + c_i \varepsilon_{i,t-1}^2 + d_i D_t$,

where D_t is a dummy variable that equals 1 if for an event day or period t, and 0 otherwise. The model can accommodate more than one dummy variable that may equal 1 for one or several days, each. In the case of multiple dummy variables, multiple dummy variable coefficients have to be estimated in each equation. In equations (5) and (6), the example of only one event day or period t is shown. Here, the coefficient γ_i gives the event (return) effect for firm i. In order to assess an event effect for a sample of firms, the mean of the γ_i coefficients over the corporations has to be calculated. d_i is the coefficient of the dummy variable D_t in the variance equation. Besides the inclusion of the dummy variable(s), the GARCH(1,1) framework is identical to that one used for assessing effects on unsystematic volatility (see equations (1) and (2)).

The cross sectional test statistic θ_t is a refinement of the usual t-statistic which takes intertemporal firm-specific heteroskedasticity into account, and can be calculated according to

$$(9)\ \theta_t = \frac{\sum_{i=1}^{N} \frac{S_{i,t}}{N}}{\sqrt{\frac{1}{N(N-1)} \sum_{i=1}^{N} \left(S_{i,t} - \sum_{j=1}^{N} \frac{S_{j,t}}{N} \right)^2}}, \text{ with}$$

$$(10)\ S_{i,t} = \frac{\hat{\gamma}_i}{\sqrt{\hat{h}_{i,t}}}.$$

Being the ratio of the estimated mean of abnormal return for each security and of its estimated standard deviation, $S_{i,t}$ is a measure of abnormal (event-induced) returns that accounts for security-specific event-induced volatility. If D_t and, consequently, γ_i (and d_i) refer to a period rather than only one day, $S_{i,t}$ is calculated using the square-root of the mean conditional variance of the respective period. γ_i and θ_t refer to average cumulative abnormal returns in this case. Under the null hypothesis of no abnormal return the test statistic θ_t is Student-t distributed with *N-1* degrees of freedom.

5. Data and Details of the Event Study

As outlined in the introduction, we test whether or not the 2006 European gas crisis implied higher unsystematic volatility for and abnormal returns of West European utilities as well as oil and gas companies. Therefore, we analyze stocks of two different groups of companies: First, we use the Dow Jones Stoxx 600 Utilities companies, secondly, the Dow Jones Stoxx 600 Oil & Gas firms (all as on September 30, 2006). Finally, our analysis includes the full sample, i.e. both groups of companies.

From the Dow Jones Stoxx 600 Utilities, sufficient data was available to include 32 (out of 35) firms in our study.[6] For Dow Jones Stoxx 600 Oil & Gas, 26 firms (out of 27) were analyzed.[7] All in all, our (full) sample comprises 58 firms. Log returns have been calculated for all time series used. The market return has been calculated from the Dow Jones Stoxx 50. All series have been carefully checked for splits and outliers.

For both event study approaches used in this paper, we use 280 observations, i.e. daily returns, for each firm. This should yield reliable parameter estimates. Our estimations start on January 12, 2005, and end on February 10, 2006. Therefore, to our understanding, we do not only consider a sufficient number of observations *before* our event window, but also the event days as well as 25 observations *after* the event are included in the estimation. In contrast to most conventional event study techniques, the approaches used here allow for doing this.

As outlined in the methodological part of this paper, we estimate *abnormal volatility* and *returns* as well as *(average) cumulative abnormal volatility* and *returns*. The choice of event periods for the estimation of cumulative abnormal returns refers to part 2 of this paper. Therefore, we treat trading days from December 28, 2005 to December 30, 2005 as announcement period and from January 3, 2006 to January 5, 2006 as withdrawal period. In order to estimate *average cumulative abnormal returns*, for each period, one separate dummy variable equaling "1" for a day being part of the respective period is introduced in the estimation for equations (7) and (8) (as far as the estimation of cumulative abnormal returns is concerned). December 27, 2005 and January 2, 2006 (crisis day) are treated individually here (with one individual dummy variable, each). In order to estimate (daily, not cumulative) *abnormal returns*, equations (7) and (8) contain one dummy variable for each trading day

[6] These are AEM, British Energy Group, Centrica, Edison, EDP, Enagas, Endesa, ENEL, EON, Fortum, Iberdrola, International Power, Kelda, Northumbrian, Public Power Corporation, RED, RWE, Scottish & Southern Energy, Severn Trent, SNAM, Solarworld, Terna, Union Fenosa, United Utilities, Veolia, Verbund, and Viridian.

[7] The firms analyzed are Acergy, Aker, BG Group, Bourbon, BP, Burren, CIA, ENA, ENI, Fugro, Maurel, Norsk, OMV, Petroleum, Repsol, Saipem, Shell, Statoil, Technip, Total, Tullow, Lundin, and SBM.

between December 27, 2005, and January 5, 2006. In order to assess *abnormal volatility*, the estimation of one model for both cumulative and daily abnormal volatility is sufficient as equations (1) and (2) do not require the inclusion of dummy variables. Cumulative abnormal volatility is simply estimated in adding up daily abnormal volatilities from the respective event (announcement / withdrawal) period.

6. Results

Before proceeding to the event study methods, we briefly check the adequacy of our approaches in testing if autoregressive conditional heteroskedasticity and, therefore, so-called volatility clustering is present in our data set. In order to do this, we employ the common ARCH-LM test (Engle, 1982). Our assumption is that given that autoregressive conditional heteroskedasticity can be found, our GARCH (1,1) framework should sufficiently capture this phenomenon (cp. chapter 4). Our results are quite clear and suggest that in the great majority of the return series analyzed, volatility clustering occurs. In about 70 per cent of our series, ARCH effects are even highly significant at the 1%-level. For nearly all of the stock returns of our sample, ignoring ARCH effects (which is in fact done by most "traditional" event study techniques) would imply at least inefficient parameter estimation.[8]

For the full sample, the approach formulated by Hilliard and Savickas (2003) that tests for event-induced abnormal unsystematic volatility in the stock returns shows a (highly) significant event impact on one day analyzed (see Table 4). On January 3, 2006, when the withdrawal of the crisis was announced, abnormal unsystematic volatility differs significantly at the 1%-level from its no-event level. Compared with this baseline, abnormal unsystematic volatility rises by 73 per cent. This volatility increase remains significant (at the 5%-level) for the whole event window (crisis withdrawal). For the three days analyzed here, volatility rose

[8] The results of the ARCH-LM tests are available on request.

by 22 per cent on average. Besides this, however, no other significant (cumulative) abnormal volatility increase for the whole sample occurs between December 27, 2005, and January 5, 2006 (see Tables 1-4).

Table 1 Abnormal unsystematic volatility for December 27, 2005 in the full sample, for utilities and for oil & gas companies analyzed

	#	58	#	32	#	26
	Full Sample		**Utility**		**Oil & Gas**	
	λ_t	P-value	λ_t	P-value	λ_t	P-value
27.12.2005	0.41	1.00	0.37	1.00	0.39	1.00

Table 2 (*Cumulative*) abnormal unsystematic volatility for the crisis announcement in the full sample, for utilities and for oil & gas companies analyzed

	#	58	#	32	#	26
	Full Sample		**Utility**		**Oil & Gas**	
	$\lambda_{t/C}$ λ_t	P-value	$\lambda_{t/C}$ λ_t	P-value	$\lambda_{t/C}$ λ_t	P-value
28.12.05	0.48	1.00	0.51	0.99	0.46	0.99
29.12.05	0.32	1.00	0.35	1.00	0.30	1.00
30.12.05	0.48	1.00	0.23	1.00	0.72	0.85
28.-30.12.05	*1.28*	*1.00*	*1.09*	*1.00*	*1.48*	*1.00*

Table 3 Abnormal unsystematic volatility for the crisis day in the full sample, for utilities and for oil & gas companies analyzed

	#	58	#	32	#	26
	Full Sample		**Utility**		**Oil & Gas**	
	λ_t	P-value	λ_t	P-value	λ_t	P-value
02.01.06	0.94	0.61	1.14	0.28	0.64	0.91

Table 4 (*Cumulative*) abnormal unsystematic volatility for the crisis withdrawal in the full sample, for utilities and for oil & gas companies analyzed

	#	58	#	32	#	26
	Full Sample		**Utility**		**Oil & Gas**	
	$\lambda_{t/C}$ λ_t	P-value	$\lambda_{t/C}$ λ_t	P-value	$\lambda_{t/C}$ λ_t	P-value
03.01.06	1.73***	0.00	1.69***	0.01	1.58**	0.03
04.01.06	0.88	0.72	1.06	0.38	0.65	0.91
05.01.06	1.04	0.40	1.61**	0.02	0.33	1.00
03.-05.01.06	*3.65***	*0.03*	*4.36****	*0.00*	*2.56*	*0.81*

Note: * and ** indicate significance at the 1%- and 5%-level, respectively.**

If we distinguish utilities from oil and gas stocks, these results largely hold. Furthermore, we can show that abnormal unsystematic volatility on January 3 is quite homogenous over the two groups of stocks. For both utilities as well as oil and gas stocks, significant (1%- and 5%-

level, respectively) abnormal unsystematic volatility with a rise of 69 and 58 per cent occurs. There are sector-specific effects on January 5, however. Only for the utilities stocks, a highly significant impact can be observed on January 5. Here, compared with the baseline of no event effect, abnormal unsystematic volatility rises by 61 per cent. If sector specific abnormal volatility is cumulated over the withdrawal event window, a (highly) significant impact therefore remains very strong for utilities (45 per cent on average; daily), while we do not get a significant result for oil and gas corporations.

All in all, for each group of firms there is at least one day (January 3, 2006, to be precise) where we observe (highly) significant abnormal unsystematic volatility. For the full sample as well as for the utilities analyzed, we furthermore get significant cumulative abnormal volatility for the period of crisis resolution. Outside of this period, abnormal unsystematic volatility often falls noticeably below its non-event level. However, this may be due to generally low stock volatility during the weeks following Christmas so that the shocks on abnormal unsystematic volatility observed are even more striking.

In any case, from a methodological point of view, the existence of event-induced volatility at a between-firm level confirms our choice of the methodology of Savickas (2003) in order to test for abnormal returns. Traditional tests would be misspecified under such conditions. As outlined in chapter 4 of this paper, the methodology applied here takes into account event-induced variance increases and especially volatility effects that differ across the firms analyzed.

Table 5 Abnormal returns of December 27, 2005 in the full sample, for utilities and for oil & gas companies analyzed

	#	58	#	32	#	26
	Full Sample		**Utility**		**Oil & Gas**	
	Abnormal return (mean, in %)	Θ (p-value)	Abnormal return (mean, in %)	Θ (p-value)	Abnormal return (mean, in %)	Θ (p-value)
27.12.2005	-0.19	-1.39 (0.17)	0.02	0.62 (0.54)	-0.45	-2.48** (0.02)

Note: Abnormal returns are based on the sample mean over the respective γ_is. ** indicates significance at 5%-level.

Table 6 (*Average cumulative*) abnormal returns of the crisis announcement in the full sample, for utilities and for oil & gas companies analyzed

	#	58	#	32	#	26
	Full Sample		**Utility**		**Oil & Gas**	
	(*Average cumulative*) abnormal return (mean, in %)	Θ (p-value)	(*Average cumulative*) abnormal return (mean, in %)	Θ (p-value)	(*Average cumulative*) abnormal return (mean, in %)	Θ (p-value)
28.12.2005	0.35	3.82*** (0.00)	0.19	2.19** (0.04)	0.56	3.14*** (0.00)
29.12.2005	-0.13	-1.10 (0.28)	-0.04	-0.49 (0.63)	-0.25	-0.90 (0.38)
30.12.2005	0.28	1.43 (0.16)	-0.11	-0.97 (0.34)	0.74	2.40** (0.02)
28.-30.12.05	*0.14*	*2.42*** *(0.02)*	*-0.02*	*0.73* *(0.47)*	*0.34*	*2.53*** *(0.02)*

Note: (Cumulative) abnormal returns are based on the sample mean over the respective γ_is. * and ** indicate significance at the 1%- and 5%-level, respectively.**

Table 7 Abnormal returns of the crisis day in the full sample, for utilities and for oil & gas companies analyzed

	#	58	#	32	#	26
	Full Sample		**Utility**		**Oil & Gas**	
	Abnormal return (mean, in %)	Θ (p-value)	Abnormal return (mean, in %)	Θ (p-value)	Abnormal return (mean, in %)	Θ (p-value)
02.01.2006	0.23	-1.12 (0.27)	0.12	-1.14 (0.26)	0.36	1.01 (0.32)

Note: Abnormal returns are based on the sample mean over the respective γ_is.

Table 8 (*Average cumulative*) abnormal returns of the crisis withdrawal in the full sample, for utilities and for oil & gas companies analyzed

	#	58	#	32	#	26
	Full Sample		**Utility**		**Oil & Gas**	
	(*Average cumulative*) abnormal return (mean, in %)	Θ (p-value)	(*Average cumulative*) abnormal return (mean, in %)	Θ (p-value)	(*Average cumulative*) abnormal return (mean, in %)	Θ (p-value)
03.01.2006	0.20	-0.20 (0.84)	0.02	-0.65 (0.52)	0.43	1.70* (0.10)
04.01.2006	0.31	1.83* (0.07)	0.49	1.55 (0.13)	0.10	1.15 (0.26)
05.01.2006	-0.02	-0.50 (0.62)	-0.28	-0.45 (0.66)	0.30	1.26 (0.22)
03.-05.01.06	*0.18*	*0.10* *(0.92)*	*0.07*	*-0.83* *(0.41)*	*0.31*	*1.70** *(0.10)*

Note: (Average cumulative) abnormal returns are based on the sample mean over the respective γ_is. * indicates significance at the 10%-level.

When abnormal returns of the full sample are analyzed, significant event impacts can be observed for December 28, 2005, as well as for January 4, 2006 (see Tables 6 and 8). These effects are both positive and significant at the 1%-, and 10%-level, respectively. On

December 28, we observe (daily) abnormal returns of 0.35 per cent for the full sample, while for January 4, these abnormal returns are smaller (0.31 per cent). When abnormal returns are analyzed cumulatively, a significant impact (at the 5%-level) can only be observed for the crisis announcement period. The abnormal average cumulative daily effect on stock returns is 0.14 per cent.

If we analyze the utilities separately, we do only get evidence for a significant effect for December 28. The abnormal return calculated is positive as well, but less important than for the full sample (0.19 per cent), and significant at the 5%-level. Significant average cumulative effects do not occur. For the oil and gas sector, significant positive effects that are stronger than in the full sample are calculated for December 28 and December 30 (0.56 and 0.74 per cent) and significant at the 1%- and 5%-level, respectively. As a consequence, average cumulative abnormal returns in the announcement period sum up to 0.34 per cent per day and are significant at the 5%-level. Furthermore, for this sector we find a significant (5%-level) negative event effect of -0.45 per cent for December 27. On January 3, a positive effect of 0.43 per cent occurs that is significant at the 10%-level. This manifests in an average cumulative abnormal return for the oil and gas sector in the withdrawal phase of 0.31 per cent that is significant at the 10%-level, as well.

All in all, the positive effect for the full sample on December 28, 2005 is robust when the two sectors are analyzed separately. Besides the negative effect for oil and gas corporations on December 27, only significant positive abnormal returns occur in our analysis.

7. Conclusion

In this paper, the impact of the 2006 European gas crisis on West European utilities is measured from a stock market perspective. Using event study methodology, we assess whether or not the Russian announcement of suspension of gas deliveries, this suspension itself as well as its withdrawal implied higher unsystematic volatility and generally abnormal returns for West European energy stocks. In the field of resource, energy and environmental economics this is, to our knowledge, the first paper measuring event impacts on *unsystematic return volatility* as well as generally considering autoregressive conditional heteroskedasticity and event-induced volatility for the calculation and significance testing of abnormal *returns*.

From a methodological point of view, the existence of event-induced volatility at a between-firm level confirms our choice of the flexible methodology of Savickas (2003) in order to test for abnormal returns. Besides the fact that the important issue of risk and volatility was neglected in resource and environmental economics so far, traditional tests for abnormal returns would be misspecified under such circumstances. We therefore suggest that event-induced volatility should more often be taken into account in event studies in environmental and resource economics.

The significant abnormal returns that occur in our analysis are almost exclusively positive. This effect is especially robust for December 28, 2005, when the crisis came into reach and became more concrete. This positive impact over-compensated the (only) significant negative effect observed of December 27, which was limited to the group of oil and gas companies. It seems that these *positive* reactions of financial markets fully anticipated the supply suspension as no abnormal returns can be measured when the withdrawal was implemented – from January 1 to January 2. We observe (highly) *significant abnormal unsystematic volatility* on January 3, 2006, when Russia reopened its valves. This is all the more striking, as low market activity related to Christmas and New Year's Day, which is not explicitly modelled, should tend to lower estimated volatility. However, oil and gas stocks reacted slightly positively, although significant only at the 10%-level. On January 4, a positive effect is visible for the whole sample, which can be explained with the legally binding ending of the conflict. This should induce stable prices for Russian gas at a relatively high level compared to the past. However, positive effects are only significant at the 10%-level.

Summarizing, the definite announcement of the crisis as well as of price increases and therefore a rise of Western Europe's energy risk and costs tended to increase market expectations with respect to energy-related firms and especially oil and gas corporations while the renewal of gas deliveries increased market uncertainty. The – in general large – oil and gas stocks of the European suppliers are up valued due to the fundamental resource price increases at the international exchanges. The effect does not only hold for oil and gas companies that directly gain from price increases due to a revaluation of resource deposits and stocks. Interestingly, it is visible for utilities, as well, although significance disappears here if the announcement period is analyzed at an aggregate time level. One factor behind these counterintuitive findings could be as well windfall profits of energy-related companies due to increasing resource and electricity prices. Sources of energy production other than oil and gas are available and utilities can at least partly switch between those sources. This point is emphasized by the fact that demand elasticities for energy are extremely low as a rule, so that price increases can often easily be passed on to the consumers. It could well be that energy companies tend to raise their markup in the wake of bad news. Finally, the stock market effect observed may reflect the expectation of energy-related industries that future energy policy, e.g. via competition policy, could increasingly take into account their interests as a reaction to their ostensible dependence or even instability. However, our results suggest that energy policy does not have to bear in mind negative effects for energy-related firms in situations when security of energy supply is in danger.

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