Non-Technical Summary

The recent years have been marked by massive price movements at the resource markets. Especially oil prices at the international energy exchanges have been rising strongly, and record high prices for oil and gas have been accompanied by non-negligible volatility. Resource price, but also resource price volatility hikes have been shown to be economically detrimental. In contrast to the overall stock market, energy stocks seem to be an exemption to this rule: According to previous research, energy corporations are gaining from resource price increases. The role of resource price volatility has not yet been explored in this context.

Stock market developments of corporations of the energy branch are a very interesting case. This is due to the fact that the sector itself is marked by several peculiarities. Perhaps most importantly, many of the inputs this sector uses and of the outputs it produces are largely both homogenous and traded at international exchanges. Given this background, besides the stock market itself, especially resource market developments are intuitive possible determinants of energy stock returns. Degree and direction of their impact on energy stocks may depend on the affiliation of the respective corporation at the sub-sectoral level, i.e. whether corporations affiliated to the oil and gas industry or to the electric power generation and transmission (electric utilities) are analyzed.

In the light of such possible interactions between the stock market and other financial markets such as the resource market, it is surprising that there is relatively little research on stock performance of energy corporations. Especially, there is no literature available that deals with European energy stocks. Moreover, the existing research exclusively relates to determinants of stock returns, while the return volatility of energy stocks is widely unexplored. Both energy stock returns and volatility may not only be driven by price changes at other financial markets, but also by the respective volatility and especially by energy market volatility. This has not been analyzed, yet.

Our results suggest that stock returns of European energy corporations are not only determined by their relationship in systematic risk to the overall stock market. An appreciation of the Euro against the U.S. Dollar, reflecting an increase in purchasing power of the European corporations on international markets, leads to positive stock market reactions for both oil and gas businesses and utilities. Our results show that Eurozone utilities on average suffer from negative stock market responses to oil price rises, while oil and gas related businesses are upvalued in such setting. Additionally, oil market volatility negatively affects oil and gas stocks. In contrast, energy stock volatility is not related to volatility of the resource market, but only driven by its own dynamics. Generally, the gas market does not seem to play a role for Eurozone energy corporations’ stock performance. This is especially surprising in the case of electric utilities given the fact that oil, in contrast to gas, is barely used for energy generation in Europe.

These findings can explain the profitability of investments in European oil and gas stock corporations during recent years. Besides the generally good market situation, the rise of the Euro against the U.S. Dollar and especially the strong increase of oil prices have promoted this development. Investments in oil and gas stocks have also been considered as relatively “conservative”. However, as suggested by the results of our empirical investigation, at least European oil and gas stocks may offer a relatively weak performance in times of high oil price volatility.

Returns and Volatility of Eurozone Energy Stocks

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February 2008

Abstract: This paper constitutes a first analysis on stock returns and stock return volatility of energy corporations from the Eurozone. According to our results, the gas market does not play a role for the pricing of Eurozone energy stocks. However, changes in the Euro to U.S. Dollar exchange rate as well as developments at the money and especially at the oil market strongly affect returns of the energy stock portfolios analyzed. While oil price hikes negatively impact on stock returns of European utilities, they lead to an appreciation of oil and gas stocks. Most importantly, we show that oil market volatility negatively affects European oil and gas stocks. In contrast, energy stock volatility is not driven by volatility of the resource market, but only by its own dynamics.

Keywords: Energy stocks; resource prices; volatility; asset pricing

JEL classification: Q40; Q43; C13; G12

Acknowledgement: We are grateful to Jörg Breitscheidel, Tim Hoffmann, Andreas Keller, Andreas Schrimpf, and Andreas Ziegler for many helpful comments and suggestions.

I. Introduction

The recent years have been marked by massive price movements at the resource markets. Resource prices at the international energy exchanges have been rising strongly, and record high prices for oil and natural gas have been accompanied by non-negligible volatility. Resource – and especially oil – price, but also price volatility hikes have been shown to be economically detrimental (e.g. Ferderer, 1996, and Sadorsky, 1999). Overall stock market developments are no exception to this rule. Against this background, the great public attention not only to resource price levels, but also to their volatility is not surprising, with oil price volatility being – particularly since the mid 1980s – relatively high also compared to volatility of other commodities (Regnier, 2007).

From previous literature, however, it is also apparent that the stock market effects of resource price developments may depend on the sectoral affiliation of the respective corporation analyzed. Particularly energy corporations are often said to gain from resource price increases. The role of resource price volatility has not yet been explored in this context. Generally, stock market developments of corporations from the energy branch are a very interesting case. This is due to the fact that the sector itself is marked by several peculiarities. Many of the inputs this sector uses and of the outputs it produces are both homogenous and traded at international exchanges. The prices of some of these goods – resources such as oil and gas – are extremely volatile, and the U.S. dollar is the predominant currency for their trading. Moreover, capital intensity of the industry, compared to other sectors, is high (Sadorsky, 2001).

In the light of such possible interactions of different financial markets, it is surprising that there is relatively little literature on the determinants of energy corporations' stock performance. Moreover, to our knowledge, for European markets as a whole only Manning's (1991) study assessing UK oil industry stock portfolios is available. Evidence from continental Europe is completely missing. According to the main result from Manning's research – using an augmented market model for weekly data – a positive effect of oil price changes on oil corporations' stock returns exists. This effect is largest for corporations purely engaged in oil exploration and production. Faff and Brailsford (1999) analyze the Australian stock market analogously using a two factor model including an "oil factor" besides the well-established market (beta) factor. With respect to the oil and gas sector that is in the focus of our research question, the authors find a positive impact of oil price changes on stock returns on a monthly basis. For the U.S., Hammoudeh et al. (2004) apply cointegration technique in order to show that oil prices have explanatory power for US oil industry equity indices. Their results rely on daily data. Using monthly data from global industry stock indices, Nandha and Faff (forthcoming) show that oil price hikes negatively impact on stocks from corporations of nearly all sectors. The oil and gas industry is, together with mining, an exemption here. According to the results from a VAR model with weekly data, alternative energy corporations are only little affected by oil price movements (Sadorsky and Henriques, forthcoming).

Most recent and comprehensive research as far as factors in returns of energy stocks are concerned has been conducted for Canada. Sadorsky (2001) develops an extensive multifactor model including the market excess return, an interest variable based on the term premium, the change of the Canadian Dollar to U.S. Dollar exchange rate, as well as oil price changes. His estimations show that each of these variables plays a statistically significant role in explaining returns from a stock portfolio of Canadian oil and gas corporations. While the market excess return and the oil price change positively impact on portfolio returns, Sadorsky's (2001) results indicate that increases in both the exchange rate and the term premium lower Canadian oil and gas stock returns. Their results with respect to an estimated beta coefficient smaller than one furthermore suggests that the Canadian oil and gas industry is on average less risky than the market. Similarly focussing on Canadian oil and gas corporations, Boyer and Filion (2007) contribute to these findings in adding gas price changes as a factor of stock returns as well as in incorporating firm-specific financial and operational characteristics ("fundamental factors") such as cash-flows and production volume. As the most surprising result from their analysis based on monthly data, Boyer and Filion find that firm production negatively affects stock returns.

The existing literature exclusively relates to determinants of stock returns, while the return volatility of energy stocks is widely unexplored. However, it is obvious that volatility is an important issue in stock attractiveness for potential investors. E.g. within the framework of a simple (μ,σ)-rule (Markowitz, 1952), both the – desired – expected return and the – undesired – volatility matter for portfolio selection. As far as the determinants of energy stock returns are concerned, the previous literature is largely restricted to the impact of (amongst others) resource *price changes*. Given the background of negative macroeconomic effects of resource price volatility, and Sadorsky's (2003) finding that even technology stocks seem to be driven by oil price volatility, it is very surprising that the relationship between energy market volatility and energy stocks has, to our knowledge, been ignored so far. In contrast, energy stock returns as well as their volatility may also be influenced by resource price volatility.

In this respect, the contribution of this paper is twofold: Firstly, we conduct a first analysis on the determinants of stock returns and volatility of energy corporations from the Eurozone. In this respect, we examine two different portfolios of energy stocks: One portfolio consisting of oil and gas corporations' and one portfolio comprising utilities' stocks. Most importantly, within our empirical approach, we tackle the issue of relationships between energy market volatility and energy corporations' stocks. Secondly, making use of a generalized autoregressive conditional heteroskedasticity (GARCH) approach, we assess determinants not only of the energy portfolio returns, but also link the respective return volatility to resource price volatility.

The remainder of this paper is structured as follows: Section two presents the six main hypotheses for our empirical investigation. In chapter three, we highlight our methodological approach; in section four we describe our dataset. Chapter five gives the results of our econometric examination. Chapter six concludes.

II. Hypotheses

Hypothesis 1: Oil and gas price changes positively affect stock returns of oil and gas producers, and negatively affect stock returns of electricity corporations.

Using a simple illustration, Chen et al. (1986) argue that macroeconomic variables systematically affect stock returns. It is based on the representation of stock prices of corporation *i* ($p_{i,t}$) as expected future cash flows of the corporation ($E(cf_{i,t})$) that are discounted by the discount rate δ_t

$$p_{i,t} = \frac{E\left(cf_{i,t}\right)}{\delta_t}, \qquad (1)$$

implying stock price changes (log returns) of corporation *i* of

$$d\left[\ln p_{i,t}\right] = \frac{d\left[E\left(cf_{i,t}\right)\right]}{E\left(cf_{i,t}\right)} - \frac{d\delta_t}{\delta_t}. \quad (2)$$

In this respect, following Chen et al. (1986), the systematic forces of the stock returns of corporation i should be both the determinants of the discount rate δ_t and of the expected future cash flows $E(cf_{i,t})$.

Given rising oil and gas prices, the resource stocks of companies related to oil and gas business or their products and services should be upvalued. Consequently, their expected future cash flows should rise. Resource price collapses, in contrast, should be economically harmful for them (Hampton, 1995). European utilities use oil and – to a much larger extent – gas as an input for electricity generation (EIA, 2007) or sell them directly to their clients. Although at least some of the utilities are supposed to exhibit non-negligible market power and electricity consumption is considered to be relatively inelastic, it is unclear whether costs stemming from resource price increases can fully and immediately be passed on to the consumers. Rising (falling) resource prices should therefore reduce (increase) utilities' expected future cash flows.

Hypothesis 2: Energy market volatility positively affects energy stock return volatility and negatively affects energy stock returns.

Following the existing literature, energy price variables – besides the market return – are the most important determinants of energy stock returns. However, not only appreciations and depreciations in levels of resources may matter for the market developments of energy stocks. Sauter and Awerbuch (2003) argue that since "the 1980s, oil price volatility is more significant in its effects on economic activity than the oil price level" (p. 11). Despite the existence of energy options, the energy industry is strongly exposed to energy price risks (Hampton, 1995). Volatility at other financial markets such as the money and the foreign exchange market are assumed to be less important. An increase (decline) of volatility at the energy market should render the expectations for future cash flows more (less) volatile.

Analogously, market volatility may impact on the value instead of the volatility of the discounted expected future cash flows of a corporation. Following Pindyck (2004), an increase in price volatility may decrease the production of the respective commodity. Resource market volatility may cause augmented expenditures for affected corporations, and may e.g. induce hedging costs for oil and gas corporations as well as for utilities. Oil and gas volatility should therefore negatively affect expected future cash flows of oil and gas corporations as well as of utilities.

III. Empirical Approach

Our goal is to accurately analyze the determinants of Eurozone energy stock returns and their volatility – using two portfolios based on stock returns of utilities on the one hand, and of oil and gas corporations on the other hand. In a first step, we stick very closely to the existing literature on energy stocks presented in the introduction of this paper. We thus start with a simple one-factor model based on (and compatible to) the Capital Asset Pricing Model (CAPM, Sharpe, 1964 and Lintner, 1965), assuming that the market excess return is sufficient to explain the excess returns of the portfolios, i.e. that the market excess return is the only relevant risk factor.

$$r_{i,t} = \alpha_i + \beta_i r_{m,t} + \varepsilon_{i,t} \quad (3)$$

Here, $r_{i,t}$ and $r_{m,t}$ are the excess returns for portfolio *i (i=1,2)* and the market portfolio at the end of period *t* (i.e., between *t*–1 and *t*) over the one month T-bill rate. $\varepsilon_{i,t}$ is the disturbance term with $E(\varepsilon_{i,t}) = 0$ and $\mathrm{var}(\varepsilon_{i,t}) = \sigma_\varepsilon^2$. α_i and β_i besides σ_ε^2 are the unknown parameters that have to be estimated by OLS.

We then extend this model by those variables that have shown to influence Canadian energy stock returns: We add the price changes of oil $r_{o,t}$, of the term premium $r_{r,t}$, of the Euro to U.S. Dollar exchange rate $r_{x,t}$ [1] (Sadorsky, 2001), and of gas $r_{g,t}$ (Boyer and Filion, 2007).

$$r_{i,t} = \alpha_i + \beta_{1i} r_{m,t} + \beta_{2i} r_{o,t} + \beta_{3i} r_{g,t} + \beta_{4i} r_{r,t} + \beta_{5i} r_{x,t} + \varepsilon_{i,t} \quad (4)$$

Additionally to the models established in the existing literature, we then enrich Equation (4) by adding the volatilities of the changes in the oil price $v_{o,t}$ and in the gas price $v_{g,t}$.

$$r_{i,t} = \alpha_i + \beta_{1i} r_{m,t} + \beta_{2i} r_{o,t} + \beta_{3i} r_{g,t} + \beta_{4i} r_{r,t} + \beta_{5i} r_{x,t} + \gamma_{1i} v_{o,t} + \gamma_{2i} v_{g,t} + \varepsilon_{i,t} \quad (5)$$

In a next step, we additionally base our analysis on a Generalized Autoregressive Conditional Heteroskedasticity (GARCH) application. Models of the GARCH-class (Bollerslev, 1986) are very appealing approaches for the analysis of high-frequent time series in financial markets. Reason for this is the fact that they address the phenomenon of so-called volatility clustering, the tendency that current volatility of asset returns tends to be positively correlated with its past values. Amongst those approaches, the use of the GARCH(1,1) model (i.e. an ARMA(1,1) model for the conditional variance of the mean-equation error term that is jointly estimated with the mean equation itself, here as usually by maximum likelihood) is widespread as it generally sufficiently explains systematic variation of asset price volatility (cp. e.g. Andersen and Bollerslev, 1998). We apply such GARCH(1,1) model for Equation (3) to (5). For simplicity, in Equation (6)/(7) the GARCH(1,1) analogue only for equation (5) is shown. We assume normal distribution for the error term $\varepsilon_{i,t} \sim N(0, h_{i,t})$.

$$r_{i,t} = \alpha_i + \beta_{1i} r_{m,t} + \beta_{2i} r_{o,t} + \beta_{3i} r_{g,t} + \beta_{4i} r_{r,t} + \beta_{5i} r_{x,t} + \gamma_{1i} v_{o,t} + \gamma_{2i} v_{g,t} + \varepsilon_{i,t} \quad (6)$$

$$h_{i,t} = a_i + b_i h_{i,t-1} + c_i \varepsilon_{i,t-1}^2 \quad (7)$$

We finally augment such GARCH(1,1) approach with return volatilities in the mean equation ((6) / (7)) by including resource (oil and gas) volatility variables into the variance equation. Doing this, we allow the conditional variance of the portfolios not only being determined by its own dynamics, but also by "external" factors. In this respect, our approach relates to the literature of so-called volatility spillovers (cp. e.g. Hamao et al., 1990) – in our setting from the energy market to the market for energy stocks.[2]

[1] Analogously to the Canadian Dollar to U.S. Dollar exchange rate in Sadorsky's (2001) analysis for Canadian energy corporations.

[2] Hammoudeh and Yuan (2008) have followed a related approach in order to test for oil and interest rate shocks on metal volatility. In contrast to Equation (8)/(9), they use lagged (oil and interest rate) returns instead of contemporaneous oil and interest volatility terms. As the stock market, in contrast to commodity (metal) markets, is supposed to adjust with high speed, assuming contemporaneous effects seems to be more plausible for our setting.

$$r_{i,t} = \alpha_i + \beta_{1i} r_{m,t} + \beta_{2i} r_{o,t} + \beta_{3i} r_{g,t} + \beta_{4i} r_{r,t} + \beta_{5i} r_{x,t} + \gamma_{1i} v_{o,t} + \gamma_{2i} v_{g,t} + \varepsilon_{i,t} \quad (8)$$

$$h_{i,t} = a_i + b_i h_{i,t-1} + c_i \varepsilon_{i,t-1}^2 + d_{1i} v_{m,t} + d_{2i} v_{o,t} \quad (9)$$

Finally, we estimate more parsimonious versions of Equation (3), (4), (5), (6)/(7), and (8)/(9) by iteratively eliminating insignificant (10%-level) explanatory variables from the respective equations.

IV. Data and Variables

The sample period of our analysis ranges from January, 1, 2002 until August 15, 2007. Due to this relatively long period, our research question can be analyzed in terms of daily data with a relatively high number of observations. In this respect, we are absolutely aware of the fact that low frequency data (i.e. weekly or monthly data) is often preferred in comparison to daily data. In case of low – daily – trading, daily data may induce errors-in-variables problems (Scholes and Williams, 1977). However, such irregularities should not occur in our setting given the fact that the corporations forming our portfolios are "big" stocks with high trading volumes. Moreover, our research question with respect to stock return volatility should be tested using daily data, as GARCH-effects often vanish in more low-frequency data types. The sample period is defined in a way that common interest rates and exchange rates from the Eurozone exist and are valid for all corporations from this region. Such common interest and exchange rates have been introduced already in 1999. In order to avoid data problems due to early adjustments (of interest and exchange rates) in the phase of Euro introduction, we set the starting point of the sample period to January, 1, 2002, when physical Euro coins and banknotes were introduced. All series used in our analysis stem from Datastream (Thomson Financial).

We analyze the returns of two different sub-sectoral portfolios of Eurozone energy stocks. We label the first portfolio oil and gas portfolio. It is the equal weighted portfolio of the most important Eurozone oil and gas business-related corporations' stock excess (log) returns. The second – the utility portfolio – is the equal weighted portfolio of the most important publicly traded Eurozone utilities' stock (excess) returns. We identify the corporations considered for the oil and gas portfolio by choosing all corporations included in the Dow Jones Euro Stoxx Oil and Gas Index (August 1, 2007), for which financial market (return) data is available for the period January, 1, 2002 until August 15, 2007 and that are located in one of the Eurozone countries.[3] The main activities of those corporations comprise crude oil and natural gas exploration and production, as well as refining and international crude oil and product trading. Some of the corporations are furthermore engaged in services in the field of oil and gas. In this respect, we are not able to distinguish between gas producers and integrated gas corporations. This, however, is due to the fact that many European energy corporations are integrated and, consequently, there is no "pure" gas producer in our portfolio.

The utility portfolio consists of all corporations included in the Dow Jones Euro Stoxx Utilities Index (August 1, 2007), for which financial market (return) data is available for the sample period and that are located in one of the Eurozone countries.[4] These corporations have a strong focus on electricity generation and power supply. In our empirical analysis, we make

[3] Those corporations are Bourbon, CGG Veritas, Eni, Fugro, Gas Natural SDG, OMV, Repsol YPF, Saipem, SBM Offshore, Technip, and Total.

[4] Those corporations are AEM, EON, Endesa, Enel, Energias de Portugal, Fortum Corp., Iberdrola, Red Electrica de Espana, RWE, Snam Rete, Solarworld, Suez, Union Fenosa, Veolia Environnement, and Verbund.

use of portfolio excess returns by subtracting the (daily) return of the one month Euro Interbank Offered Rate (Euribor) from the average stock return (log return) of the corporations considered. The (arithmetic) means of both portfolio excess return series do not significantly differ from zero at any conventional level (Table 2). Moreover, both series are stationary according to a Dickey-Fuller unit root test (Table 3).[5]

The market excess return for our analysis is calculated from the Dow Jones Euro STOXX (and, consistently with the portfolio excess log returns, from the one month Euribor). It is the broadest market index of the Eurozone stock market, representing large, mid and small capitalisation companies of all Eurozone members.[6] The Dow Jones Euro STOXX has a varying number of components (September 2007: 317 corporations). In order to test whether there is an impact of oil price changes on the returns of our two portfolios, we make use of the time series of (Crude Oil) Brent (Euro per barrel) being the most relevant traded crude for European energy firms. Consistently with the existing literature, we use a variable based on the (one month) forward instead of the spot price series. The use of future or forward prices is due to the fact that they are less noisy in comparison to spot prices that are more strongly affected by very short run demand and supply fluctuations (cp. Sadorsky, 2001, Boyer and Filion, 2007). Consequently, we use the price change of the (one month) forward natural gas time series from Intercontinentalexchange (ICE, London; Euro per 100.000 British Thermal Units) as gas variable. This is the only European time series on natural gas that is available to us for the whole period 2002 to 2007 as time series from continental European energy exchanges (e.g. from the APX, Zeebrugge, or the EEX, Leipzig) are much shorter (they only start in 2005 or 2007, respectively). The disadvantage of using ICE data is that UK gas prices may be driven by fundamentals of its domestic supply and demand if the UK interconnector to Belgium is full or shut down, so that prices may temporarily decouple from continental gas prices (Kjärstad and Johnsson, 2007). Generally, UK and continental gas prices are closely related due to arbitrage possibilities, though. Our interest rate variable is constructed as the change of the so-called term premium, i.e. the difference in price changes for holding a three and a one month bill (cp. e.g. Harvey, 1989). We calculate the interest variable from three and one month Euribor, the most important interest rates from the Eurozone. Analogously to the U.S. Dollar to Canadian Dollar exchange rate in the related literature on Canadian energy stocks, we incorporate the U.S. Dollar to Euro exchange rate in our analysis. It is defined in a way that a value of 1.1 of this exchange rate implies that 1.10 Dollar is worth the same as one Euro, so that a rise of the exchange rate implies a rise of the Euro against the U.S. Dollar. Here as well, the explanatory variable is based on the price change of this exchange rate.

If capital markets work efficiently, only innovations, i.e. unexpected movements of selected systematic variables can affect stock returns and therefore the energy stock portfolio returns analyzed here. The assumption of being innovations should hold for the explanatory variables outlined above: Price changes from financial markets are generally accepted being innovations. This is confirmed by the fact that for none of the explanatory variables presented above there is any indication for a unit root according to the Dickey-Fuller test (Table 3). With only one exception, the means of those variables furthermore do not significantly differ from zero (Table 2): Only the price change of the Dollar to Euro exchange rate has a weakly significant positive mean, which however does not cast general doubts on the assumption of

[5] For those as well as all other explanatory variables, a unit root test without trend term was conducted. According to visual inspection, none of the series exhibits trends.

[6] From 2002 to 2007, these 12 members were Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain. Corporations from Slovenia, the 13th member country since January 2007, do not form part of the index. However, there are no Slovenian corporations forming our utility and oil and gas portfolios, either.

exchange rate changes being innovations. In contrast, energy market volatility we furthermore integrate in our empirical approach (see proceeding chapter), is positive by definition and generally believed not being an innovation. This is illustrated by the success of estimators of the GARCH-class (cp. e.g. Engle, 2001) that model volatility by autoregressive moving-average (ARMA) processes. Consequently, volatility terms of the changes of the oil price $w_{o,t}$, and of the gas price $w_{g,t}$ (i.e. squared price changes) exhibit highly significant positive means in our sample (Table 2). We cope with this problem which could introduce an errors-in-variables problem of our estimations (Chen et al., 1986) by using errors of an ARMA(1,1) process of these volatilities instead of the volatilities themselves in our estimations. This is done by estimating an ARMA(1,1) model for the volatility of the two return series *j* (oil, gas):

$$w_{j,t} = \theta_j + \vartheta_j w_{j,t-1} + \rho_j u_{j,t-1} + u_{j,t}, \qquad (10)$$

with $w_{j,t}$ representing the squared price change from market *j (j=1,2)* at the end of period *t* (i.e., between *t*–1 and *t*). $u_{j,t} \sim N(0,\sigma^2)$ is the white noise disturbance term. θ_j, ϑ_j, and ρ_j besides σ^2 are the unknown parameters that have to be estimated by maximum likelihood. $u_{j,t}$ is at the same time the error term of the model and therefore the volatility innovation that can be used as explanatory variable in our regression analysis. Here, it will be denoted *v* with subscripts indicating time and market. For the gas volatility, an ARMA(1,1) inadequately describes the data generating processes of the series;[7] here, we simply use demeaned series (i.e. the error term of a regression on a constant) instead of the error terms from an ARMA approach. We are aware of the fact that the method of calculating volatility innovations is simple, but the approach is straightforward and consistent with the GARCH(1,1) approach followed in this paper. It is strongly related to the method of Hamao et al. (1990) in calculating "volatility surprises" from stock markets: The authors estimate augmented market models for the respective markets and use the squared residuals from these models as volatility terms. However, given the fact that resource price changes (we use instead of stock returns in Hamao et al., 1990) can generally not be explained by augmented market models, our approach seems more adequate for our special setting. Hamao et al. (1990) model volatility spillovers only with respect to stock return volatility, but not to stock returns themselves as we additionally do. This explains why we, in contrast to Hamao et al. (1990), use variables in levels instead of squared values. Our results have proven high robustness over alternative approaches in constructing the volatility variable that are, for brevity, not reported here. By construction, the newly generated variables do not exhibit significant arithmetic means (10%-level; Table 2) and there is no indication for a unit root in any of these variables (Table 3).

Both the oil and gas price are furthermore graphically shown in the appendix. These are the price series of the most volatile possible determinants of the European energy stock returns. Sudden shifts or breaks in these series may also have an influence on the relationship between their price changes, volatilities, and the energy stock returns analyzed. Figure 1 suggests that the oil price was relatively stable and mean reverting between 2002 and 2004, but constantly growing between 2004 and 2007. The gas price, in contrast, remained relatively stable at one price level during the whole sample period, with the exception of a price explosion in late 2005 which reflects the Russo-Ukrainian gas dispute at that time (Figure 2). Visual inspection

[7] I.e. the null hypothesis of joint insignificance of the estimated parameters can not be rejected at the 10%-level using a chi-squared test. All estimation results are available from the authors on request.

of the exchange rate series suggests a relatively less volatile development of this series in comparison to the oil and gas price.

A look at the correlations between the variables considered in this analysis reveals that both dependent variables (the two energy portfolio excess return series) are strongly and positively related (Table 4). Amongst the explanatory variables, the market excess return correlates most strongly with both portfolio excess return series. Moreover, the change of the term premium exhibits a relatively strong and positive correlation to the dependent variables. Multicollinearity amongst the explanatory variables is no severe problem in our setting. As exemptions, correlations between the market excess return and both the change of the term premium and of the exchange rate are relatively high. Of course, volatilities $w_{j,t}$ and volatility innovations $v_{j,t}$ from the respective market correlate strongly (and even perfectly if $v_{j,t}$ is the demeaned volatility). As lined out above, only $v_{j,t}$ terms are employed as explanatory variables in the empirical analysis.

V. Results

As far as the utility portfolio is concerned, the market excess return enters highly significantly into the regression equation of the one-factor model (Equation (3)). The estimated parameter (beta factor) is smaller than one (0.75; Table 5). Adding the above described additional macroeconomic price change variables to the equation (Equation (4)) gives mixed results: Besides the market return, both the oil price change and the price change of the Dollar to Euro exchange rate show significance at the 1%- and the 5%-level, respectively. The estimated parameters have the expected signs; negative (-0.03) for the oil price change, and positive (0.07) for the exchange rate. The estimated parameter of the gas price change shows weak significance (10%-level). It is, against intuition, positive, but very small (0.01). The change of the term premium does not show significance at any conventional level. Those results also hold when insignificant explanatory variables are subsequently eliminated from the estimated equation. Applying the regression specification-error test (RESET) for omitted variables, we can not reject the null hypothesis of no omitted variables, indicating that our approach is well specified. However, using the two standard tests on autocorrelation (Breusch-Godfrey LM test for autocorrelation and Durbin's alternative test for autocorrelation) we get highly significant evidence for autocorrelation of first order in all regression equations. The test on autoregressive conditional heteroskedasticity (ARCH LM test) furthermore suggests highly significant ARCH effects. As far as autocorrelation is concerned, the inclusion of a lagged dependent variable to Equations (3) and (4) barely affects the estimation results for the other explanatory variables, the estimated autocorrelation coefficient of first order showing only weak statistical significance. Therefore, those results are not computed here[8] and we confine ourselves to base our estimations on Newey-West standard errors that are consistent in the presence of both heteroskedasticity and autocorrelation.

Given the phenomenon of autoregressive conditional heteroskedasticity, we make use of a GARCH(1,1) approach for all specifications. Both variance equation coefficients (besides the constant term) differ highly significantly from zero for all specifications, underpinning the volatility dynamics present in the portfolio excess returns. The estimated coefficients from the variance equation do not suggest, as expected, an infinite conditional variance, with the sum of the two estimated GARCH coefficients being smaller than one. The GARCH mean equation results do not strongly differ from the standard results for Equation (3) and (4); the

[8] Those estimation results are available on request from the authors.

only remarkable difference is the insignificance of the gas return coefficient against the surprising positive effect from standard regression. Allowing for the impact of energy market volatility on utility portfolio excess returns (Equation 5) does not affect the results (Table 6); there is no evidence for any significant impact of such explanatory variables. Moreover, energy market volatility does not significantly affect the portfolio excess return volatility (Equation (8)/(9)).

The two hypotheses on utility stock returns and volatility lined out above are, in this respect, only partly supported by our estimation results. *Hypothesis 1* holds for the negative oil price change - utilities portfolio return relationship, but not for the (negligible) gas price change - utilities portfolio return relationship. In contrast to *Hypothesis 2*, we do not find a significant positive relationship between energy market volatility and utility portfolio volatility. Moreover, there is no evidence for an effect of energy market volatility on utility stock returns.

For the oil and gas portfolio excess return series as well, the estimated coefficient of the market excess return enters highly significantly and with a value smaller than one (0.75) into the regression equation of the one-factor model (Equation (3); Table 7). Augmenting the model by macroeconomic price change variables (Equation (4)) gives positive and highly significant effects of the oil price change, the term premium and the Euro-Dollar exchange rate on the oil and gas excess portfolio returns. The estimated coefficients are not only statistically significant, but also economically, with point estimates of 0.10 (oil), 0.29 (term premium), and 0.21 (exchange rate). The "gas beta", in contrast, does not show statistical significance at any conventional level. Autocorrelation is less of a problem in the oil and gas stock portfolio case than for the utility portfolio excess returns. Both the Breusch-Godfrey LM test and Durbin's alternative test for autocorrelation suggest significant evidence for autocorrelation of first order only in the one-factor model (and here only on the 10%-level). In contrast, each regression equation exhibits highly significant autoregressive conditional heteroskedasticity (following the results of an ARCH LM test). Moreover, the RESET test indicates a misspecification of our approach, although the significance is not overwhelming. In this respect, the consideration of volatility spillovers in the mean equation and of a time-varying volatility seems to be a possible solution to these problems.

Using a GARCH(1,1) specification, estimated coefficients for all explanatory variables from the mean equation show lower values than in the standard case. These differences, however, are not statistically significant at the 5%-level. Both variance equation coefficients, additionally to the constant term, differ highly significantly from zero for all specifications, underpinning the volatility dynamics present in the portfolio excess returns. As in the utility portfolio case, the estimated coefficients from the variance equation indicate a finite (mean-reverting) conditional variance. The inclusion of energy market volatility variables does, in contrast to the utility portfolio case, have an impact on oil and gas portfolio excess returns (Equation (5); Table 8). While estimated coefficients and their respective significance levels for the explanatory variables in levels are largely robust to the results reported above, the oil volatility has a – in most cases even highly – significant and negative impact on oil and gas portfolio excess returns. In contrast, energy market volatility does not affect oil and gas portfolio volatility (Equation (8)/(9)).

The results computed for the oil and gas portfolio provide major support for the hypotheses formulated in section three. As in the utility portfolio case, the estimation results confirm *Hypothesis 1* concerning positive oil price change - utility portfolio return relationship, but we do not find a statistically significant impact of the gas price change. Against *Hypothesis 2*, there is no evidence for energy market "volatility spillovers" to oil and gas stock return volatility. However, the proposition that energy market volatility negatively affects returns of oil and gas business stocks is confirmed by the empirical analysis.

Table 1 Central Results

GARCH (1,1) estimation (parsimonious version of Equation (8)/(9))	*Utility Portfolio*	*Oil and Gas Portfolio*
Mean Equation		
α_i	0.00**	0.00***
	(0.00)	(0.00)
β_{1i} **(market)**	0.77***	0.73***
	(0.01)	(0.02)
β_{2i} **(oil)**	-0.02**	-0.00
	(0.01)	(0.02)
β_{2i} **(oil) x dummy_2004**	-	0.14***
		(0.02)
β_{4i} **(interest rate)**	-	0.24***
		(0.06)
β_{5i} **(exchange rate)**	0.07**	0.16***
	(0.03)	(0.04)
γ_{1i} **(oil volatility)**	-	-0.66**
		(0.30)
Variance Equation		
a_i	0.00***	0.00***
	(0.00)	(0.00)
b_i **(GARCH (1) term)**	0.91***	0.88***
	(0.01)	(0.02)
c_i **(ARCH (1) term)**	0.06***	0.07***
	(0.01)	(0.01)
Obs.	1466	1466
Wald-Test (Chi-sq.)	4144.20***	2358.09***

Note: *, ** and *** show significance at the 10%-, 5%-, and 1%-level, respectively.

In order to test whether the estimated coefficients in the regression analysis of both portfolio excess returns are stable over time, we have conducted recursive estimations over the sample period. Table 9 and Table 10 show the results of the (annual) recursive estimation of the parsimonious specification of Equation (5) for both portfolios. The results suggest that no structural breaks are present in the utility portfolio case. Parameter estimates for the "oil beta" of the oil and gas portfolio, however, seem to indicate a structural break for this relationship in 2004, with an only weak impact of the oil price change until end of 2003 / early 2004 and a relatively stronger impact between early 2004 and 2007. Given this we have re-estimated the relevant equations making use of an (additional) shift dummy for the "oil beta". The results of these regressions are presented in Table 11. They confirm the presence of a structural break in the relationship between oil price changes and oil and gas portfolio returns. While no significant impact of the oil price change on the portfolio excess return could be found for the timeframe 2002 to 2004, the effect between 2004 and 2007 is significant and significantly stronger than the effect found in specifications not taking into account such structural break. All other results from these regressions hold. The structural break itself coincides with rising oil prices (see above as well as Figure 1). The central results (parsimonious versions of Equation (8)/(9) including the shift dummy for the oil and gas stock portfolio regression) are displayed in Table 1).

VI. Conclusions

In this paper, we conducted a first analysis on the determinants of Eurozone energy corporations' stock returns and stock return volatility. We empirically examined stocks of oil and gas business as well as of utilities, both averaged in respective portfolios. Our results suggest that stock returns of European energy corporations are not only driven by their relationship in systematic risk to the overall stock market. In contrast, changes in the oil price besides other macroeconomic variables play an important role for energy stock developments. Interestingly, we show that oil market volatility negatively affects oil and gas stocks. In contrast, energy stock volatility is not related to volatility of the energy market, but only driven by its own dynamics.

As found in the related literature, average systematic risk of Eurozone energy corporations seems to be smaller than that one of the market. Against the empirical evidence for Canada, the return of the term spread is not negatively related with Eurozone portfolio returns. While both Sadorsky (2001) as well as Boyer and Filion (2007) explain the negative relationship for Canadian energy corporations with high capital intensity of the industry, this does not seem to hold for its European counterpart. Still, the positive effect of the term premium we find for oil and gas corporations is in line with what has been observed for the stock markets of many OECD countries (Hjalmarsson, 2004). An appreciation of the Euro against the U.S. Dollar, reflecting an increase in purchasing power of the European corporations on international markets, leads to positive stock market reactions for both oil and gas businesses and utilities.

More importantly, our results show that Eurozone utilities on average suffer from negative stock market responses to oil price rises, while oil and gas related businesses are upvalued in such setting. The effect of oil market developments on the stock market is not, at least in the oil and gas portfolio case, restricted to a simple linear relationship between price changes at both markets: While, subsequently to a structural break from 2004 in this relationship, the oil price change positively impacts oil and gas stock returns, oil volatility has a negative effect on stock returns. Interestingly, and in contrast to the Canadian experience where there is a stock return sensitivity to a variation in gas prices (although smaller than to oil prices; Boyer and Filion, 2007), the gas market does not seem to play a role for Eurozone energy corporations' stocks at all. This is especially surprising in the case of electric utilities given the fact that oil, in contrast to gas, is barely used for energy generation in Europe (EIA, 2007). One reason behind this finding could be the fact that a large part of the gas sold in Europe is based on long-term contracts at a price that is determined by a formula that links gas to oil prices in order to prevent from any incentive for fuel switching (cp. e.g. Silverstovs et al, 2004). In this respect, it seems plausible that stock market participants use the oil price as the main indicator for resource price developments as a whole. Another explanation would be that, consistent with the findings of Haushalter (2000), energy companies hedge more strongly against gas than against oil price risks.

Given these findings, it is not surprising that during the last years, investments in European oil and gas stock corporations have been very profitable. Besides the generally good market situation, the rise of the Euro against the U.S. Dollar and especially the strong increase of oil prices have promoted this development. In the light of beta coefficients smaller than one as not only found in this analysis, but also in investigations for extra-European energy stocks, investments in oil and gas stocks have also been considered as relatively "conservative". However, as suggested by the results of our empirical approach, at least European oil and gas stocks may offer a relatively weak performance in times of high oil price volatility. Whether this holds true for extra-European oil and gas stocks as well, may be one direction for future research.

As no comprehensive energy corporation-specific database for the Eurozone was available to us, we could not test whether the influence of "fundamental determinants" such as proven reserves and production volumes resembles the effects Boyer and Filion (2007) have found for the Canadian stock market. Another direction for prospective investigations in the field of determinants of energy stock returns could be the integration of the so-called Fama-French factors into the empirical analysis. Such factors have not been calculated for the European stock market, yet, but are easily available at least for the U.S. and have proven explanatory power for example for the American (Fama and French, 1993, 1996) and for the German stock market (Ziegler et al., 2007). So far, it is unexplored whether a multifactor approach according to Fama and French may contribute to the accurate analysis of energy corporations' stock returns.

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Appendix

Table 2 Summary Statistics

Variable	**Mean**	**Std. Dev.**
$r_{Utility}$	0.0003607	0.0003002
$r_{Oil\ and\ Gas}$	0.0005333	0.0003396
r_m	-0.0000004	0.0003344
r_o	0.0005622	0.0005163
w_o	0.0003906***	0.0000182
v_o	-0.0000042	0.0000180
r_g	-0.0001254	0.0012385
w_g	0.0022457***	0.0002806
v_g	0.0000014	0.0002806
r_t	0.0000434	0.0000805
r_x	0.0002720*	0.0001416

Note: *, ** and *** show significance at the 10%-, 5%-, and 1%-level, respectively.

Table 3 Dickey-Fuller Unit Root Tests

Variable	**Test Statistic**
$r_{Utility}$	-37.483***
$r_{Oil\ and\ Gas}$	-35.831***
r_m	-38.300***
r_o	-41.894***
w_o	-35.823***
v_o	-38.162***
r_g	-36.882***
w_g	-37.143***
v_g	-37.143***
r_t	-31.339***
r_x	-38.864***

Note: *** shows significance at the 1%-level.

Table 4 Correlation Matrix

	$r_{Utility}$	$r_{Oil\ Gas}$	r_m	r_o	w_o	v_o	r_g	w_g	v_g	r_t	r_x
$r_{Utility}$	1.0000										
$r_{Oil\ Gas}$	0.6766	1.0000									
r_m	0.8363	0.7357	1.0000								
r_o	-0.0093	0.1734	0.0473	1.0000							
w_o	-0.0049	-0.0383	0.0092	-0.0146	1.0000						
v_o	-0.0134	-0.0448	0.0058	-0.0135	0.9881	1.0000					
r_g	0.0307	0.0201	0.0054	0.0483	-0.0147	-0.0084	1.0000				
w_g	-0.0146	-0.0094	-0.0334	-0.0080	-0.0306	-0.0239	0.5780	1.0000			
v_g	-0.0146	-0.0094	-0.0334	-0.0080	-0.0306	-0.0239	0.5780	1.0000	1.0000		
r_t	0.2496	0.2589	0.2759	-0.0498	-0.0018	-0.0038	-0.0057	-0.0123	-0.0123	1.0000	
r_x	-0.1770	-0.1305	-0.2575	-0.1700	0.0020	0.0027	-0.0139	0.0435	0.0435	-0.0425	1.0000

Note: 1466 observations. Pearson’s correlation coefficients for the respective variable pairs are given.

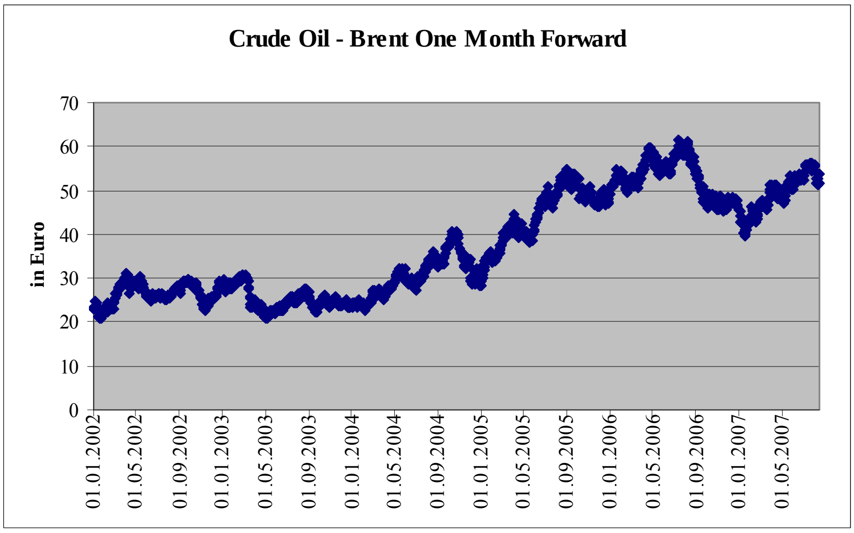

Figure 1 Price Oil Forward (Euro per barrel)

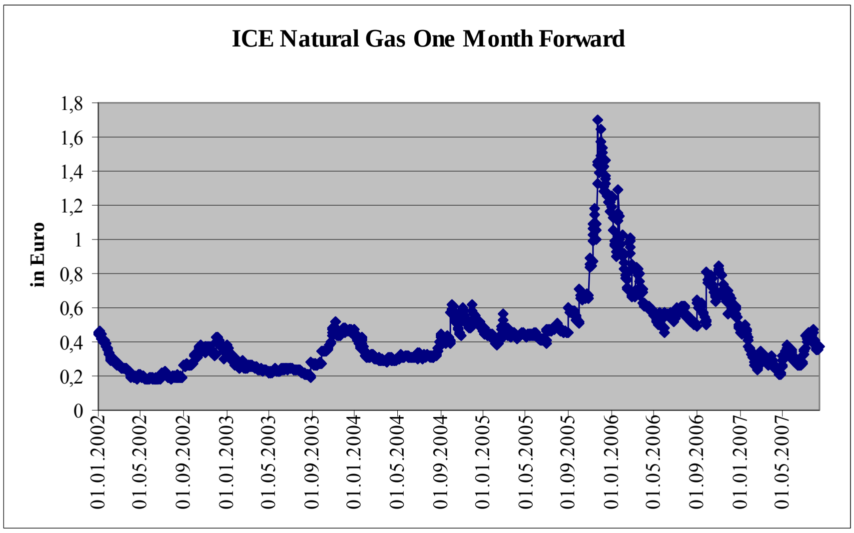

Figure 2 Price Gas Forward (Euro per 100.000 British Thermal Units)

Table 5 Results Utility Portfolio I

	Equation (3)	*GARCH (1,1) Equation (3)*	*Equation (4)*	*GARCH (1,1) Equation (4)*	*Equation (4) parsimonious*	*GARCH (1,1) Equation (4) parsimonious*
Mean Equation						
α_i	0.00** (0.00)	0.00*** (0.00)	0.00** (0.00)	0.00*** (0.00)	0.00** (0.00)	0.00** (0.00)
β_{1i} **(market)**	0.75*** (0.01)	0.76*** (0.01)	0.76*** (0.02)	0.76*** (0.01)	0.76*** (0.02)	0.77*** (0.01)
β_{2i} **(oil)**	-	-	-0.03*** (0.01)	-0.02*** (0.01)	-0.03*** (0.01)	-0.02*** (0.01)
β_{3i} **(gas)**	-	-	0.01* (0.00)	0.00 (0.00)	0.01* (0.00)	-
β_{4i} **(interest rate)**	-	-	0.06 (0.06)	0.06 (0.05)	-	-
β_{5i} **(exchange rate)**	-	-	0.07** (0.03)	0.07 (0.03)	0.07** (0.03)	0.07** (0.03)
Variance Equation						
a_i	-	0.00*** (0.00)	-	0.00*** (0.00)	-	0.00*** (0.00)
b_i **(GARCH (1) term)**	-	0.91*** (0.01)	-	0.91*** (0.04)	-	0.91*** (0.01)
c_i **(ARCH (1) term)**	-	0.06*** (0.01)	-	0.06*** (0.01)	-	0.06*** (0.01)
Obs.	1466	1466	1466	1466	1466	1466
R-squared	0.70	-	0.70	-	0.70	-
F-Test	3405.14***	-	359.96 ***	-	443.77***	-
Wald-Test (Chi-sq.)	-	4143.71 ***	-	4040.11***	-	4144.20***
ARCH (Chi-sq.)	66.66***	-	69.01***	-	69.74***	-
BG-Autoc. (Chi-sq.)	6.10**	-	5.97***	-	6.04***	-
Durb. Autoc. (Chi-sq.)	6.12**	-	5.97***	-	6.04***	-
RESET (F)	0.63	-	0.72	-	0.63	-

Note: Newey-West autocorrelation and heteroskedasticity-robust standard errors in brackets (OLS estimations). *, ** and *** show significance at the 10%-, 5%-, and 1%-level, respectively.

Table 6 Results Utility Portfolio II

	Equation (5)	*GARCH (1,1) Eq. (6)/(7)*	*GARCH (1,1) Eq. (8)/(9)*	*Equation (5) parsimonious*	*GARCH (1,1) Eq. (6)/(7) parsimonious*	*GARCH (1,1) Eq. (8)/(9) parsimonious*
Mean Equation						
α_i	0.00** (0.00)	0.00*** (0.00)	0.00*** (0.00)	0.00** (0.00)	0.00** (0.00)	0.00** (0.00)
β_{1i} **(market)**	0.76*** (0.02)	0.76*** (0.01)	0.77*** (0.01)	0.76*** (0.02)	0.77*** (0.01)	0.77*** (0.01)
β_{2i} **(oil)**	-0.03*** (0.01)	-0.02*** (0.01)	-0.02*** (0.01)	-0.03*** (0.01)	-0.02*** (0.01)	-0.02*** (0.01)
β_{3i} **(gas)**	0.01 (0.01)	0.00 (0.00)	0.00 (0.00)	0.01* (0.00)	-	-
β_{4i} **(interest rate)**	0.06 (0.06)	0.06 (0.05)	0.05 (0.05)	-	-	-
β_{5i} **(exchange rate)**	0.07** (0.03)	0.07** (0.03)	0.07** (0.03)	0.07** (0.03)	0.07** (0.03)	0.07** (0.03)
γ_{1i} **(oil volatility)**	-0.31 (0.26)	-0.25 (0.23)	-0.25 (0.23)	-	-	-
γ_{2i} **(gas volatility)**	-0.01 (0.02)	-0.01 (0.02)	-0.01 (0.02)	-	-	-
Variance Equation						
a_i	-	0.00*** (0.00)	-13.84*** (0.33)	-	0.00*** (0.00)	0.00*** (0.00)
b_i **(GARCH (1) term)**	-	0.91*** (0.01)	0.91*** (0.01)	-	0.91*** (0.01)	0.91*** (0.01)
c_i **(ARCH (1) term)**	-	0.06*** (0.01)	0.06*** (0.01)	-	0.06*** (0.01)	0.06*** (0.01)
d_{2i} **(oil volatility)**	-	-	-1102.98 (959.74)	-	-	-
d_{3i} **(gas volatility)**	-	-	-8.87 (51.44)	-	-	-
Obs.	1466	1466	1466	1466	1466	1466
R-squared	0.70	-	-	0.70	-	-
F-Test	495.91***	-	-	443.77***	-	-
Wald-Test (Chi-sq.)	-	4054.80***	4042.66***	-	4144.20***	4144.20***
ARCH (Chi-sq.)	69.10***	-	-	69.74***	-	-
BG-Autoc. (Chi-sq.)	6.18**	-	-	6.04***	-	-
Durb. Autoc. (Chi-sq.)	6.17**	-	-	6.04***	-	-
RESET (F)	0.71	-	-	0.63	-	-

Note: Newey-West autocorrelation and heteroskedasticity-robust standard errors in brackets (OLS estimations). *, ** and *** show significance at the 10%-, 5%-, and 1%-level, respectively.

Table 7 Results Oil and Gas Portfolio I

Oil and Gas	*Equation (3)*	*GARCH (1,1) Equation (3)*	*Equation (4)*	*GARCH (1,1) Equation (4)*	*Equation (4) parsimonious*	*GARCH (1,1) Equation (4) parsimonious*
Mean Equation						
$\alpha_{i,t}$	0.00** (0.00)	0.00*** (0.00)	0.00* (0.00)	0.00*** (0.00)	0.00* (0.00)	0.00*** (0.00)
$\beta_{1i,t}$ (market)	0.75*** (0.02)	0.71*** (0.01)	0.74*** (0.02)	0.72*** (0.02)	0.74*** (0.02)	0.72*** (0.02)
$\beta_{2i,t}$ (oil)	-	-	0.10*** (0.01)	0.08*** (0.01)	0.10*** (0.01)	0.08*** (0.01)
$\beta_{3i,t}$ (gas)	-	-	0.00 (0.00)	0.00 (0.00)	-	-
$\beta_{4i,t}$ (int.)	-	-	0.29*** (0.08)	0.24*** (0.06)	0.29*** (0.08)	0.24*** (0.06)
$\beta_{5i,t}$ (ex. r.)	-	-	0.21*** (0.05)	0.15*** (0.04)	0.21*** (0.05)	0.15*** (0.04)
Variance Equation						
a_i	-	0.00*** (0.00)	-	0.00*** (0.00)	-	0.00*** (0.00)
b_i (GARCH (1) term)	-	0.88*** (0.02)	-	0.89*** (0.02)	-	0.89*** (0.02)
c_i (ARCH (1) term)	-	0.08*** (0.01)	-	0.07*** (0.01)	-	0.07*** (0.01)
Obs.	1466	1466	1466	1466	1466	1466
R-squared	0.54	-	0.57	-	0.57	-
F-Test	1727.74***	-	390.54***	2261.69***	309.57***	-
Wald-Test (Chi-Sq.)	-	2271.07***	-	-	-	2259.80***
ARCH (Chi-sq.)	38.91***	-	36.39***	-	36.78***	-
BG-Autoc. (Chi-sq.)	3.10*	-	0.52	-	0.52	-
Durb. Autoc. (Chi-sq.)	3.10*	-	0.52	-	0.52	-
RESET (F)	3.13**	-	3.94***	-	3.93***	-

Note: Newey-West autocorrelation and heteroskedasticity-robust standard errors in brackets (OLS estimations). *, ** and *** show significance at the 10%-, 5%-, and 1%-level, respectively.

Table 8 Results Oil and Gas Portfolio II

	Equation (5)	*GARCH (1,1) Eq. (6)/(7)*	*GARCH (1,1) Eq. (8)/(9)*	*Equation (5) parsimonious*	*GARCH (1,1) Eq. (6)/(7) parsimonious*	*GARCH (1,1) Eq. (8)/(9) parsimonious*
Mean Equation						
α_i	0.00*	0.00***	0.00***	0.00*	0.00***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
β_{1i} **(market)**	0.74***	0.72***	0.72***	0.74***	0.72***	0.72***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
β_{2i} **(oil)**	0.10***	0.08***	0.08***	0.10***	0.08***	0.08***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
β_{3i} **(gas)**	0.00	-0.00	-0.00	-	-	-
	(0.01)	(0.01)	(0.00)			
β_{4i} **(interest rate)**	0.29***	0.24***	0.24***	0.29***	0.24***	0.23***
	(0.08)	(0.06)	(0.06)	(0.08)	(0.06)	(0.07)
β_{5i} **(exchange rate)**	0.21***	0.15***	0.15***	0.21***	0.16***	0.15***
	(0.05)	(0.04)	(0.04)	(0.05)	(0.04)	(0.04)
γ_{1i} **(oil volatility)**	-0.88***	-0.73***	-0.73***	-0.89***	-0.73**	-0.71***
	(0.32)	(0.28)	(0.28)	(0.32)	(0.28)	(0.28)
γ_{2i} **(gas volatility)**	0.01	0.02	0.02	-	-	-
	(0.03)	(0.03)	(0.03)			
Variance Equation						
a_i	-	0.00***	-12.92***	-	0.00***	-12.52***
		(0.00)	(0.39)		(0.00)	(0.28)
b_i **(GARCH (1) term)**	-	0.89***	0.89***	-	0.89***	0.87***
		(0.02)	(0.02)		(0.02)	(0.03)
c_i **(ARCH (1) term)**	-	0.07***	0.07***	-	0.07***	0.08***
		(0.01)	(0.01)		(0.01)	(0.01)
d_{2i} **(oil volatility)**	-	-	-66.69	-	-	-
			(655.26)			
d_{3i} **(gas volatility)**	-	-	-34.89	-	-	-
			(103.52)			
Obs.	1466	1466	1466	1466	1466	1466
R-squared	0.57	-	-	0.57	-	-
F-Test	281.15***	-	-	227.08***	-	-
Wald-Test (Chi-sq.)	-	2266.57***	2258.37***	-	2263.11***	1756.91***
ARCH (Chi-sq.)	36.70***	-	-	37.92***	-	-
BG-Autoc. (Chi-sq.)	0.87	-	-	0.86	-	-
Durb. Autoc. (Chi-sq.)	0.86	-	-	0.85	-	-
RESET (F)	3.43**	-	-	3.47**	-	-

Note: Newey-West autocorrelation and heteroskedasticity-robust standard errors in brackets (OLS estimations). *, ** and *** show significance at the 10%-, 5%-, and 1%-level, respectively.

Table 9 Model Stability Utility Portfolio (Equation (5) parsimonious)

	2002	*2002-2003*	*2002-2004*	*2002-2005*	*2002-2006*	*Full Sample Period*
α_i	-0.00	0.00	0.00	0.00**	0.00**	0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
β_{1i} **(market)**	0.68***	0.73***	0.73***	0.74***	0.76***	0.76***
	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)
β_{2i} **(oil)**	-0.06**	-0.05***	-0.03***	-0.03***	-0.03***	-0.03***
	(0.03)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
β_{3i} **(gas)**	0.03**	0.01	0.01	0.01	0.01	0.01*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)
β_{4i} **(interest rate)**	-	-	-	-	-	-
β_{5i} **(exchange rate)**	-0.00	0.06	0.08	0.07**	0.07**	0.07**
	(0.10)	(0.06)	(0.04)	(0.03)	(0.03)	(0.03)
γ_{1i} **(oil volatility)**	-	-	-	-	-	-
γ_{2i} **(gas volatility)**	-	-	-	-	-	-
Obs.	260	521	783	1043	1303	1466
R-squared	0.74	0.75	0.73	0.71	0.71	0.70
F-Test	115.90***	250.07***	292.49***	331.95***	397.60***	443.77***

Note: Newey-West autocorrelation and heteroskedasticity-robust standard errors in brackets (OLS estimations). *, ** and *** show significance at the 10%-, 5%-, and 1%-level, respectively.

Table 10 Model Stability Oil and Gas Portfolio (Equation (5) parsimonious)

	2002	*2002-2003*	*2002-2004*	*2002-2005*	*2002-2006*	*Full Sample Period*
α_i	0.00	0.00	0.00**	0.00***	0.00*	0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
β_{1i} **(market)**	0.60***	0.63***	0.64***	0.66***	0.72***	0.74***
	(0.03)	(0.03)	(0.02)	(0.02)	(0.03)	(0.02)
β_{2i} **(oil)**	0.01	-0.00	0.01	0.05***	0.10***	0.10***
	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
β_{3i} **(gas)**	-	-	-	-	-	-
β_{4i} **(interest rate)**	0.62***	0.50***	0.35***	0.28***	0.30***	0.29***
	(0.17)	(0.10)	(0.10)	(0.09)	(0.09)	(0.08)
β_{5i} **(exchange rate)**	0.12	0.09	0.10**	0.08*	0.18***	0.21***
	(0.13)	(0.07)	(0.05)	(0.05)	(0.05)	(0.05)
γ_{1i} **(oil volatility)**	-1.39***	-0.97***	-0.78**	-0.88***	-0.86***	-0.89***
	(0.43)	(0.36)	(0.28)	(0.29)	(0.32)	(0.32)
γ_{2i} **(gas volatility)**	-	-	-	-	-	-
Obs.	260	521	783	1043	1303	1466
R-squared	0.68	0.70	0.65	0.60	0.57	0.57
F-Test	124.05***	180.91***	197.76***	207.69***	197.49***	227.08***

Note: Newey-West autocorrelation and heteroskedasticity-robust standard errors in brackets (OLS estimations). *, ** and *** show significance at the 10%-, 5%-, and 1%-level, respectively.

Table 11 Results Oil and Gas Portfolio with Structural Change in Oil Beta (January 2004)

	Equation (4)	*Equation (5)*	*GARCH (1,1) Eq. (8)/(9)*	*Equation (4) parsimonious*	*Equation (5) parsimonious*	*GARCH (1,1) Eq. (8)/(9) parsimonious*
Mean Equation						
α_i	0.00*	0.00	0.00***	0.00*	0.00	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
β_{1i} **(market)**	0.75***	0.75***	0.73***	0.75***	0.75***	0.73***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
β_{2i} **(oil)**	-0.01	-0.01	-0.00	-0.01	-0.01	-0.00
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
β_{2i} **(oil) x dummy_2004**	0.18***	0.18***	0.14***	0.18***	0.18***	0.14***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
β_{3i} **(gas)**	0.00	-0.00	-0.00	-	-	-
	(0.00)	(0.01)	(0.00)			
β_{4i} **(interest rate)**	0.27***	0.27***	0.23***	0.27***	0.27***	0.24***
	(0.08)	(0.08)	(0.06)	(0.08)	(0.08)	(0.06)
β_{5i} **(exchange rate)**	0.22***	0.22***	0.16***	0.22***	0.22***	0.16***
	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)	(0.04)
γ_{1i} **(oil volatility)**	-	-0.80***	-0.66**	-	-0.81***	-0.66**
		(0.30)	(0.30)		(0.30)	(0.30)
γ_{2i} **(gas volatility)**	-	0.02	0.02	-	-	-
		(0.03)	(0.02)			
Variance Equation						
a_i	-	-	-12.76***	-	-	0.00***
			(0.36)			(0.00)
b_i **(GARCH (1) term)**	-	-	0.89***	-	-	0.88***
			(0.02)			(0.02)
c_i **(ARCH (1) term)**	-	-	0.07***	-	-	0.07***
			(0.01)			(0.01)
d_{2i} **(oil volatility)**	-	-	-99.00	-	-	-
			(654.42)			
d_{3i} **(gas volatility)**	-	-	36.00	-	-	-
			(90.47)			
Obs.	1466	1466	1466	1466	1466	1466
R-squared	0.59	0.59	-	0.59	0.59	-
F-Test	205.67***	265.15***	-	246.71***	206.20***	-
Wald-Test (Chi-sq.)	-	-	2350.39***	-	-	2358.09***
ARCH (Chi-sq.)	31.89***	32.52***	-	32.13***	32.56***	-
BG-Autoc. (Chi-sq.)	0.00	0.06	-	0.00	0.05	-
Durb. Autoc. (Chi-sq.)	0.00	0.06	-	0.00	0.05	-
RESET (F)	4.09***	3.43**	-	4.08***	3.52**	-

Note: Newey-West autocorrelation and heteroskedasticity-robust standard errors in brackets (OLS estimations). *, ** and *** show significance at the 10%-, 5%-, and 1%-level, respectively.