CRUDE OIL AND OIL-RELATED TURKISH COMPANY STOCKS: A VOLATILITY ANALYSIS

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Abstract

This paper investigates the impact of Brent crude oil price fluctuations on three companies trading in the Turkish stock market, which have different levels of exposure to the crude oil market. We introduce a novel bivariate asymmetric quadratic GARCH model, which serves as a tool for our analysis. In a first step, we find evidence for asymmetric behavior of company stock volatility with respect to upward and downward trends of crude oil and stock prices. The asymmetric conditional volatility model is then used to assess the immediate impact of oil price changes on stock volatility. The model enables us to clearly differentiate between conditional volatility patterns and allows a quantification of the phenomenon of bivariate asymmetric news impact on volatility. Some of our findings can be readily related to recent hypotheses in the area of behavioral finance.

Key words: Crude oil price volatility, stock price volatility, Turkish stock market, bivariate asymmetric quadratic GARCH, conditional volatility, behavioral finance.

1 Introduction

1.1 Crude Oil and the Macroeconomy

Following the fluctuations of crude oil prices in the 1970s (the time when political events in the Middle East and supply policies of the OPEC were dominating the prices), macroeconomic effects of crude oil price movements became a topic of utmost importance. However, there is still no consensus as to the exact effects of oil price volatility on economy.

One direction of research concerns the question whether crude oil price fluctuations may have an inflationary effect. On the one hand, Abel and Bernanke (2005) state that an increase in the price of oil is followed by a "burst in inflation". Moreover, Gisser and Goodwin (1986) provide evidence that not only inflation is affected by oil price shocks, but also some other major macroeconomic variables carry the impact of oil price movements as well. On the other hand, in their study of the US economy, Barsky and Kilian (2004) report that oil price fluctuations are not sufficient to explain inflationary movements.

Another macroeconomic concept that is argued over for being vulnerable to oil prices is GDP. Olson (1988) and Barsky and Kilian (2004) find that crude oil price fluctuations cannot account

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for economic slowdowns, pointing to the low portion of oil costs relative to other goods in GDP. However, there are also studies that point to the opposite. Pirog (2005) tries to shed light on this phenomenon from two different perspectives. First, if monetary policy makers take this increase as a catalyst of inflation, they may adopt a tight monetary policy which slows down the economy's growth. Alternatively, given a probable inelasticity of oil demand, consumers may cut their spendings on other goods to save money for oil consumption, which will also reduce GDP growth. Hooker's (1999) findings are in line with Pirog's explanations. According to him, there is a clear effect of oil prices on GDP performance before 1980 (a time of high volatility of crude oil prices), but after 1980, oil prices influenced GDP through cautionary monetary actions.

1.2 Crude Oil and the Stock Market

Apart from macroeconomic discussions, our aim in this paper is to find out whether there is an interaction between oil price changes and certain stock price movements, namely those of Turkish oil-related companies, in terms of volatility. Before proceeding to our methodology and empirical results, some explanations concerning possible reasons for the vulnerability of Turkish oil-related companies' stocks to crude oil price changes are in order.

A simple but straightforward idea as to why stocks of oil-related companies can be influenced by oil prices is related with these companies' earning prospects as oil is either the most important factor of production or primary good for oil-related companies. In case of a price shock, oil-related companies may need to reduce their final output owing to the increased input price. Rotemberg and Woodford (1996) point to this fact and find that a 10% increase in oil prices actually reduces the output by 2.5% after five or six quarters in the case of the US. Also Elwood (2001) states, in an aggregate supply and demand framework, that oil price increases lead to a decrease in the supply of output, especially in oil importing countries. Intuitively, in case of an oil price decrease, oil firms may increase their outputs to benefit from increased profit margins.

While firms may react to price changes by controlling their output levels, how the stock markets evaluate these price fluctuations and whether these fluctuations lead to volatility in stocks of oil-related companies are more important questions as far as our paper is concerned. At this step, the above discussion of earnings is a crucial point for stock markets' reaction to crude oil price changes, in the sense that all the news are priced in the market. In its broadest form, stock prices are discounted values of investors' future earnings expectations of a firm (Huang, Masulis and Stoll, 1995). Driesprong, Jacobsen and Maat (2005) state that oil price changes influence not only future earnings of a company, but also discount rates that investors use to discount those future earnings. Moreover, if these companies operate in the oil sector, the effect will be much stronger. At this point, the assumption of homogenous behavior of actors in stock markets becomes pivotal. If the investors act in this way, they will all process and understand the information, which is the change in oil prices, in the same way and reach the same future prospect for earnings, adjusting the price to a level that reflects their joint prospect of earnings reflect. This behavioral assumption leads to two implications: firstly, earnings have to fully reflect the change in stock prices, and secondly, there should be no volatility in the stock after a piece of news is announced (in other words, a change in oil price has occurred) as there will be a one time adjustment of stock prices. However, Jones and Kaul (1996), Sloan (1996) and Brown and Han (2000) provide evidence that this relationship between future earnings and stock doesn't hold all the time, thus, there is no homogenity in the market. A good explanation as to why this relationship may not hold can be provided by invoking the Gradual Information Diffusion Hypothesis (GIDH) proposed by Hong and Stein (1999): If investors are having difficulties in assessing the impact of news (change in oil prices) on stock prices or react at different times, an underreaction or overreaction following the news may occur. Empirical evidence for this hypothesis in the case of oil price movements is put forward by Driesprong, Jacobsen and Maat (2005). They show that stocks react immediately to changes in oil prices and tend to get lower after an oil price increase and higher after an oil price decrease, adding that this reaction also depends on whether the country is a net energy importer.

Driesprong, Jacobsen and Maat's (2005) findings are clear indicators of the existence of volatility in the stocks that occurs when the oil price changes; if the investors underreact to oil prices as a result of difficulties they have in assessing impacts of changing oil prices on oil-related companies' stocks or moving at different times, a correction must follow this underreaction as some investors will try to exploit possible arbitrage opportunities. As Hong and Stein (1999) propose, these exploiting activities lead to overreaction due to excessive movements. Naturally, further correction movements and trials of exploiting arbitrage opportunities will occur until the stock prices stabilize. In this sense, it becomes obvious that it is not unreasonable to presume that oil price changes may lead to volatiliy in oil-related companies' stocks.

From an earnings point of view, we can also reach the same conclusion that impact on volatility is expected when news is announced (an oil price change occurs). Given that investors assess the available information in different ways or at different times, their expectations for future earnings will differ as well. In this sense, investors with different expectations will have different views as to where a fair stock price should be. The trading activities will continue until investors agree on the prices, and until that time the stock prices may move in either direction. Shane and Brous (2001) suggest that investors may agree on the price in two different ways: Either they may change their stock price expectations due to additional news, or their prospects for future earnings are affected by extra information from sources outside the oil market — such as private discussions or disclosures of company activities.

2 The Companies Under Investigation

Providing some brief but important characteristics of the firms under investigation will prepare the ground for an assessment of the impact of crude oil price movements on stock volatility.

2.1 Tüpraş

Founded in 1983, Tüpraş is Turkey's largest and Europe's eighth largest oil refiner with an annual oil processing capacity of 27.6 million tons. Currently, the company owns four oil refineries and one petrochemicals facility in Turkey. The company processed 26.2 million tons of crude oil in 2006, reaching a capacity usage of 94.9%. Tüpraş operates also in related fields such as oil derivative distribution (Opet) and crude oil transportation (Ditaş).

Currently, 51% of Tüpraş is owned by Enerji Yatırımları A.Ş (the Koç-Shell joint venture's subsidiary for investments in the energy sector) and 49% is publicly trading. The large volume of public access to this company makes it an interesting object for analysis in our study, as the impact of investors is likely to be seen in stock quotations.

2.2 Petrol Ofisi

The main business areas of the company are the distribution of oil-related products (mostly fuel) through its numerous gas stations (3584), and the production of some of these commodities, in two naphta plants, 11 fuel and one LPG terminals and 28 air supply facilities. According to their 2006 annual report, Petrol Ofisi is the Turkish leader in the fuel distribution market, with a share of 39% (8 million tons). As of December 2006, the ownership structure of Petrol Ofisi was as follows: 52.73% Doğan Holding, 34% OMV Aktiengesellschaft, 13.27% publicly trading. Petrol Ofisi is embedded in a vast trade network for oil derivatives to guarantee continuity of supply, leading to a lesser immediate exposure to oil price shocks. The fact that only 13% of Petrol Ofisi is publicly owned can be expected to further reduce the magnitude of oil price shock impact on company stock price volatility.

2.3 Turkcell

Founded in 1993, Turkcell focuses on telecommunication services. The company currently has 32.8 million clients all over the country, being the largest GSM operator of Turkey. As of May 2007, 71.61% of Turkcell was privately owned by holdings, while 24.39% was publicly trading. It should be mentioned that Turkcell is the company which represents the largest weight in the stock index İMKB100. We are including Turkcell stock in our study as a control device for our modeling efforts — crude oil price shocks should not have the same impact on Turkcell as they have on the other companies under investigation.

3 Trend and Volatility

Is there a relationship between the direction of oil and stock price trends on the one hand, and the magnitude of stock price volatility on the other? This section explores whether volatilities of Turkish oil-related company stocks behave differently under several joint trend scenarios.

For their sample period of 1976–2000, Wei and Zhang (2006) show that stock return volatility is negatively related to earnings. This suggests that volatility is trend-specific: During an upward trend in crude oil prices, which depresses future earnings, the volatility of the stock return can be expected to increase as well. We are therefore going to investigate whether the volatilities of Turkish oil and oil-related company stock prices are trend-specific. We proceed as follows. For each of the assets we considered (Tüpraş, Petrol Ofisi, Turkcell, İMKB100, and Brent crude oil):

- A trend line is computed by applying a one-sided moving average smoother (a linear filter) to the logged series of weekly prices in question. (Throughout our study, we use data from the years 1995–2007.) The filter has a length of 50, with weights decreasing linearly, attaching more weight to more recent observations. We used the logarithm of the original series because the resulting trend properties are more distinct in the case of an exponentially increasing series.
- A week belongs to an upward (downward) trend if the differenced smoothed series for that week is positive (negative).

See Figure 1 for an example. Next, we consider pairs of Brent crude oil and a company stock. There are four trend combinations for each given pair: Brent trend up/down; stock trend up/down. To see if the volatility of a stock is trend-specific, i.e. if the volatility of returns is different for different trend combinations, a (univariate) GARCH(1,1) model is fitted to the series of weekly returns on a stock and on Brent. This model yields a series of conditional standard deviations. An average conditional standard deviation is then computed for each trend combination. The results of this procedure are given in Table 1. This table shows overall

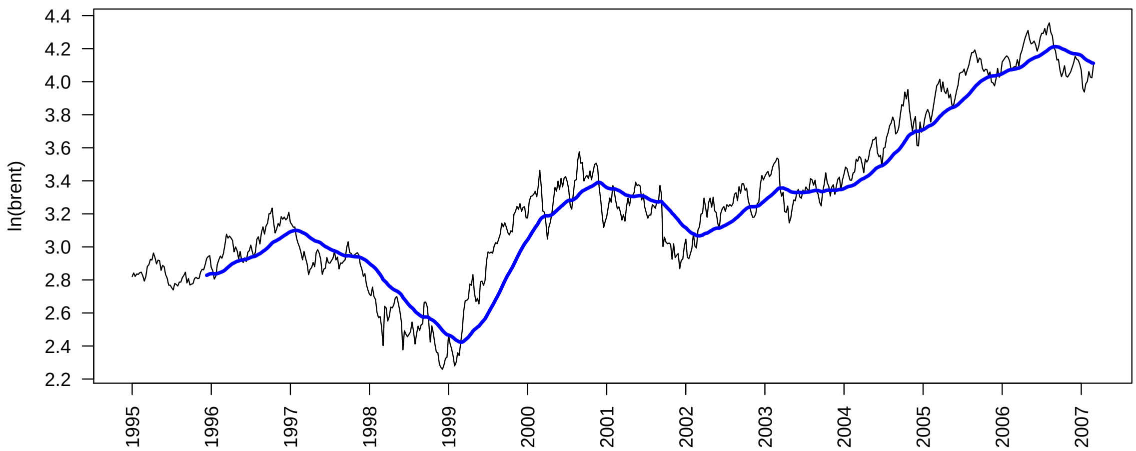

Figure 1: Brent crude oil: Logged price series and its trend

Brent trend		up	down	up	down	
stock trend		up	up	down	down	overall
Tüpraş	avg.csd.	7.52	10.70	7.27	7.58	8.37
Petrol Ofisi	avg.csd.	10.89	11.76	8.64	9.18	10.50
Turkcell	avg.csd.	6.67	8.92	7.67	7.97	7.29
İMKB100	avg.csd.	6.08	7.13	6.26	7.34	6.51

Table 1: Trend-specific average conditional volatilities

average conditional standard deviation (avg.csd), as well as for trend combinations[1].

For an assessment of these results, it is advisable to reduce the information contained in Table 1 by retaining only the signs (+ or −) of the deviation from the overall avg.csd values; this leads us to Table 2. Using this table, we observe a clear difference in the volatility behaviour between oil-related companies and Turkcell: The former show a decreased level of risk in the case of a downward trend, while the latter's risk is above average in the case of a downward period. Thus our results do not confirm the conclusions obtained by Wei and Zhang (2006) in this respect. Our results indicate asymmetry in the volatility of stocks with respect to the price trend of the stock: It is of relevance for the volatility of company stock whether we are in an upward or in a downward trend. In addition, the effects of trends of Brent crude oil prices and company stock may interact.

However, evidence for this kind of asymmetry and interaction was found only indirectly — using two separate, univariate, symmetric models to obtain conditional standard deviations; asymmetry was then found by averaging conditional standard deviations over different periods. This approach does not permit a study of the direct impact of news (i.e., past returns) on future risk. In addition, an analysis based on trends is intrinsically limited to long-term developments and cannot capture sudden effects. A further disadvantage is that focusing on the dichotomy upward/downward trend wastes information on the effect of gradual shifts in return magnitude on the next period's risk. In what follows, we shall undertake an analysis based on a model which remedies these disadvantages.

[1] Applying a significance test leads, in all cases, to the rejection of the null hypothesis that overall and a trend-specific conditional standard deviation are actually equal.

oil-related companies:

		Brent trend up	Brent trend down
stock trend	up	+/−	+
	down	−	−

Turkcell:

		Brent trend up	Brent trend down
stock trend	up	−	+
	down	+	+

Table 2: Trend-specific direction of volatility deviation

4 News Impact on Volatility

The general purpose of GARCH models is to analyze the conditional volatility (standard deviation) of a time series in a dynamic way. GARCH processes are models for phenomena in time which display a certain form of heteroskedasticity.

4.1 The One-Dimensional GARCH Model

The classical GARCH(1,1) process[2] is

$$\epsilon_t = \sqrt{h_t} \cdot \nu_t, \quad h_t = \alpha_0 + \alpha_1 \epsilon_{t-1}^2 + \beta h_{t-1}, \tag{1}$$

where (ν_t) is white noise with $\text{var}(\epsilon_t) = 1$ and $\alpha_0, \alpha_1, \beta_1$ are non-negative parameters with $\alpha_1 + \beta_1 < 1$. The conditional variance of ϵ_t is then given by $\text{var}(\epsilon_t | \epsilon_{t-1}, \epsilon_{t-2}, \dots) = h_t$. A model for returns on stocks can then often be constructed as $X_t = c + \epsilon_t$, where (ϵ_t) is a GARCH process and c is a constant.

A very important topic in our context is news impact. This means: How does this period's (mean-corrected) return ϵ_t influence the next period's volatility? For a GARCH(1,1) model, the news impact function is given by[3]

$$x \mapsto \alpha_0 + \alpha_1 x^2 + \beta \sigma^2, \tag{2}$$

according to the conditional variance specification h_t in equation (1). Here, σ^2 is the unconditional variance of the process. This reveals a serious limitation of the GARCH(1,1) model: News impact is symmetric in the sense that there is no difference in news impact between positive and negative news, that is, it is not relevant for h_t whether ϵ_{t-1} is positive or negative. This is in many situations implausible. Furthermore, we need a bivariate model, because we are interested in the joint behaviour of crude oil prices and Turkish companies' stock prices. In short, we need a bivariate model which is capable of allowing for asymmetric news impact.

4.2 The baqGARCH (Bivariate Asymmetric Quadratic GARCH) Model

The following model suits our purposes:

$$\epsilon_t = \mathtt{H}_t^{-1/2} \cdot \nu_t, \tag{3}$$

where (ν_t) is a bivariate white noise process with $\text{cov}(\nu_t) = \mathtt{I}$ (the 2×2 unity matrix) and

$$\mathtt{H}_t \ = \ \mathtt{C}'\mathtt{C} \ + \ \mathtt{A}'\epsilon_{t-1}\epsilon_{t-1}'\mathtt{A} \ + \ \mathtt{B}'\mathtt{H}_{t-1}\mathtt{B} \ + \ S_w(\epsilon_{t-1}) \cdot \Gamma'\epsilon_{t-1}\epsilon_{t-1}'\Gamma \tag{4}$$

[2] Engle (1982), Bollerslev (1986); see also Tsay (2003).
[3] Univariate news impact is investigated systematically in Engle and Ng (1993).

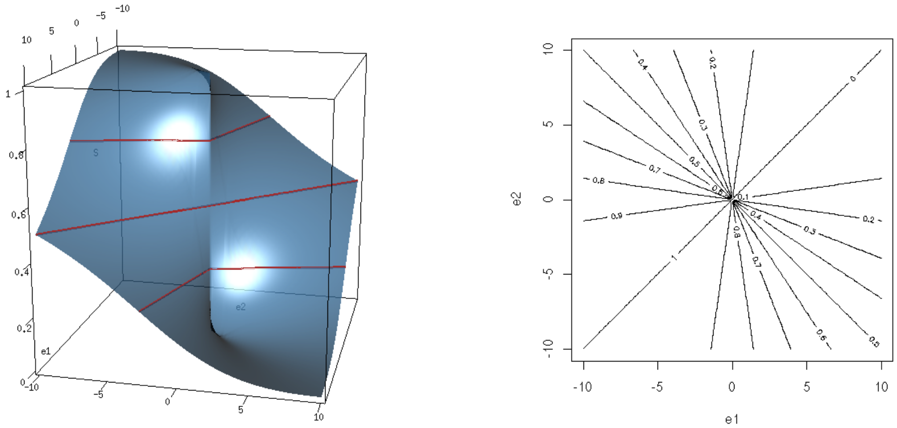

Figure 2: The weight function S_w

with parameter matrices $\mathtt{C} = (c_{ij})$ $(c_{21} = 0)$, $\mathtt{A} = (a_{ij})$, $\mathtt{B} = (b_{ij})$, $\Gamma = (\gamma_{ij})$ $(i, j = 1, 2)$. S_w is a weight function which is defined as

$$S_w(e_1, e_2) = 0.5 - \frac{\cos(\frac{\pi}{4} + w) \cdot e_1 + \sin(\frac{\pi}{4} + w) \cdot e_2}{2\sqrt{e_1^2 + e_2^2}}, \text{ if } e_1^2 + e_2^2 \neq 0, \text{ and } = 0 \text{ otherwise.} \tag{5}$$

The graph of this function and its contour lines are displayed in Figure 2. The parameter w in the weight function S_w determines the angle for which the (mean-corrected) return vector (e_1, e_2) leads to an excess impact on next period's volatility[4]. We call the model defined by (3), (4), and (5) the baqGARCH (bivariate asymmetric quadratic GARCH) model. This model can be seen as a generalization of the BEKK model (see Engle and Kroner, 1995; Bauwens et al., 2003) to allow for asymmetry in the volatility specification; the BEKK model is similar but has no S_w term. (Actually, our model nests the BEKK model.) It can also be seen as an extension of the GJR model (Glosten, Jaganathan and Runkle, 1993) to two dimensions.

The matrix $\mathtt{H}_t$ is the conditional covariance matrix of ϵ_t, given $\epsilon_{t-1}, \epsilon_{t-2} \ldots$. A model for a bivariate series of returns on stocks is $X_t = M_t + \epsilon_t$, where M_t is a conditional mean specification in case the two series display cross- and/or autocorrelation, or a constant if the series are uncorrelated. (The latter case holds for the examples we consider below.)

In a broad sense, news impact on volatility can then be studied in the baqGARCH model by letting the conditional volatility matrix $\mathtt{H} = (h_{ij})$ depend on $x = (x_1, x_2)$:

$$x \mapsto \mathtt{H}(x) \ = \ \mathtt{C}'\mathtt{C} \ + \ \mathtt{A}'xx'\mathtt{A} \ + \ \mathtt{B}'\Sigma\mathtt{B} \ + \ S_w(x) \cdot \Gamma' x x' \Gamma, \tag{6}$$

where Σ is the unconditional covariance matrix of the process, in analogy to (2). Since the focal point of our analysis in the present paper is an investigation of shocks on next week's volatility forecast of company stock (which is represented by the second component in x), we restrict our attention to the news impact function (NIF)

$$x \mapsto h_{22}(x), \tag{7}$$

which is the conditional volatility of company stock. Contour lines of this function are displayed in Figures 3 and 4.

[4] For details of the construction of S_w, see Schmidbauer (2008).

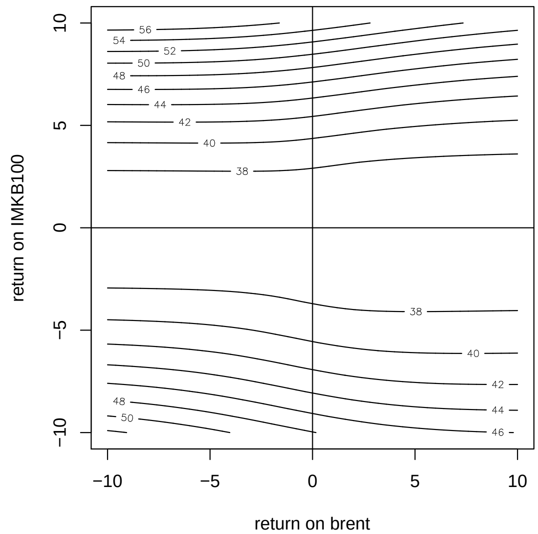

Figure 3: News impact function, İMKB100

5 Empirical Results

We are now in a position to investigate the impact of Brent crude oil price changes on the stock market volatility, using data from 1995 through 2007. We begin with İMKB100, being a summary measure of the Turkish stock market. After that, we shall again turn to the main aim of our study, namely the investigation of the interdependence between Brent crude oil prices and oil-related companies' stocks: Tüpraş and Petrol Ofisi, and non-oil related Turkcell for comparison.

5.1 Brent Crude Oil and the Stock Index İMKB100

The two time series involved are:

- weekly returns on Brent crude oil (i.e., price changes in percent),
- weekly returns on İMKB100.

We use data from the first week in January of 1995 to mid-January of 2007. The parameters obtained when fitting the baqGARCH model to this bivariate series and are given in the Appendix. The news impact function on the variance of next week's returns on İMKB100 is shown in Figure 3. The weekly returns (price changes) on Brent crude oil are shown on the abscissa axis, while the ordinate axis refers to returns on İMKB100 for the same week. The lines depicted in the figure are contour lines of the news impact function, that is, the variance forecast for returns on İMKB100 for the next week, given this week's returns on Brent and İMKB100.

The contour lines are not equally dense for positive and negative price changes of Brent. This indicates an asymmetry in the following way: It is of relevance for next week's İMKB100 volatility if Brent prices have increased or decreased this week — with a tendency towards higher volatility if Brent prices have fallen. Further asymmetry can be observed with respect to returns on İMKB100 itself — a gain in İMKB100 this week will tend to increase İMKB100 volatility for the next week more than a loss does.

It is fair to ask if the shape of the news impact function displayed in Figure 3 is warrented by the observed bivariate series of returns on Brent and İMKB100. To discuss this question, we

	Brent return area		
	56	50	53
İMKB100 return area	39	39	38
	54	50	42

Table 3: Average variance forecasts by previous week's returns

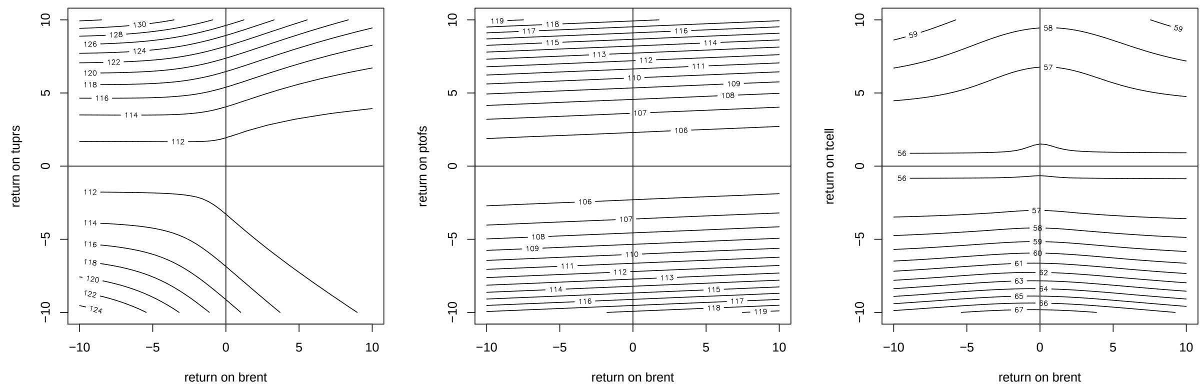

Figure 4: News impact functions: Tüpraş, Petrol Ofisi, Turkcell

proceed as follows. As in the previous chapter, we fitted a univariate GARCH(1,1) process to each return series. This operation yields two series of conditional standard deviations. For each week, we have thus the following data: (i) the return on Brent, (ii) the return on İMKB100, and (iii) the conditional variance (the variance forecast) for the next week's return on İMKB100.

The (two-dimensional) plane of returns was then divided into nine fields, according to the position of the returns (for each return r_1, r_2: $r_i \in (-\infty, -3)$, $r_i \in [-3, +3]$, $r_i \in (+3, +\infty)$), and an average conditional variance (an average variance forecast) was computed for each field. In other words, conditional variance is stratified with respect to bivariate returns. The resulting nine averages are given in Table 3. A visual inspection of Figure 3 reveals that the numerical values in Table 3 reproduce the pattern of contour lines. We interprete this as strong evidence that the baqGARCH model is able to describe the series of joint weekly returns on Brent crude oil and İMKB100 appropriately.

We shall now investigate the impact of crude oil price changes on company stock volatility, again using the news impact functions (NIFs) as exhibited in Figure 4.

5.2 Brent Crude Oil and Tüpraş

A hefty impact of crude oil prices on Tüpraş stock volatility is to be expected according to our discussion in the introduction, in particular according to the GIDH. We shall now interpret the four quadrants of the NIF in terms of possible investor behavior, referring to our previous discussions.

While oil prices decrease and Tüpraş stock prices increase (the second quadrant of the NIF), we have observed that the volatility for the next week — thus, the risk level — increases as well: Investors facing decreased oil prices will expect an increase in the profit margin of Tüpraş and consequently be led to demand more Tüpraş stock, thus increasing the trading volume of the stock. High trading activities naturally increase the stocks' movement, in other words, volatility.

We observe (in the fourth quadrant of the NIF) that while bad news is received from both the crude oil market (an increase of prices) and Tüpraş (a loss in stock price), the risk level stays the same or even decreases. This phenomenon has two possible explanations. The first invokes behavioral finance: Thaler and Johnson (1990) state that investors may shift to risk seeking behavior in the case of losses, based on prospect theory (Kahneman and Tversky, 1979). Thus, those investors who already own Tüpraş stock may stick to their stocks —in other words, take the risk of losing more — hoping the stock's future returns will cover the losses they already have incurred. The second explanation is that investors who see that Tüpraş stock is losing may stay away from the company stock in expectation of depressed earnings and therefore refrain from buying that company's stock. In any case, a lower trade volume, which leads to low volatility, will result.

The lower-left corner of Tüpraş's NIF (third quadrant; both prices decrease) is very much in line with GIDH's assumption that investors may have difficulties in assessing the news, and act non-homogeneously as a consequence. Investors' different attitudes to the same news (the hope that decreasing crude oil prices may be beneficial for company's future earnings vs. the fear that Tüpraş's stock returns will continue getting depressed) will add to stock volatility.

The case when both stock returns and crude oil prices increase (the first quadrant) is very similar to the previous case (with reversed signs). Difficulties in comparing the effects of these conflicting price movements will incite trading activities in both sides (long and short) and create additional volatility.

5.3 Brent Crude Oil and Petrol Ofisi

As explained in Section 2, a change in the price of crude oil is expected to have at least an indirect effect on Petrol Ofisi, albeit less pronounced than on Tüpraş. Indeed, the NIF of Petrol Ofisi shows only a minor influence of the oil price. It is interesting to note that the steepest ascent of the NIF is again in the case of conflicting price movements (second and fourth quadrant of the NIF). Picking up on our discussion in Section 2, we can invoke crude oil stocks to explain this effect: If the company holds high enough stocks for use in case of a crude oil price hike — which increases the output price of Petrol Ofisi's suppliers —, then investors may not feel the need to change their expectations regarding future earnings of the company[5].

5.4 Brent Crude Oil and Turkcell

Even though Turkcell's product range is not related to oil, its NIF does show a slight impact of crude oil. The NIF reveals that the direction of the oil price movement is irrelevant, and an impact of oil prices is present only in a week after Turkcell stock price increased. This phenomenon may be due to possible investor perception that Turkcell is vulnerable to changes in oil prices via their macroeconomic effects or effects on the entire stock market. Similar to Petrol Ofisi, this conditional risk can be related to the company's own dynamics, and an event study may identify the driving forces. This topic is beyond the scope of the present study.

[5]Rajgopal and Venkatachalam (1998) state that large firms can pass on their increased costs to customers easily. However, this mechanism may be mitigated in the case of Petrol Ofisi, due to competition in the oil distribution market.

6 Conclusions

In this study we investigated the behavior of pairs of time series. The first and second component consist of weekly price changes of Brent crude oil and weekly returns on company stock, respectively, for the years 1995–2007. The main goal of this analysis is to assess the news impact on the company stock price volatility, where the term *news* means: this week's price changes of (i) Brent crude oil and (ii) company stock; by *volatility* we mean the volatility forecast for the next week.

Technically, we use a novel model, which we call the bivariate asymmetric quadratic GARCH model. We could demonstrate that the model is capable of reproducing extant volatility patterns, revealed by stratifying conditional volatilities with respect to joint returns.

Three Turkish companies are chosen for the present study: Tüpraş, an oil refiner, Petrol Ofisi, a distributor of oil-related products, and Turkcell, a telecommunications operator which is not directly related to crude oil. We found distinctive features in the pattern of news impact for these three companies, which are in line with hypotheses derived from recent economic literature. For example, we found that news impact is strongest in the case of Tüpraş, for which we further found that decreasing oil prices implicate the highest extra risk. News impact with respect to crude oil price movements was less pronounced in the case of the other two companies.

Further research with a similar scope may be undertaken with samples of companies in other countries and diverse stock markets. Furthermore, it would be desirable to confirm our results on the basis of event studies, which explicitly model investor behavior. Finally, the distinct risk structure of companies with respect to oil price movements will have implications for portfolio management as well as for economic policy formulation. These are wider topics, which are beyond the scope of our present investigation.

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Appendix: The Fitted Models

The following table shows the estimated parameters of the fitted models. The numbers in parentheses are the t values of the estimates. The fitted models were obtained by excluding parameters in a stepwise procedure with the AIC as a criterion. Non-zero entries in the matrix Γ indicate asymmetry in news impact.

	C		A		B		Γ		w
İMKB100	1.059	−1.494	−0.236	0.000	0.942	0.000	0.000	0.000	−1.4704
	(5.023)	(−4.506)	(−4.839)	(−)	(46.661)	(−)	(−)	(−)	(−2.264)
	0.000	0.353	0.062	0.897	0.062	0.897	−0.065	0.339	
	(−)	(0.329)	(−)	(4.144)	(3.225)	(51.464)	(−0.963)	(2.649)	
Tüpraş	0.566	−0.042	0.257	0.000	0.961	0.000	0.000	0.000	−1.2883
	(4.078)	(−0.133)	(7.551)	(−)	(96.397)	(−)	(−)	(−)	(−7.988)
	0.000	1.352	0.000	0.000	0.003	0.940	−0.011	0.461	
	(−)	(6.045)	(−)	(−)	(1.003)	(104.305)	(−0.873)	(11.666)	
Petrol Ofisi	0.582	−1.500	0.166	−0.015	0.979	0.028	0.000	0.000	0.0000
	(5.913)	(−2.592)	(5.636)	(−0.219)	(157.107)	(1.526)	(−)	(−)	(−)
	0.000	1.703	−0.001	0.359	0.004	0.917	0.000	0.000	
	(−)	(2.991)	(−0.088)	(9.974)	(0.981)	(70.227)	(−)	(−)	
Turkcell	1.578	−1.320	−0.282	0.000	0.890	0.062	0.000	0.000	0.7231
	(3.563)	(−2.714)	(−4.767)	(−)	(25.065)	(1.571)	(−)	(−)	(2.388)
	0.000	0.003	−0.087	0.151	0.000	0.953	0.183	0.303	
	(−)	(0.001)	(−2.344)	(2.878)	(−)	(56.214)	(3.331)	(5.055)	