

ALMAN OTOMOBİL ENDÜSTRİSİ: BRENT PETROL VE ÇELİK'İN FİNANSAL ETKİLERİ¹

GERMAN AUTOMOBILE INDUSTRY: THE FINANCIAL IMPACTS OF BRENT OIL AND STEEL

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Öz

Otomobil sektörü çelik ve petrol olmak üzere iki önemli kaynaktan beslenmektedir. Bu nedenle çelik ve petrol endüstrilerinin mali yapısı hem otomotiv endüstrisi hem de sanayileřen dünya açısından büyük önem taşımaktadır. Bu çalışmada, dünya çelik pazarını anlamak için, dünya çelik liderliğı olarak Çin çelik pazarına odaklanılmıştır. Bu makale, DCC GARCH (Dinamik Koşullu Korelasyon Çok Değıřkenli GARCH) modellerini kullanarak bu üç sektörün finansal volatilite analizini yapmayı amaçlamaktadır. Ana bulgulara göre, Alman otomobil sektörünün mali yapısı büyük ölçüde Brent petrol getirilerinden etkilenmektedir. Çin çelik vadeli işlemlerinin getirilerinin, Alman otomobil markalarının getirileri üzerindeki etkisine dair istatistiksel bir kanıt bulunmamaktadır. Bu bulgular, Alman otomobil endüstrisinin çelik dalgalanmalarına karşı bağıřık ancak petrol dalgalanmalarına karşı bağıřık olmayan bir yapıya sahip olduğı anlamına gelebilir. Bu bağlamda Almanya'nın uluslararası ekonomi politikası önemlidir. Diğere taraftan Alman otomobil devleri ve onların Çinli iřtirakleriyle olan ilişkileri de sonucun bir başka parçası olabilir.

Anahtar Kelimeler: Alman Otomobil Endüstrisi, Brent Petrol, Çelik

JEL Sınıflaması: D2, L79, F18

Abstract

The automobile industry nourishes by two important resources: steel and oil. For this reason, the financial structure of the steel and oil industries is so important for the sake of the automobile industry and also the industrializing world. To understand the world steel market, this paper concentrates on the Chinese steel market as its world steel leadership. This paper aims to make a financial volatility analysis of these three industries by utilising DCC M-GARCH (Dynamic Conditional Correlation Multivariate GARCH) models. According to the main results, the German automobile industry's financial structure is largely impacted by Brent oil returns. There is no statistical evidence of the impact of the Chinese steel futures' returns on the returns of German automobile brands in a relationship. These findings can mean that the German automobile industry has financial immunisation against steel fluctuations but oil fluctuations. In this context, the international politics of Germany is so important. On the other side, German automobile giants and their relationships with Chinese affiliates can be another part of the conclusion.

Keywords: German Automobile Industry, Brent Oil, Steel.

JEL Classification: D2, L79, F18

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1. Introduction

The development of the automobile industry is strictly, soundly and comprehensively dependent on two important supply chains. One is the petroleum and related products and services industry (oil industry) and the other is the steel industry. This paper focuses on analysing the financial side of this business between automobile, steel and oil industries.

Almost since the beginning of 20. Century, the automobile industry sustains its existence. A lot of worldwide crises. While unwanted and undesired events occurred in this period, automobile industry crises hit the whole economic system many times. Investors, consumers, and manufacturers were affected by these events negatively. In terms of financial words, the automobile, steel and oil industries witnessed many breaks and were open to breaks structurally. For instance, Beckers and Strom(2015) examine these processes with a Vector Auto-Regression model and detect financial fragility and breaks. Mensi et al. (2022) especially emphasize the important impacts of Brent oil prices, and natural returns over other financial markets such as gold. At the same time, Brent oil prices can have a dramatic interaction with the micro, macro and international economic variables (Vochozka et al., 2020). On the other side, financial information, as the one of important variables in this equation, also has a dramatic impact on the volatility mechanisms of Brent oil in spot markets and other markets due to the creation of entropic relationships between investors' minds and sentiments (Benedetto et al., 2018). Besides, Chen et al. (2015) correct the framing impacts of Brent oil prices with breakages, fragilities and transmissions with their statistical model.

As it is known, the steel industry is very important for world economies and also a dominant factor in the automobile industry, Rosen, (1958: 1079) emphasizes the importance of the steel industry and becoming a subject of cartelization and competition within big countries such as France, Germany, Belgium, Luxemburg and the Netherlands and also the United Kingdom and the United States throughout a long period. However, Pariser et al. (2018: 11) verify these relationships in their analysis results and also emphasize the importance of external steel trade mechanisms over Chinese external economic policies. According to their analyses, not only the pure steel trade but also its derivatives are subjects of this trade such as the nickel and chromium stainless steel trade, pig iron trade, and scrap steel trade (especially, Chan et al, 2012). With these findings, the contribution of Labson et al. (1995) also should be underlined that after exploration of the importance of steel, the good relationships between Australia and China over iron ore. This event is one of the cornerstones in the world markets that explain how an industrial movement can change all of the business world. The works of Arık and Mutlu (2014:1) also create a clear wisdom for balance in trade relationships between the physical (commodity) and financial markets.

In light of the arguments above, the manufacturers of the automobile industry should be aware of one reality is that their industry like many other industries under the impacts of the steel and oil industries. They should always ensure a balancing mechanism between financial and commodity markets. Considering the importance of financial commodities on industrial financial structure, the participants of industries should understand the sentiments and minds of the investors frankly. This paper aims to investigate the relationships between automobile industry investments and brent oil and steel investments. To reach this purpose, the research will be divided into three sections. Firstly, it will talk about one important umbrella model that collects a lot of the other concepts under the name of literature review. After a literature review section, there will be a methodology part. The Multivariate GARCH model, which is selected as the research model, is presented in this section with all of its details, the main causes of the selection will be detailed. The research findings, discussions and conclusions will be realized and policy implications will be given in the last section.

2. Literature Review

As one of the biggest industries around the world, it is easily and quickly affected by international political, economic and technological variables. The minds, sentiments and emotions of the stakeholders become especially important. For example, especially even after the revolution of greenization in industries, consumers in the automobile industry are impacted by this movement deeply and decide to purchase or demand greener products and focus on sustainable products and services (Lin and Chen, 2013:1), and regulators of automobile industry insist on environmental issues such as Carbon accounting (Lee, 2012). On the other hand, multi-dimensional supply chain problems and imperfections such as communication problems, joint action, and performance have direct impacts on the automobile industry (Govindan et al., 2009). Besides these, business cycles are very important in the automobile industry. To Understand the job division, and bilateral agreements at a country-specific level, and seeking for correct technology can be counted as the main dynamics of this industry in terms of business cycles and cost management in business cycles (Blanchard, 1983). Also, the dimension of the competition and dependent environment in the automobile industry is so large that both the demand and supply sides can be directly affected by even small changes (Breshnahan, 1987) and the relationship between stakeholders and manufacturers can cause criminal movements. Farberman gives the name of the criminogenic market structure to this movement (Farberman, 1975: 438). Maybe, the most important variable in this complex industrial structure

is the redefinitive force of culture. “Japan Revolution” is a summarized version with its impacts on the whole industry structure, the transition from “Fordism” to “Toyotaism” is explained by culture and how culture changes the structure of the whole industry (Dohse et al, 1985). Bergouignan et al. (2000) underline the efficiency and effectiveness of multinationalisation and globalization in the automobile industry. According to them, Japanese automobile companies sustain a good effort in both of them, on the other hand, the European companies are unsuccessful in reaching success in globalisation. For Sturgeon et al. (2009: 7), the creation of global, regional, national and local value chains should not only be examined by regional and global suppliers but also by geography of production and characteristics of the value chain and its linkages. Digital transformation effects the industry deeply, transformations to renewable energy resources, and power electric vehicles and digitalism with all of its roots change the format of the industry, and consumer policies evolve toward consumer satisfaction and wellness, profits, productivity and competitiveness of the industry reformed to a new structure most importantly (Albert et al., 2021).

Today’s automobile industry (e.g. Tesla Motors) generally focuses on dense and intensive marketing communications to reach an effective financial perspective and to be beneficial in terms of building relationships with customers (Falat and Holubcik, 2017). In the middle of this chaos, the automobile industry should sustain its financial existence through short-, middle- and long-term financial activities such as working capital management. Nevertheless, as the industry realizes these management strategies, the context of country gains importance (Pirttila et al., 2019). In the analyses of Filbeck et al., (2016) stock performance, operating performance and profitability are the main variables in stock chains of the automobile industry. However, Pauwels et al. (2004) underline the impacts of marketing actions on the financial metrics, including top-line, bottom-line and stock market performance. Sometimes, the inferences of Ray (2011) are especially important in this financial equation. According to it, the world economic conjuncture experienced special hardships after the economic crisis of 2007 and 2008. Developing countries and their fiscal situations such as India suffered also this economic tensions. In the end, the results of the crisis are felt by also total automobile industry. Ray continues his/her analysis through Altman Z scores (a direct measure of bankruptcy) and creates a framework. Findings of this analyse show that the Indian automobile industry suffered from the negative impacts of the 2007-2008 global crisis. However, Rafique (2011) explains the importance of effective and efficient asset management policies in automobile industry of Pakistan’s automobile industry. Although his/her analysis is a comprehensive one, there is no clear evidence if there is a relationship between the capital structure and the profitability of the company and its financial leverage. New sustainable and governance dynamics should have impacts on the financial dynamics of the automobile industry. The analyses of McPeak and Guo (2014) serve to clarify to these relationships, the automobile maker’s financial performances are affected by many sustainability activities performances and naturally Corporate Social Responsibility (CSR) operations in the governance structure.

3. Methodology

Returns are one of the main variables in financial management. Unlike the stock prices that respond to the markets to the business management’s understandings and financial activities of companies with a lot of varieties, returns show us the direct attitudes of investors toward a company if they are calculated correctly depending on the difference between the behaviours of markets and the behaviours of investors. According to the literature review section, these relationships are also correct for the automobile industry. Fama and French (2010: 270) highly concentrated on the relationships between risk, size and value of the company and market to determine the return or returns. Although the concept of the asset return is open to discussion, the content of the asset returns is still in ambiguity. It’s normal to give a price to a financial asset, but it’s so hard to manage it due to free market rules and even-regulated market conjunctural rules depending on the minds and sentiments of the investors and market rules. It can be concluded here that asset returns are vulnerable to markets (the other substitutions), perception of the risk in the investors’ psychology, and the power and size of the companies (Mwalla and Karasneh, 2011; Basiewicz and Auret, 2010; Foye et al., 2013). All of this information should direct the analysts to a questionnaire as in Fama and French (1993), which includes i) how can a market produce a risk in different financial markets? ii) how can an asset of companies produce risk alone? iii) What are the risk-dependent relationships between different financial markets and their products? Therefore, classical theorems of Fama and French’s three-variable and five-variable models were added to the economic and financial epistemology. They are really good explanations of the importance of returns in the financial markets, portfolio selection and management style of companies. On the other side, the financial interaction between returns of the supply chain’s different elements has great importance not only for the sake supply chain but also for the sake of global economy depending on globalism and multinationalism policies as stated in the literature review. For these reasons, the Multivariate DCC GARCH model is selected as the research method in this paper to measure interactions.

GARCH models have used prominently in the analysis of financial time series and are used to eliminate the heteroscedasticity problem. Financial time-series such as foreign exchange rates, inflation rates, and stock prices may exhibit some volatility that varies over time, and this variation is an indicator of ARCH effects or

heteroscedasticity problems (Dagnew et al, 2024). According to another resource, Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models are effectively used for volatility forecasting of different time-series variables like strategic commodities, financial securities, macroeconomic indicators, etc (Bauwens et al., 2006). DCC GARCH Models are designed to detect the existence of contagion (monetary policy, risk measurement, asset pricing portfolio allocation etc.) in the financial series. Its major advantage is detecting possible changes in conditional correlations over time. In this way, the dynamic behaviours of the related time series can be measured easily(Çelik, 2012). Firstly, the multivariate GARCH (M-GARCH) model was introduced by (Engle & Kroner, 1995) for estimating volatility transmission between prices of different time-series variables like strategic commodities, financial securities, macroeconomic indicators, etc. There are different types of M-GARCH models such as BEKK M-GARCH, VEC M-GARCH, DCC M-GARCH and its versions of CCC M-GARCH and VCC GARCH models. While Aggarwal et al., (2021) underlines the BEKK GARCH model to explore the volatilities, which is a restricting model because of the conditional covariances and variance and cross relationships like VEC GARCH model (İmre, 2021), conditional covariance among the pairs of Bi-Variate estimation can be examined using DCC GARCH. There are also other researches in which different DCC GARCH model versions are selected as research methods, for example, Akkoç and Cıvır (2019) measure the strategic relationships between gold, oil and stock market prices that are the main important variables under the impacts of liberalisation policies in Turkey via this way. However, Hou and Li (2016) measure the information transmission between U.S. and China index futures markets with an Asymmetric DCC Garch Model. Besides these, Jones and Olson (2013) relate macroeconomic uncertainty and inflation via the DCC GARCH methodology. The research model of this research, DCC GARCH model can be written in the light of Engle (2002) as follows,

$$y_t = \mu_t + \varepsilon_t \quad \varepsilon_t | F_{t-1} \sim N(0, H_t)$$

Equation 1.

$$\varepsilon = H_t^{1/2} u_t \quad u_t \sim N(0,1)$$

Equation 2.

$$H_t = D_t^{1/2} R_t D_t^{1/2} \quad D_t = \text{diag}(h_{11t}^{1/2}, \dots, h_{NNt}^{1/2})$$

Equation3.

where,

F_{t-1} stands for all information available up to $t - 1$ time. And y_t , μ_t , ε_t , and u_t are $N \times 1$ -dimensional vectors representing the analyzed time series, conditional mean, error term, and standardized error term, respectively. Furthermore, R_t , H_t and $D_t = \text{diag}(h_{11t}^{1/2}, \dots, h_{NNt}^{1/2})$ a $N \times N$ -dimensional matrices illustrating the dynamic conditional correlations³, time-varying conditional variance⁴ matrices and, the time-varying conditional variances (Gabauer, 2019: 789). The important point in this formulization is that the value of R_t , CCC GARCH model assumes that the conditional correlation matrix is time-variant, whereas the DCC GARCH model and VCC GARCH model allow the conditional correlations to vary over time. Thus, the DCC GARCH and VCC GARCH models are more flexible than the CCC GARCH model (Alsharif, 2020).

4. Data

Research data is taken from investing.com and yahoofinance.com. The data interval is between 01.03.20213 and 9.11.2023. The returns are calculated benefiting from Equations 4 and 5.

$$R_i = (R_t - R_{t-1}) / R_{t-1}$$

Equation 4.

To reach adjusted financial data for automobile brands only, we utilized the following equation.

$$R_{adj} = R_i - R_m$$

Equation 5.

³In probability theory and statistics, the conditional correlation is the correlation of two variables X and Y conditionally to an event A.

⁴ In probability theory and statistics, a conditional variance is the variance of a random variable given the value(s) of one or more other variables.

where,

R_{adj} = market-adjusted return,

R_m = Market return,

R_i = Asset return

The descriptive statistics are shown in Table 1.

Table 1. Descriptive statistics

	<u>Market- adjusted return BMW</u>	<u>Market- adjusted return Mercedes</u>	<u>Market-adjusted return Volkswagen</u>	<u>Return- Chinese futures</u>	<u>Brent-oil returns</u>
<i>Mean</i>	-0.000185	-0.000034	-0.000334	0.002126	-0.000998
<i>Median</i>	-0.000302	-0.000212	-0.000759	0.000000	0.001174
<i>Maximum</i>	0.077686	0.163008	0.107735	1.012594	0.376623
<i>Minimum</i>	-0.087917	-0.173414	-0.189223	-0.113057	-3.059661
<i>Standard Deviation</i>	0.010893	0.012522	0.015215	0.049080	0.069532
<i>Skewness</i>	-0.298667	-0.096219	-0.746949	18.58821	-33.51964
<i>Kurtosis</i>	9.587602	30.59221	21.65731	378.2061	1422.428
<i>Jarque-Bera</i>	4945.946 (0.000)	86066.19 (0.000)	39601.53 (0.000)	16070194 (0.000)	22826169 (0.000)
<i>Sum</i>	-0.501716	-0.094173	-0.906011	5.768973	-2.707235
<i>Sum Sq. Dev.</i>	0.321781	0.425258	0.627817	6.532898	13.11185
<i>Observations</i>	2713	2713	2713	2713	2713

5. Findings

According trial and error method and AIC and SIC information criteria which are utilized for eliminate ARCH impacts in the series, to detect which ARCH model is followed by the disturbance term, the disturbances terms of Adjusted BMW returns follow an ARCH [1], of Adjusted Mercedes returns follow ARCH [1], of Adjusted Volkswagen returns follow GARCH [1,1], of Chinese steel future follow ARCH [1] and of BRENT OIL return follow GARCH [1,1]. ARCH and GARCH models are utilized for foresighting of the volatilities in time series analysis (Özdemir, 2025 and Kocoğlu, 2024). Economically, volatilities show as the unexpected value changes in returns, for a classical market description, volatilities are beginning point of loss and benefits. The volatilities can change depending on idiosyncratic characteristics of financial assets or market characteristics or both of them. The existence of ARCH [1,1] and GARCH [1,1] in the model show that there is a volatility clusters in related series and investors can benefit or lose under their impacts.

Table 2. DCC GARCH Model results

<u>Parameters</u>	<u>Models</u>	<u>DCC Garch Model</u> <u>Coefficient Results (z stats, prob.)</u>
<i>ARCH model for return Adjusted BMW</i>	Arch (1) coefficient	0.149 (6.78, 0.000)
	Constant	0.000 (30.03, 0.000)
<i>ARCH model for return Adjusted Mercedes</i>	Arch (1) coefficient	0.299 (8.47, 0.000)
	Constant	0.000 (25.80, 0.000)
<i>ARCH model for return Adjusted Volkswagen</i>	Arch (1) coefficient	0.141 (5.24, 0.000)
	Garch (1) coefficient	0.648 (7.11, 0.000)
	Constant	0.000 (2.27, 0.023)
<i>ARCH model for return Chinese steel future</i>	Arch (1) coefficient	-.002 (-28.39, 0.000)
	Constant	0.0024(14.02, 0.000)
<i>ARCH model for Brent oil return</i>	Arch (1) coefficient	1.828 (24.90, 0.000)
	Garch (1) coefficient	0.310 (5.31, 0.000)
	Constant	0.0002243(14.02, 0.000)
<i>Lambda 1</i>	0.100	3.30 (0.001)
<i>Lambda 2</i>	0.828	17.36(0.000)

The validity of the research model can be estimated with the chi-squared method. According to the results of the chi-square (540.29, p-value = 0.000), the model has model fit. It can be understood from Lambda 1 value that (0.100) %10 of the correlation depends on the shocks. On the other hand, Lambda 2 value shows that (0.828) %82 of the correlation depends on the lags of the model. The correlation coefficient results can be seen in Table 3.

Table 3. Correlation coefficient results

<u>Correlation Parameter</u>	<u>Coefficient</u>	<u>Z (prob)</u>
Adjusted Return Volkswagen- Adjusted Return BMW	0.433	26.35 (0.000)
Adjusted Return Volkswagen- Adjusted Return Mercedes	0.376	21.57 (0.000)
Adjusted Return BMW-Adjusted Return Mercedes	0.498	31.55 (0.000)
<i>Adjusted Return BMW-Chinese Steel Future Return</i>	<i>0.014</i>	<i>0.73 (0.466)</i>
<i>Adjusted Return Mercedes- Chinese Steel Future Return</i>	<i>-0.020</i>	<i>-1.00 (0.317)</i>
<i>Adjusted Return Volkswagen- Chinese Steel Future Return</i>	<i>0.026</i>	<i>1.29 (0.197)</i>

Adjusted Return BMW-Brent Oil Return	0.055	31.55 (0.000)
Adjusted Return Mercedes-Brent Oil Return	0.088	3.95 (0.000)
Adjusted Return Volkswagen-Brent Oil Return	0.067	3.14 (0.000)
Brent Oil Return-Chinese Steel Future Return	-0.003	-0.15 (0.881)

According to correlation coefficient results, the relationship between the Adjusted Returns of Volkswagen AG, Mercedes AG and BMW AG are relatively high, positive and significant. On the other side, there are insignificant correlative relationships between Chinese steel future returns and adjusted returns of Volkswagen AG, Mercedes AG and BMW AG regardless of direction and power statistically. Brent oil returns are in a calmly positive correlation relationship with the adjusted returns of three automobile giants. Therefore, it means that the volatility clusters, so loss and benefit possibilities are opener in oil returns and in opponent companies' returns than in steel returns.

6. Discussions And Conclusion

The market cap of these three automobile giants can shed more light on the importance of the research. According to revenue, Volkswagen AG is the twelfth biggest brand in the world with \$321.24 Billion, Mercedes AG is the thirty-fifth biggest brand in the world with \$160.61 Billion, BMW AG is the thirty-sixth biggest brand in the world with a revenue of \$159.61 Billion within 7972 companies⁵. If it is concentrated on the industry, there are 63 automobile brands around the world. Mercedes AG is the fifth largest automobile brand in the world, BMW AG is the sixth and Volkswagen is the seventh. In Germany, they are the first three companies and represent almost %90 of the all of the German automobile industry with their affiliates⁶.

According to model results, it can be said that the returns of the German automobile industry companies are moving together but in shock times with a small percentage. On the other side, as it is concentrated on many unwanted events during the research period depending on Chinese steel futures return and Brent oil returns, the research model is also correct.

Besides these, the automobile industry strictly depends on steel. The world steel industry is in the hands of China. Therefore, the financial structure of the steel market is very important for the automobile industry. Even though many crises occurred in the steel market in this period (For example in the years of 2008 and 2022), the German Automobile Industry sustained its financial immunization against steel market volatilities. The sub-branches of Volkswagen AG, Mercedes AG and BMW AG in China, good bilateral international relationships with China and Germany, and sound and preventive financial policies of Germany can be the causes of these results. The Chinese automobile industry is the third of the world economy. Almost every big brand has a branch on the border of China, Liu and Yeung (2013) examine this relationship in the Chery brand and underline the importance of location and developing technology in automobile production processes such as assembling. Liu et al., (2014) and Gang (2004) confirm the advantages of a strong steel industry for the automobile industry in China. For Yin and Chen (2013) and Sheng et al. (2024), steel is a strategic and political industry and resource of China, at the same time, it has direct impacts on international collaborations and partnerships. The largeness and impacts of the Chinese steel industry show their impacts on bilateral and multilateral international agreements as such in Kazakhstan and India (Serikkaliyeva et al, 2024). Therefore, the economy of the steel market is in the hands of the Chinese government. Immunization against steel commodity return changes can be described with the power of political variables considering the effects of politics on economics, activism and the superiority of German brands in the automobile industry.

As it is known, Germany is oil dependent country. The relationships between these firms' returns and Brent oil returns are normal. Similarly, the research design can be utilized to all of the automobile brands and regional analysis can be realized. Lastly, this type of research can carry to other industries and world samples. Today, value chains and financial relations around these value chains are important. For automobile investors and regulators, it can be said that the corporal or individual investors should follow brent oil returns more stricter than steel returns.

⁵ <https://companiesmarketcap.com/largest-companies-by-revenue/>, 9.10.2023,

⁶ <https://companiesmarketcap.com/automakers/largest-automakers-by-market-cap/>. , 9.10.2023.

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