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BACHELOR THESIS

The Impact of an Announcement of a New Car Model on the Price of Stocks of Automobile Companies

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

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Abstract

This work studies the impact of an introduction of a new car model on the stocks of the introducing company and its rivals and also the impact of an earnings announcement on the stocks of the introducing company. I use two different approaches to explore these effects, one focusing on the stock returns through the CAPM and the other focusing on the volatility of stocks using GARCH model. I found that the new model introduction has a significant positive effect on the returns of stocks of the announcing company but I found no definite effect on the returns of stocks of the competition. Moreover, I found that the new model introduction has no effect on the volatility of stocks of the announcing company and similarly I found no definite effect on the volatility of stocks of the competition. Furthermore, I found that the earnings announcement has no definite effect on the stock returns of the announcing company but that it has a significant positive effect on the volatility.

JEL Classification	G10, G12, G14, G15
Keywords	automobile industry, stock market, release of information, price determination, capital asset pricing model, autoregressive conditional heteroskedasticity, generalized autoregressive conditional heteroskedasticity

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Abstrakt

Táto práca sa zaoberá dopadom uvedenia nového automobilu na akcie týkajúcej sa spoločnosti a jej konkurentov a takisto sa zaoberá dopadom zverejnenia hospodárskeho výsledku na akcie danej spoločnosti. Použil som dva rôzne prístupy na rozbor týchto efektov, jeden zameraný na výnosnosť akcií s použitím CAPM a druhý zameraný na volatilitu akcií s použitím GARCH modelu. V práci som zistil, že uvedenie nového automobilu má signifikantný pozitívny efekt na výnosnosť akcií danej spoločnosti ale že nemá jednoznačný efekt na výnosnosť akcií konkurenčných spoločností. Ďalej som zistil, že uvedenie nového automobilu nemá dopad na volatilitu akcií danej spoločnosti a takisto že nemá dopad na volatilitu akcií konkurenčných spoločností. Navyše som zistil, že zverejnenie hospodárskeho výsledku nemá jednoznačný dopad na výnosnosť akcií týkajúcej sa spoločnosti ale že má signifikantný pozitívny dopad na ich volatilitu.

Klasifikace JEL	G10, G12, G14, G15
Klíčová slova	automobilový priemysel, akciový trh, zverejnenie informácií, stanovenie ceny, capital asset pricing model, autoregressive conditional heteroskedasticity, generalized autoregressive conditional heteroskedasticity

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Contents

List of Tables

List of Figures

Acronyms

ARCH Autoregressive Conditional Heteroskedasticity

BMW Bayerische Motoren Werke

CAPM Capital Asset Pricing Model

DAI Daimler

DAX German Stock Index

GARCH Generalized Autoregressive Conditional Heteroskedasticity

NYSE New York Stock Exchange Composite Index

TMC Toyota Motor Corporation

TTM Tata Motors

VW Volkswagen

Bachelor Thesis Proposal

Author	Ján Micenko
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Proposed topic	The Impact of an Announcement of a New Car Model on the Price of Stocks of Automobile Companies

Topic characteristics The automotive industry accounts for substantial part of GDP of many countries in Europe, especially Germany, Czech Republic, and Slovakia. Therefore, it is extremely important to analyze and evaluate what causes fluctuations and volatility in market price of companies in this industry. The thesis would try to capture the impact of an announcement of a new car model on a price of stocks of automobile companies. We will use various statistical and econometric models and examine the behavior of stocks in response to this new information.

The examined companies would be from all over the world supplying different types of car models for different groups of customers so that we can get a bigger picture and verify if it is valid for all, or only for some specific kind of firms or models.

Another approach might be such that we would pair, or make groups of, automobile companies regarding the target customers. That means we would make these groups such that the companies in them are the biggest rivals and competitors and their products are the closest substitutes. Then we would try to search for some cross-effect in these groups.

Closer look could also be taken on the impact of sales and profits announcement of the companies on the price of their stocks.

Hypotheses

1. The announcement of a new car model affects the price of stocks of this company.

2. The announcement of a new car model affects the price of stocks of the competitors.

3. The sales and profits announcement has an impact on the price of stocks of this company.

Outline

1. Introduction
2. Brief characteristic of examined companies and models
3. Methodology
4. Empirical Analysis
5. Conclusion

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Author Supervisor

Chapter 1

Introduction

The automobile industry accounts for a substantial part of GDP of several countries across the globe and there are very few other regions in the world where this fact is as true as it is for the case of the Central Europe. That means that this industry is very important for these particular economies. Consequently, it is crucial to understand and to be able to identify the events and other specifics that affect the performance and valuation of the companies in this industry. And so focusing on the core of these companies and on the main product that they supply to the market, one realizes that it might make sense to examine what impact an introduction of new model has on the stocks of the introducing company and on those that are involved as well, i.e. on the competition. To put it differently, do the markets react to the publishing of first official information and pictures of a new car? And if so, is it true for all companies in general or not? Also, are the rivals affected by these events? To my best knowledge, no prior research focusing exclusively on the new product introduction by automobile companies and its effect on behavior of stocks has been conducted.

Concerning the methods used in this study, I decided to focus on two attributes of the stocks, returns and volatility. I expect the new car model introduction to have positive effect on stock returns of the introducing company and negative effect on stock returns of the competition. In addition, I expect the new car model introduction to increase the volatility of stocks of introducing company as well as of the competitors. I employ two models that are suitable for the purposes of this study. These are the CAPM and the GARCH(1,1) model where both of them are extended by one dummy variable indicating whether the studied event occurred or not. By this approach, the statistical inference

about the dummy variable provides answers to the proposed questions.

The thesis is structured as follows. Chapter 2 deals with the literature that is relevant to this work. It comments and summarizes the results of the previous research in this specific area. Chapter 3 is focused on the methodology that I use in order to answer the questions proposed. Apart from the formulation and discussion of the models, it also contains the statistical tests that I use to verify the appropriateness of the data, i.e. whether they fulfill the necessary assumptions. Chapter 4 describes the dataset and the process of obtaining it. It also characterizes the studied companies in more detail and thus provides deeper motivation for the topic. Chapter 5 presents the results of the models and discusses their implications.

Addressing the results of the study, I found that, overall, the introduction of new model has a positive effect on stock returns of the announcing company. However, no impact on volatility of stocks was detected. Moreover, no definite cross-effect of new model introduction on stock returns and volatility of competitors was found. Finally, the earnings announcement had no effect on the stock returns of the announcing company but it increased the volatility of stocks.

Chapter 2

Literature Review

In the recent past we all witnessed one of the biggest financial meltdowns in the history of financial markets and we were once again reminded how integrated and fragile the world is. Almost everyone was affected by the crash and the society had a hard time rescuing the system and itself. Understandably, researchers were for a long time interested in finding a way to predict and more importantly to avoid such turmoil in the future. In other words, they tried to find some relationship between various variables and then to justify their effect on the financial markets. Consequently, the literature concerning the impact of some specific event, information release or evolution of variable on the whole financial markets or individual stocks is really extensive. However, the research concerning the impact on the stocks of companies in automobile industry is rather small.

Several studies were concerned with the product liability issues and produced contradictory results. Jarrell & Peltzman (1985) used the data from 1967 to 1981 and found that the product recall had a significant impact on the stock prices of drug and automobile companies. They also concluded that excessive losses were associated with destroyed goodwill of these companies. Similarly, Hartman (1987) found that the product recalls had negative effect on the resale values of the defective models and the valuation of the company on the market. Barber & Darrough (1996) based their analysis on the data from U.S. automobile market from 1973 to 1992 and focused on American and Japanese producers. They documented that recalls announcements had significant negative effect on markets. They also found that the effect was larger for Japanese manufacturers. They reasoned that it was mainly due to the fact that Japanese carmakers announced the recalls less frequently. However, they

also concluded that the total decline in the market value of the company was larger for American producers because of more frequent recalls.

On the other hand, Hoffer *et al.* (1988) reexamined the above-mentioned study conducted by Jarrell and Peltzman and ended with completely different results. They revised the approach used, corrected the data set and concluded that there is very little evidence of significant impact on the shareholders of the company or its competitors. Garber *et al.* (1998) investigated specifically the effect of the trial verdict on the price of stock of the company and the sales of the particular model. They expected that the verdict announcements would affect the sales and price of stocks. They examined the data from 1985 to 1996 for U.S. automobile market and found no evidence in support of their hypotheses. They concluded that the sales were not affected because of consumer loyalty, settlement strategies of producers and poor awareness of consumers about the verdicts. In addition, they concluded that stock prices were not affected because of uncertainty of outcome due to possibility of appeal, of other more important events occurring during the trading day and because investors predicted the outcome correctly and already contained the information. In another study, Hoffer *et al.* (1987) examined the behavior of the trading volume and stock price of U.S. car manufacturers during the automotive recall announcements. The study failed to provide evidence for informational efficiency and concluded that the market responded to the announcement once the information was made available to all investors.

Other studies relevant to this subject were aimed at the response of stocks to the introduction of new products. Chaney *et al.* (1991) studied this impact on market value of introducing firms and found a significant positive effect. Moreover, the impact varied across industries and depended also on the number of announced products. Overall, more innovative and technologically based companies and the announcements of more new products experienced larger effects. They also stated that the original products, i.e. products that were truly new, had larger effects and that the amount of the systemic risk of the company and the frequency of the announcements were negatively correlated with the impact. Chen *et al.* (2005) investigated the cross effect of announcement of new product on the stock prices of industry rivals. They found that the rivals experienced significant negative return on their stocks. Similarly, they concluded that the more technologically based the company, the more significant the unfavorable effect. In addition, they found that for very new products the impact on rivals was more favorable. They also claimed that there was neg-

ative relation between the impact on the announcers and the rivals and that the effect was more visible for smaller rivals and firms with better investment opportunities.

The last set of studies is one that relates the stock prices and various aggregate macroeconomic variables or other variables that change over time. Even though these studies do not represent the core literature and are not as relevant to the subject matter as the studies already mentioned above, I decided to include them so as to have clear evidence on the stock market response to the various information releases. Schwert (1981) analyzed the response of stocks to the newly released information concerning inflation. Using the daily returns from 1958 to 1978 for the Standard and Poor's index he found a small negative effect of the unexpected inflation on this index. Pearce & Roley (1985) concluded that unexpected inflation had only limited effect on stock markets for the period from 1977 to 1982. However, they reported significant impact of surprising information concerning monetary policy on the stocks and suggested that the responses occurred only at the time of announcements of unexpected news. More recently, Cakan (2012) claimed that information about unemployment affected only the market volatility and not the returns, based on the data from 1981 to 2005. On the other hand, his study implied that inflation had a negative effect on stocks and that together with unemployment they had bigger effect on volatility when the economy was in recession rather than in expansion. Lis *et al.* (2012) investigated the relationship between the crude oil price changes and the stocks of car companies. Based on data from 1982 to 2007 for Brent crude oil and the US, German and Japanese automotive companies they found that these companies' reaction to the price fluctuations was similar to that of market in general. In addition, they concluded that there was no evidence in favor of excessive sensitivity of Japanese companies to these price changes while there was for German and that more recently US and German companies tended to be more sensitive.

As to address my contribution to this field, my research is focused on the specific impact of an introduction of new car model on the stocks of automobile companies. I investigate the direct effect on the announcing company and also the cross-effect on the biggest rivals that produce the closest substitutes. In addition, some of these car models represent the breakthrough models that brought biggest innovations to the market, caused revolution of the industry or established a completely new class of vehicles. Lastly, I analyze the effect of the earnings announcement of these companies on their stock prices.

Chapter 3

Methodology

This part of the thesis is aimed at providing all the necessary theoretical background that I use. As noted earlier, I intend to explore the impact of an introduction of a new model on the stock prices of automotive companies. I use two different approaches, one looking at the daily returns and the other at the volatility of the stocks. Therefore, I use the modified CAPM (Capital Asset Pricing Model) and the GARCH (Generalized Autoregressive Conditional Heteroskedasticity) model, respectively. Therefore, this chapter begins with definition of the CAPM, continues with the formulation of the GARCH model and the last part is concerned with the statistical tests, through which I will verify the suitability of the models on the selected dataset.

This methodology should enable me to then answer the questions asked in this study. Firstly, I would like to find out whether the announcement of a new model affects the stocks of the announcing company, secondly, whether this affects the stocks of its competition and finally, whether the earnings announcement has any impact on the announcing company.

The formulas and definitions used in this chapter are based on those provided by Sharpe (1964), Brooks (2008) and Wooldridge (2009).

3.1 CAPM

To discuss briefly the CAPM, it is a model used to determine the price of the risk. In other words, it is employed so as to calculate the return of an asset given the risk-free rate, the market risk premium and the sensitivity of asset return to the market return. The derivation of the CAPM follows.

The classical CAPM equation is defined as

$$E(r_i) = r_f + \beta_i \Big(E(r_M) - r_f \Big),$$

where $E(r_i)$ is the expected rate of return of asset i, r_f is the risk-free rate of return and $E(r_M)$ is the expected market rate of return.

However, as the CAPM works with the expected values of rates of return of asset i and of market, the estimation of the model is done on the realized data and so the equation becomes

$$r_i - r_f = \beta_i \big(r_M - r_f \big),$$

where now r_i is the rate of return of asset i and r_M is the market rate of return.

This is a result of the fact that the expected returns are hard to obtain and the former model is almost impossible to estimate.

In addition, CAPM is very often estimated by the linear regression model and takes on the form of equation

$$r_i - r_f = \alpha_i + \beta_i \big(r_M - r_f \big) + \epsilon_t,$$

where additionally α_i is the constant and ϵ_t is the disturbance term.

Moreover, as in this study I am dealing with the time-series data, the model is somewhat different and is defined as

$$r_{it} - r_{ft} = \alpha_i + \beta_i \big(r_{Mt} - r_{ft} \big) + \epsilon_t,$$

where r_{it} is the rate of return of asset i at time t, r_{ft} is the risk-free rate of return at time t and r_{Mt} is the market rate of return at time t.

Furthermore, I also require another variable in the model that will indicate whether a studied even occurred or not and the model therefore is

$$r_{it} - r_{ft} = \alpha_i + \beta_i \big(r_{Mt} - r_{ft} \big) + \gamma_i D_{it} + \epsilon_t,$$

where D_{it} is a dummy variable equal to one if for the asset i at time t the event occurred and zero otherwise.

The necessary assumptions of the CAPM, based on the formulation by Sharpe (1964), could be summarized as follows. All investors are rational, risk averse, have homogenous expectations about returns and risks of assets and can

borrow or lend independently at the risk-free rate. Capital markets are perfect as assets are perfectly divisible and there are no transaction costs, taxes or information asymmetry.

It is clearly visible that these assumptions are quite restrictive and might be violated in many situations. However, it is beyond the scope of this text to attempt to verify whether these assumptions hold for used dataset. Nevertheless, interested readers might refer, among others, to Black *et al.* (1972), Roll (1977), Chae & Yang (2008) and Goetzmann & Kumar (2004) for the discussions.

As I am dealing with the time-series dataset, it is essential to specify the Classical Linear Model assumptions for Time Series Regressions. Briefly, as defined by Wooldridge (2009), these are:

- Model is linear in parameters.
- There is no perfect collinearity in the sample.
- Explanatory variables are strictly exogenous.
- Disturbance terms are strictly homoskedastic.
- Disturbance terms in two different time periods are uncorrelated conditional on all explanatory variables in all time periods.
- Disturbance terms are independently and identically distributed as $N(0, \sigma^2)$ and are independent of all explanatory variables in all time periods.

As I am using the method of Ordinary Least Squares (OLS) for estimation, first five assumptions are needed to hold to imply that the OLS is Best Linear Unbiased Estimator (BLUE) and all assumptions together need to hold to justify the statistical inference.

However, it often happens for the financial time-series data that some of these strong CLM assumptions are violated resulting in invalid statistical inference and inaccurate and wrong conclusions. Fortunately, there is a weaker set of assumptions under which the valid large-sample statistical inference can be performed. As suggested by Wooldridge (2009), these are called the Asymptotic Gauss-Markov Assumptions for Time-Series Regressions and are defined as follows:

- Model is linear in parameters and weakly dependent.
- There is no perfect collinearity in the sample.
- Explanatory variables are contemporaneously exogenous.
- Disturbance terms are contemporaneously homoskedastic.
- Disturbance terms in two different time periods are uncorrelated conditional on all explanatory variables in these two time periods.

It is clearly visible that these assumptions are somewhat weaker when compared to the CLM assumptions. On the one hand, the assumptions on the exogeneity of explanatory variables, homoskedasticity and no serial correlation are weaker while on the other hand, the assumption on linearity requires also the weak dependence. The assumptions on the exogenous explanatory variables and homoskedasticity are weaker as these do not impose any restrictions on how the disturbance term is related to the independent variables in other time periods. Similarly, the assumption on no serial correlation conditions only on the independent variables in the specific time periods. In the last part of this chapter I will introduce various tests that will provide me with tools necessary for verifying these assumptions.

3.2 GARCH

In this section I present the GARCH model which is used in this study to model volatility. As the modified CAPM enables me to find out whether the occurrence of event has any impact on rates of return, the GARCH model will allow me to do the same for volatility. The derivation and intuition of GARCH formulated here is based on Brooks (2008).

Next few lines are meant to provide a brief description of the intuition behind the GARCH model. The GARCH model is used to model volatility. Unlike the ARMA model, in which the conditional variance given the past is constant, GARCH allows for persistence in the volatility, i.e. volatility clustering. This means that GARCH allows for periods of high as well as low levels of volatility. This is crucial as in financial time-series data this phenomenon of high and low volatility periods is very often present, hence the wide application of GARCH in finance nowadays. The specification and derivation of the GARCH used in this study follows.

First of all, I will be using the Autoregressive process of order one (AR(1)) and it is defined as:

$$r_t = \mu + \rho r_{t-1} + u_t,$$

where u_t is the disturbance term.

Second of all, the definition of the GARCH(1,1) model is:

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta \sigma_{t-1}^2,$$

where σ_t^2 is the conditional variance. As we can see, the model is no longer in the common linear form, therefore one cannot use the estimation by OLS as in CAPM. Fortunately, one can employ the maximum-likelihood technique as it is suitable for non-linear models as well. To obtain the Maximum Likelihood Estimates (MLE) of the GARCH model, the log-likelihood function (LLF) needs to be maximized. Under the normality assumption of the errors, it is specified as:

$$L = -\frac{T}{2}\log(2\pi) - \frac{1}{2}\sum_{t=1}^{T}\log(\sigma_t^2) - \frac{1}{2}\sum_{t=1}^{T}\big(r_t - \mu - \rho r_{t-1}\big)^2/\sigma_t^2.$$

However, in order to obtain a model that suits well the purposes of this study, there need to be done a slight modification. Although I use the exact same AR(1) formulated above, I include the dummy variable in the GARCH. Therefore, the final set of equations is:

$$r_t = \mu + \rho r_{t-1} + u_t,$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta \sigma_{t-1}^2 + \gamma D_t,$$

$$L = -\frac{T}{2}\log(2\pi) - \frac{1}{2}\sum_{t=1}^{T}\log(\sigma_t^2) - \frac{1}{2}\sum_{t=1}^{T}\big(r_t - \mu - \rho r_{t-1}\big)^2/\sigma_t^2.$$

It is important to mention that the GARCH model has several shortcomings and quite strict and unrealistic assumptions. As suggested by Bollerslev (1986), the model assumes normal disturbances and stationarity of volatility which might not be the case for many applications. Nevertheless, the GARCH(1,1) model, while being the simplest model of the GARCH-family models, seems to be the most suitable.

3.3 Statistical Tests

This section deals with the statistical tests that I will apply in order to verify the appropriateness of the models for the dataset. To elaborate, I will focus on the assumptions of no serial correlation and homoskedasticity of disturbances, because the serial correlation and heteroskedasticity is very often present in the financial time-series data and represents an issue. Tests, procedures, hypotheses and intuition in this section stand on the formulation of Wooldridge (2009).

I will be testing for AR(1) serial correlation and allow for non-strictly exogenous explanatory variables.

The test proceeds as follows. First of all, run the regression of the specified model and obtain the residuals for all t. Second of all, regress the residuals on their first lag and all explanatory variables for all t and obtain the information about coefficient $\hat{\rho}$ on the lag. Last of all, test the null hypothesis $H_0 : \rho = 0$ against the alternative $H_1 : \rho \neq 0$ using the t-statistics $t_{\hat{\rho}}$. Under the null hypothesis the conclusion is that there is no serial correlation in the disturbances and so the tested assumption holds. On the other hand, if the null is rejected at small enough significance level, say 5 %, the conclusion of the test is the opposite and one needs to deal with serial correlation.

I will perform two tests for heteroskedasticity in time-series regressions, Breusch-Pagan and White test.

The procedure of the Breusch-Pagan test is following. Firstly, run the regression of the specified model and obtain the residuals for all t. Secondly, Regress the squared residuals on all explanatory variables for all t. Finally, perform F-test for joint significance of regressors. The null hypothesis is $H_0 =$ regressors are jointly insignificant and the alternative is $H_1 =$ regressors are jointly significant. Under the null, the model has homoskedastic error terms and the tested assumption is therefore fulfilled, while under the alternative, i.e. if the null of homoskedasticity is rejected at sufficiently small significance level, the model suffers from heteroskedasticity.

The procedure of the White test follows. First, run the regression of the specified model and obtain the residuals and the fitted values for all t. Second, regress the squared residuals on the fitted values and the squares of the fitted values. Last, obtain F or LM statistic for joint significance of the regressors and compute p-value. The null hypothesis is $H_0 =$ regressors are jointly insignificant

and the alternative is H_1 = regressors are jointly significant. Similarly to Breusch-Pagan test, under the null hypothesis, the model has homoskedastic error terms while under the alternative, heteroskedasticity is present.

Chapter 4

Dataset and Characteristic of Companies

This part of the thesis is meant to provide closer information about the nature of the dataset and the reasoning behind the selection of the particular automotive companies. The selected automakers are BMW, Mercedes-Benz, Audi, Škoda, Volkswagen, Jaguar, Land Rover, Toyota and Lexus. BMW, Mercedes-Benz, Audi, Škoda and VW are European manufacturers and are traded at the Frankfurt Stock Exchange in Germany. BMW is traded as the BMW AG and Mercedes-Benz is traded as the part of the Daimler. In addition, Audi, Škoda and Volkswagen are all traded as the part of Volkswagen Group. Land Rover, Jaguar, Toyota and Lexus are all traded at the New York Stock Exchange. Land Rover and Jaguar are also European producers but since mid-2008 belong to the Tata Motors. Finally, Toyota and Lexus are Japanese producers traded together as the part of Toyota Motor Corporation. The chapter also includes the succinct description of the history, main achievements, current standing in the global market and expressed goals for the future direction of the selected companies. I decided to include this additional information so as to attract the reader and increase the interest for this particular field. In addition, through supplying this further information the reader might encounter the bigger picture of the whole industry which could encourage next research in this area.

4.1 Dataset

In this study, I use the daily stock market data for the automotive companies mentioned above. Moreover, I also include the data of stock market indices for the Frankfurt Stock Exchange and New York Stock Exchange, DAX and NYSE respectively. These data are then used to calculate the daily returns of individual stocks and aggregate stock markets. Finally, I add the 12-month LIBOR (London Interbank Offered Rate) subsequently divided by 250 so as to obtain the daily risk free rate. However, it turned out that the daily risk free rate was essentially zero. All of these data concerning stock markets were downloaded from finance.yahoo.com (2013).

The studied period stretches from the 3 January 2005 to 7 February 2013. I decided to focus on this specific period based on the number of introductions of new models and the number of introductions of the special breakthrough models.

The last and most important variable in the dataset is a dummy variable indicating whether on the specific day occurred the introduction of new model or not. The dummy takes on a value of one for the days on which the introduction did occur and is zero otherwise. Moreover, I chose to treat the facelift of a model same as the new generation of a model or a completely new model. As to describe the facelift, it is a slight modification of a design, selection of engines and features of a currently offered model. It often occurs in the middle of a lifetime of the particular model and it enables the producer to accommodate it with the latest attainments. Therefore, it helps to keep the sales numbers stable and remain competitive in the market. By including the facelifts in the dataset, I was able to increase the number of new model introductions and obtain a large-enough sample. Finally, the number of announcements of new car models totaled at 144.

The gathering of stock market data was straightforward, as it was freely accessible on the internet and I only had to download it and shortly review whether the format and nature were correct. However, the obtaining of the exact day on which the first information and images of new models were released was really cumbersome and time-consuming. I could have made the process easier by taking the world premiere of the model as that important day, but for majority of the models this premiere occurs on one of the biggest and most popular car shows that take place four times a year. However, with this approach I would most probably conclude that the stocks of automobile companies are re-

sponsive to the presence of car shows which I do not consider to be interesting. I wanted to pick the exact day when the first piece of information was made available and see whether it makes the stocks react. Therefore, I had to search for this information for all models in the study one by one. I mostly used information from the two websites, www.auto.cz (2013) and www.goauto.com.au (2013). In the articles published by these servers I searched for the first posts mentioning the specific models and whenever possible, verify whether the news contained the phrase "today" or "yesterday" and then decided which day to pick.

4.2 BMW

BMW AG (Bayerische Motoren Werke, Aktiengesellchaft) was founded on the 21 July 1917. In its beginnings, it profited mostly from ongoing war in Europe due to increasing demand for engines. It only started to focus on automobiles in late 1920's and its first car went to mass production and sale in the midst of the Great Depression in 1929. It turned out to be very popular and this success helped BMW to survive the difficult times. Later in the century, it has become the synonym of sport vehicles that are suitable for daily use. To this day, BMW has been steadily growing and increasing its market share. Moreover, the highest growth and biggest expansion took place in this century. As we will see, it holds also for other car manufacturers. Understandably, it was caused by the unprecedented upsurge in the information technology and massive application of its achievements in the car industry. New techniques and discoveries provided the producers with almost endless opportunities and ways how to improve the transport. To be more specific, the most recent contributions to the car industry introduced by BMW are definitely the hydrogen powered engine and the head-up display. In 2005, BMW was the first to ever consider the use of hydrogen powered engine in an automobile and published the specifics of this proposition. Unfortunately, the hydrogen engine was never in mass production due to high costs associated with the construction of the hydrogen stations. In addition, in 2003 BMW was the first European car-maker that introduced the head-up display. It used the technology which is popular in the aviation and thus enabled the drivers to see the information about the speed and navigation directly on the windshield. It therefore increased the safety of travel because the driver no longer had to diverge his sight from the road. This new feature became very popular and other producers soon followed suit.

To address the introduction of new models in the studied period from 2005-2013, BMW was one of the most creative producers. It introduced altogether 22 new models and presented the market with few breakthrough models that literally established new class of the vehicles. At this point, it is worth mentioning X1, X3, X6, 5GT and 3GT. The X1, introduced in 2009, is the smallest from the family of SUVs (Sport Utility Vehicle) and was a success. The X3, first introduced in 2003, was targeted at the buyers who were looking for SUV that was smaller and more efficient than the bigger X5 already on the market since late 90s. It also experienced unexpected sales number and in 2010 the next generation was introduced.

Despite all these accomplishments, the real breakthrough took place with the X6, 5GT and subsequently the 3GT models. In late 2007, BMW took a brave step and designed X6, a model that was defined as the combination of the utility and ability to travel in challenging conditions, namely the advantages provided by SUV, and the performance, design and ability of the genuine sports car. On the other hand, introduced a year later, the 5GT model combined the advantages of SUV and the comfort and security of a saloon or a limousine. Subsequently, in 2013 the 3GT model was developed with the same intensions but was targeted at customers that demanded a smaller version. The first two meant a huge success for BMW, with the X6 showing a tremendous sales numbers. To this day, no other producer has yet developed a direct competition and the whole SAV (Sport Agility Vehicle) market is supplied by BMW.

Currently, BMW is traded on the Frankfurt Stock Exchange at around 70 Euros per share, with capitalization over 45 billion Euros. At the beginning of the studied period in 2005, BMW was traded at approximately 30 Euros per share and then in 2009 it hit the bottom just below the 20 Euros and afterwards experienced steady growth throughout the rest of the selected period finishing in early 2013.

4.3 Daimler

As noted above, I use the data of Daimler AG as Mercedes-Benz is part of it. Mercedes-Benz was founded in 1886 as Benz Patent Motorwagen, first automobile ever, was produced by Karl Benz. The company has a broad history and made a tremendous contribution to the whole automobile industry. The most notable that are worth mentioning are the introductions of airbags and seatbelts in second half of last century and various stabilisation and security

systems at the beginning of the millennium, represented by ESP (Electronic Stabilisation Programme) and Pre-Safe. All these features brought more safety to the automotive market and cars made by Mercedes-Benz were assumed to be among the most luxurious and prestigious for a long time. However, in the last decade or so the image of the Mercedes-Benz was harmed due to imperfect engineering and manufacturing which resulted in the increasing defectiveness of the vehicles. It is also visible from the price of the company as it exhibits declining pattern and it has not returned to the values that prevailed in the 90s.

Concerning the introduction of new models in the studied period, Mercedes-Benz introduced 32 new models among which were few that created the new segment of cars. As in the case of BMW, the new models came to existence as the designers decided to build an automobile combining the desired features of various types of vehicles. The most popular and successful was the CLS model, introduced in 2004, which combined the characteristics of the sports car and a saloon. The competition, namely Audi and BMW, soon followed suit with their respective models, A7 and 6 Gran Coupe. On the other hand, the least popular model, R, is currently considered as a bad project and the decision to develop this model is seen today as a mistake and step in wrong direction. Introduced in 2005, the R combined the desirable features of SUV, saloon and a van. It exhibited somewhat questionable and controversial design and never saw a direct competition, as the sales figures were unsatisfactory. In addition, Mercedes-Benz decided in 2012 to stop the production of this vehicle. Another and more recent model, CLA, is said to be the smaller and less expensive version of CLS targeted mostly at younger customers. It was only revealed in January 2013.

The Daimler AG is traded at around 44 Euros at the moment and is capitalized at roughly 48 billion Euros. Throughout the studied period, the price of stock fluctuated between 18 and 76 Euros, reaching its highest value in October 2007 and hitting the bottom after a freefall in February 2009.

4.4 Volkswagen Group

The data of Volkswagen Group, division of Volkswagen AG, are of interest as three of the studied companies, Audi, Škoda and Volkswagen, are part of it. However, there are also several other automobile producers included in Volkswagen Group. The most popular and well-known are Porsche, Seat, Bentley,

Bugatti and Lamborghini. Nevertheless, I decided to focus on the three marks mentioned above because they experienced large sales numbers not only in Europe but also in the USA, in ever-growing China and in other countries around the globe as well. Moreover, Škoda was originally founded in Czech Republic and is by far the most successful carmaker in the domestic market.

Volkswagen was founded in 1937 by Ferdinand Porsche in Germany. The last century was characterized by continued growth and series of acquisitions at the end of it. Consequently, the company saw tremendous enlargement and this resulted in it being the world's largest car producer by sold units. It is currently traded at around 170 Euros per share and is capitalized at almost 80 billion Euros. In the period of interest, the stock price fluctuated in very wide bands between 30 and 945 Euros. Stock was traded around the lower bound in 2005 and the excessive price of the stock occurred in October 2008, when Porsche announced the plan to take over the Volkswagen AG. This information skyrocketed the stock price to unprecedented levels. To illustrate this, in just two months the price increased by fivefold. Now, let us have a look at the inventions and some important car models for every manufacturer separately.

4.4.1 Audi

The most important and breakthrough innovation brought by Audi to the automobile industry is the concept of a four-wheel-drive vehicle used in rally motorsport. Although the idea and first realization of all-wheel-drive vehicle dates as back as 1893, the biggest achievement came almost a century later, in 1980, when Audi developed its Quattro model for rally racing. This car turned into immediate success and became a legend in the motorsport history. Later this concept of quattro was applied in several passenger vehicles and as the demand for it increased we can now see that it is available for all Audi models. As this feature provided the cars with better traction and increased the ability in difficult terrain, other producers soon followed suit and offered the all-wheel-drive in their products as well. This is not an unexpected surprise, as the majority of great inventions are followed by similar development.

Audi has not showed extensive creativity as we have seen in the case of BMW and Mercedes-Benz, at least in terms of introduction of new types of vehicles. During the studied period, the number of newly introduced models has totaled at 24, majority of which were only the new generations of specific models or the answer to the new types of vehicles presented by the competition.

However, there is one particular model worth mentioning, the R8. Introduced in 2006, this supersport was a remarkable step as no one expected a car like this to be supplied by mostly conservative company like Audi. Nevertheless, it was accepted by the consumers and surprisingly took a portion of a market controlled by Ferrari, Lamborghini, Maserati, Bentley, Aston Martin and Mercedes-Benz, as all of these have sportscars in their model range.

4.4.2 Škoda

The biggest innovations and exceptional models brought to market by Škoda occurred mostly during the various periods of last century and as these times are not of interest here, I will skip them and mention only currently supplied vehicles.

As in the case of the Audi and, as we will see in the case of the remaining selected producers, Škoda did not bring any new models that were not already produced by some other manufacturer in some slight modification in the studied period. It presented the market with only 9 models. However, Škoda occupies different position in a market and even though it is not among the most innovative car producers, it still is very successful and competitive. It is mainly a result of its main interests, which are keeping all its models up to date, filling them with latest technology, offering all necessary features and at the same time maintaining low price to make the cars more affordable for the majority of customers. Consequently, as noted earlier, Škoda exhibits the highest sales figures in several countries, mostly in Europe.

4.4.3 Volkswagen

Volkswagen was among the first producers that developed and designed cars that established certain new type of vehicle, but, again, most of these took place several decades ago. Nowadays, it seems that the main goals of the Volkswagen is to introduce models that can compete on the market by keeping pace with competition in terms of technology, quality and design. Therefore, Volkswagen maintains the conservative approach to introducing new vehicles. That is, it mainly supplies the classical models and develops new types only after they prove to be marketable by other companies.

However, there are at least two exceptional models for the case of Volkswagen worth mentioning. In 2008, with the Passat CC the firm presented a car based on the successful Mercedes-Benz CLS but which was smaller and much

cheaper and affordable. Thus, the new lower class of sport sedans was established. It took the competition roughly 18 months to respond to this new model with Audi being the first to do so with its A5 Sportback. The second interesting model by Volkswagen is the Beetle. The first generation was originally designed as the family car and was predetermined to success due to its unique look, low price and high quality. On the other hand, the current generation of Beetle, introduced in 2011, is far from what it was originally designed for. Its features place it somewhere between a double-door light efficient sports car and a hatchback. Therefore, it does not have a direct competitor and is with its characteristics the only car of this type on the market. Finally, Volkswagen introduced a total of 21 new models in the studied period.

4.5 Tata Motors

Tata Motors was established in 1945. However, I am only interested in its data from July 2008 till February 2013, as it acquired two of the automotive producers I intend to study, Jaguar and Land Rover, in July 2008. These two companies, founded in 1922 and 1948 respectively, had a rough time surviving the first decade of this century. Even though in their beginning they earned the position in the market and the reputation of high quality and fine engineering, they both experienced a gigantic decline in last decade. Until the acquisition by Tata Motors, it seemed like the investors involved in the ownership only wanted to get rid of them and their troubled situation. As a result, very little money was spent on innovation and research and this led to even bigger problems. Consequently, Jaguar and Land Rover could no longer compete with the rest of producers because of using outdated processes and not being able to offer the latest attainments.

Fortunately, the change that came in 2008 brought new approach to dealing with difficulties and this vital step enabled Jaguar and Land Rover to increase the sales numbers and be profitable again. One particular decision by Tata Motors made a huge difference and is considered a smart idea. The owner suggested that any innovation by either of producers should be directly applied in the other company as well. Hence, the companies could gain from each other and thus be able to profit from roughly twice as many inventions. Therefore, keeping pace with the competition would be made easier and the companies could win their share of the market back. The plan worked and Jaguar and Land Rover are now back and more successful than ever after just few years

under new owner. Overall, Jaguar and Land Rover introduced a total of 9 new models during the studied period.

Throughout the studied period, the stock price of Tata Motors fluctuated between 3 and 35 US Dollars. It fell to the bottom in the February 2009 at the height of the financial crisis and climbed to the top in November 2010. It is currently traded around 27 US Dollars per share and is capitalized at approximately 17 billion US Dollars. Let us now have a closer look at some of the models of these producers separately.

4.5.1 Jaguar

Jaguar, as suggested above, went through an enormous change in a last few years. However, this restructuring started to take place even before the acquisition by Tata Motors. Interestingly, the results started to show beginning in 2008. Formerly, Jaguar was focused on manufacturing very conservative models that were all based on the popular models from past. In particular, the XJ model was closely related to its predecessor in terms of design although the difference between production of the first XJ and the one from 2008 was exactly 40 years. But this tactic did not produce any success and there had to be some transition.

It started with a new XK model early in 2006 through which Jaguar unveiled the future direction of the company. This model had a fresh new design which became popular and was soon applied to the rest of the models as well. It took Jaguar only one year to introduce completely new model, XF, which adopted this new look and finally, in 2009 the brand new XJ arrived with similar features. However, it is worth mentioning that Jaguar have not revealed any special model that would establish completely new type of vehicle.

4.5.2 Land Rover

Land rover is a producer focused exclusively at the production of SUVs and vehicles designed to handle hard conditions. Similarly to Jaguar, it went through massive changes recently. There was a big improvement in technology used so that these cars could continue to compete with the other producers.

On the other hand, some of its current models clearly retain the features of their predecessors and still are well selling. To be more specific, the latest generation of Range Rover is still related to the family of Range Rovers and shows good sales numbers with respect to the fact that it is one of the most

expensive cars in its segment. As in the case of Jaguar, Land Rover has not come up with some breakthrough model. However, it has presented the plans to seriously enlarge the product range in the near future by introducing the new models that would combine various features of already established types of vehicles.

4.6 Toyota Motor Corporation

Toyota Motor Corporation, established in 1937, is the third largest car producer in the World in terms of production. It operates several automobile companies among which are Toyota and Lexus, the last two companies that are of interest in this study. This corporation stands behind one of the most remarkable inventions in the last few decades in automotive industry, which is the so-called hybrid engine. It is the combination of the classical combustion engine and emission-free electric engine. Although the idea of the hybrid engine dates back to the beginning of 20th century, it was widely implemented and offered to the market first by Toyota in 1997. This innovation enabled the company to significantly decrease the consumption of the vehicles and therefore was beneficial to the environment. From other inventions, it is worth mentioning the Intelligent Parking Assist System first offered in Prius in 2003.

Addressing the market performance of Toyota Motor Corporation, it is currently traded slightly above 100 US Dollars per share with capitalization over 320 billion US Dollars. Between the 2005 and 2013 the stock price fluctuated between 58 and 137 US Dollars, achieving the highest and the lowest values in February 2007 and December 2008, respectively.

4.6.1 Toyota

As noted above, remarkable invention was brought to the market in 1997 when Toyota introduced its new model Prius. Through this model, Toyota offered the market the first hybrid engine production car. Moreover, the Prius had a somewhat unique design placing it somewhere between a minivan and a hatchback.

Furthermore, this uniqueness gave the Prius its own place in the market and was soon very popular and recognized. As people started to be more concerned about the environment and wanted to contribute to the overall reduction of emissions, they stared to buy the Prius, even though it was overpriced when

compared to the closest substitutes with classical combustion engines. Toyota then soon started to offer this type of engine across the vast majority of the models.

4.6.2 Lexus

Lexus is a luxurious division of Toyota and it was established in 1989. It offers various models but did not introduce any special vehicles that would not be offered by other producers. However, as Toyota earned success with its hybrid engine, it decided to offer them across the model range of Lexus as well. Moreover, the Intelligent Parking Assist System was for the first time made available to the world outside of Japan through one of the Lexus models in 2006.

Although the marque is rather young, it built up a reputation of high-quality engineering and its models, in particular sedan GS, saloon LS and the SUV RX, became very popular and won a large market share very soon. This is true especially for the case of US market where the hybrid engines are demanded the most.

Chapter 5

Discussion of Results

In this chapter, I present the results of the proposed models as well as provide some basic summary of the data.

The first section is concerned with the summary statistics. The graphs of the daily stock prices and daily returns for all companies and indices are also included and this section comes to end with the correlation matrix indicating the level of correlation between individual companies and indices. The second section focuses on the results of the CAPM approach to the studied questions and discusses the results for all of the companies individually. Finally, the last section concentrates on the GARCH approach to answering the studied questions and similarly incorporates the analysis of the outcome.

Moreover, it is often the case that the financial time-series data suffer from heteroskedasticity of disturbances. It is widely known issue and interested readers might refer to Cont (2001) for the compelling discussions. Therefore, in this chapter I use heteroskedasticity robust estimation so as to be able to cope with this obstacle.

5.1 Basic Statistics

5.1.1 Stock Prices

First of all, I intend to discuss the dataset in more detail. Thus, the table of summary statistics (Table 5.1) follows.

As can be seen from the table, there are some differences in the number of observations. In the case of European companies and the stock market index, only one observation was missing for the BMW. Unexpectedly, there seemed to be some issue with the companies traded on NYSE and also with the NYSE

Table 5.1: Summary Statistics

Company	Obs.	Mean	St. Dev.	Min	Max
BMW	2086	43.58832	13.3757	17.04	75.93
Daimler	2087	42.46275	11.29812	17.44	77.76
Volkswagen	2087	120.2794	70.48293	31.88	945
Toyota	2017	88.995	18.63004	57.68	137.77
Tata Motors	1140	18.25208	7.903597	3.14	36
DAX	2087	6131.105	1044.114	3666.41	8105.69
NYSE	2017	7832.266	1160.421	4226.31	10311.61

Source: author's computations.

index. However, after closer examination of the data I found that there was no real problem at all as on all days that reported missing value were bank holidays. Moreover, as I investigated the European companies on these days, their stock prices did not change and there was no volume of trade indicating that no trading was executed. In addition, as discussed earlier, the reason for Tata Motors having only 1140 observations is because I am only interested in time span between July 2008 till February 2013, i.e. after the Tata Motors acquired Jaguar and Land Rover, the two companies that I wanted to investigate.

Another important implication that could be drawn from the table is the information about the volatility. On the one hand, the most volatile was the stock of Volkswagen which fluctuated between 31.88 and 945 Euros. The reasons for such wide fluctuation bands were explained in the preceding chapter. Moreover, during the week before and after this excessive stock price, there were no new car model introductions by any of the producers and also when these data were deleted and models in subsequent sections were estimated, there were no significant differences when compared to the estimated coefficients using the complete data. Hence, I decided to continue with the complete data as it did not alter the estimation in a significant way and it therefore did not present an obstacle. On the other hand, the least volatile stock was that of Toyota Motor Corporation which fluctuated between 57.68 and 137.77 US Dollars.

Now, let us have a look at the graphs of the daily stock prices (Figures 5.1 and 5.2) so as to review the overall performance and evolution of the market valuation of studied automobile producers.

It is visible from the graphs (Figure 5.1) that there are several similarities between producers except Volkswagen Group. The most recognizable is that the 4 remaining companies and both indices hit the bottom in terms of stock

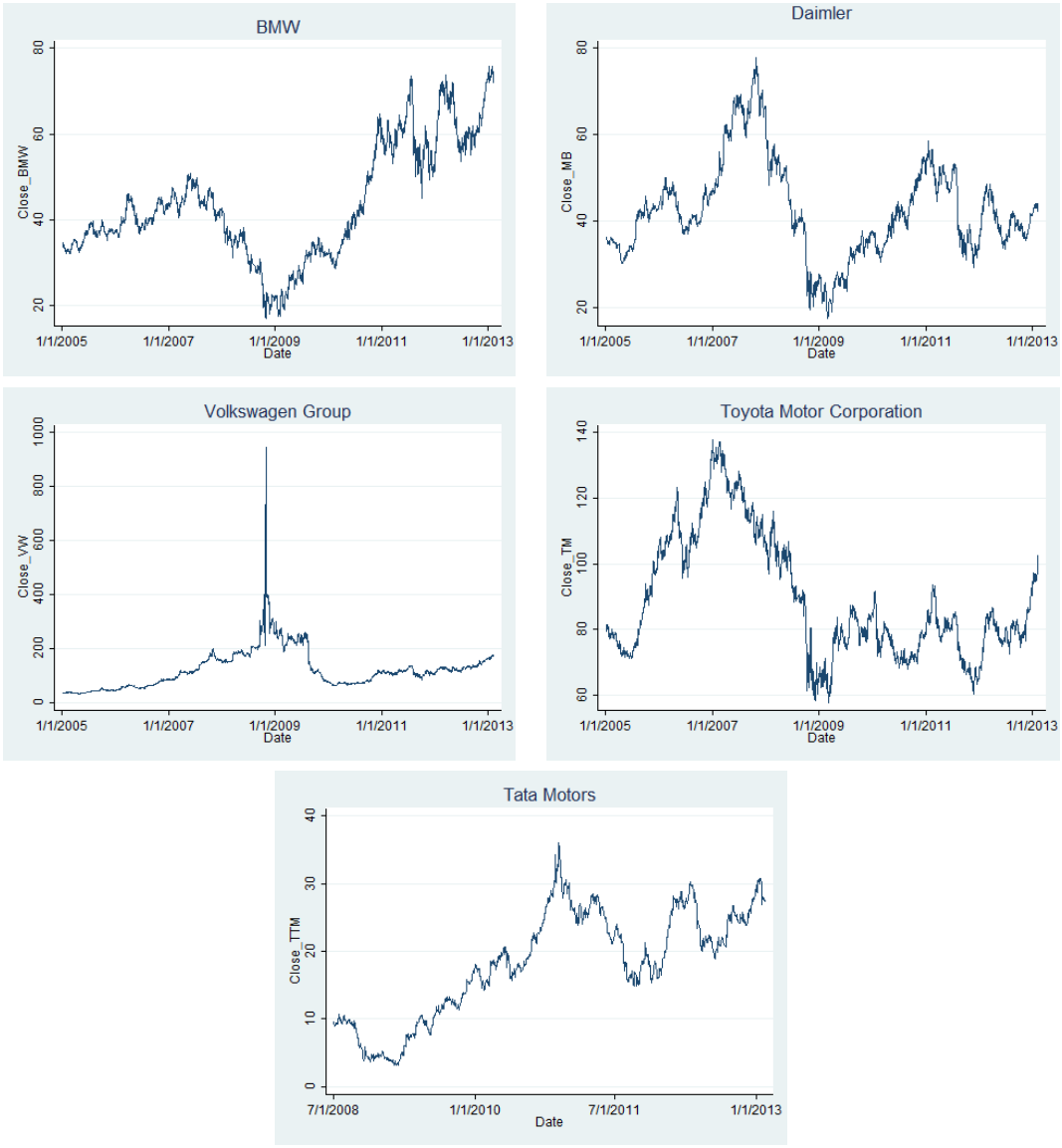

Figure 5.1: Stock Prices of the Companies

price around the beginning of 2009. Moreover, the companies can be divided in two separate groups. In the first group, BMW and Tata Motors show similar pattern which can be described by overall growth. Stocks of these two companies experienced decline throughout the whole year 2008 but were mostly rising during the rest of the selected period with occasional drops. In the other group, Daimler and Toyota Motor Corporation are also very much alike and can be characterized by tremendous surge from the beginning of studied period up to the height of the boom in the early 2008, succeeded by massive fall ending in 2009 and followed by slight upward movement and then stagnation around the sample mean.

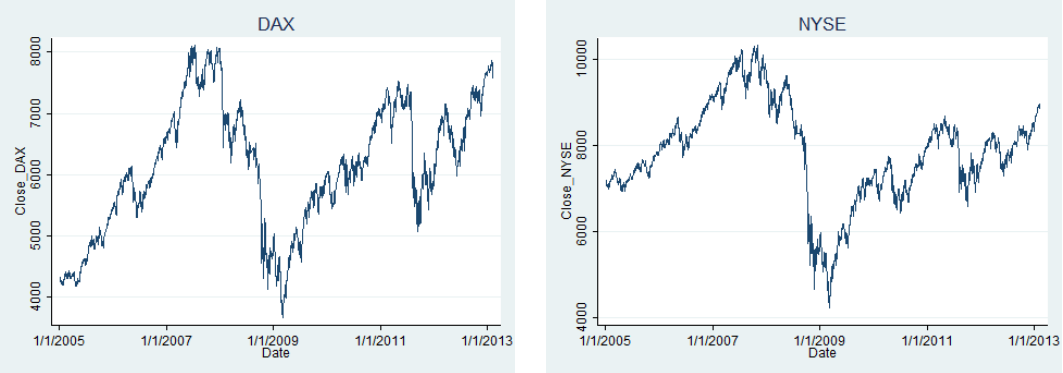

Figure 5.2: Stock Prices of the Market Indices

The case of Volkswagen Group is unique and completely different from the rest of the studied companies. The stock price was steadily increasing for the time period from 2005 to 2009, then experienced sudden jump to unstable level due to reasons explained in previous chapter, returned back to preceding values, fell dramatically in the late 2009 and was again steadily growing throughout the rest of the chosen period.

To characterize the stock market indices (Figure 5.2), it is obvious that they followed similar pattern. In the studied period, the primary upsurge was followed by huge decline which turned into growth once again finishing at values comparable with those prevailing before the slump.

5.1.2 Stock Returns

This subsection focuses on the stock returns of the individual companies and indices (Figures 5.3 and 5.4). There are few inferable specifics that are worth mentioning. Firstly, it is clear that the stock were most volatile during the

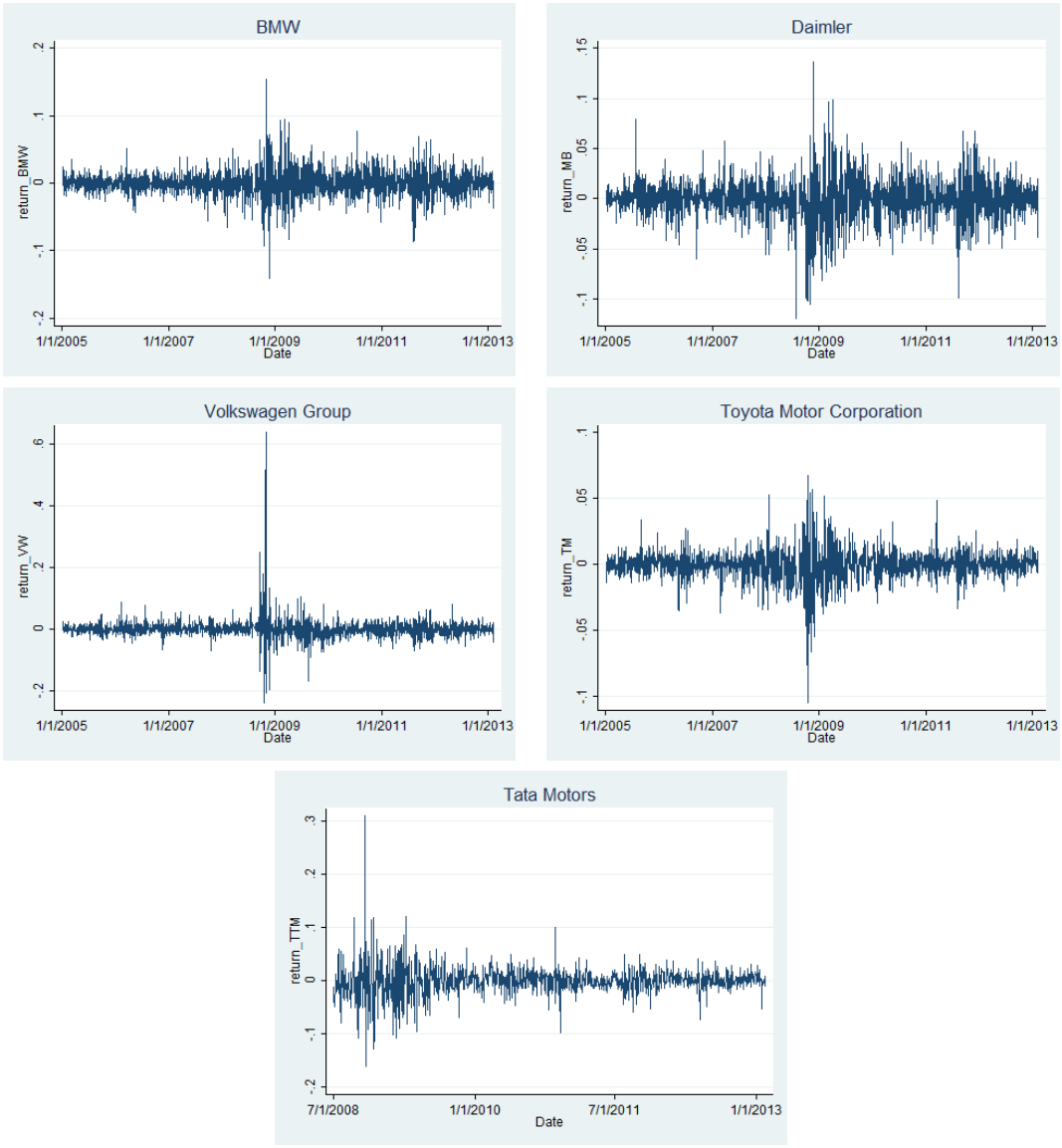

Figure 5.3: Stock Returns of the Companies

slump in the late 2008 and early 2009. Understandably, this holds for all studied companies and indices as the financial crisis spread quickly through the entire financial system. Secondly, the second half of the studied period, i.e. from 2009 to 2013, appears to be more volatile than the first half. It might be the consequence of fragile confidence in the performance of markets and lurking bad condition of the national economies.

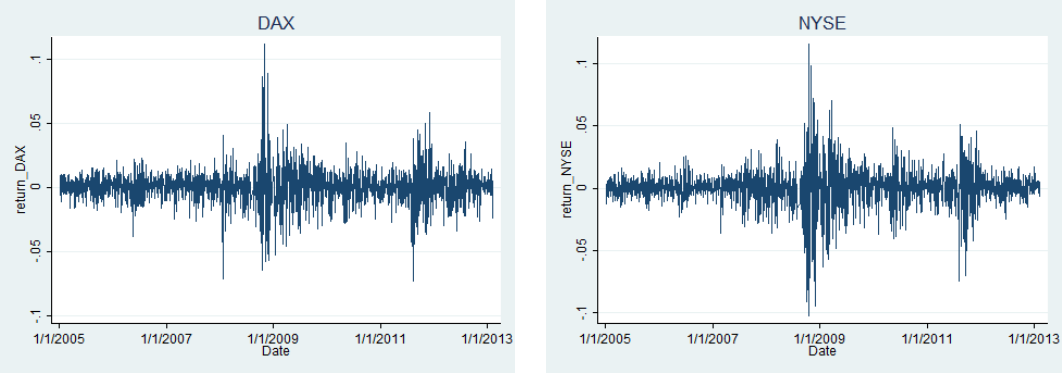

Figure 5.4: Stock Returns of the Market Indices

Moreover, it is especially true for the case of Europe and USA. In Europe there are still some unresolved issues concerning the functioning and future direction of Eurozone and most of the EU nations are either in recession or in stagnation. And even though the US economy is growing, the magnitude of growth is rather insufficient and does not reflect its true potential. In my opinion, these are the reasons that could explain the evolution of the stock returns.

5.1.3 Correlation between Companies

Here I present the readers with the correlation matrix of stock returns and provide a brief analysis of the level of correlation between the individual companies and indices. Hence, the correlation matrix (Table 5.2) is as following.

While looking at the correlation matrix, interesting results can be spotted. First of all, all of the companies are strongly correlated with the index of the market on which they are traded on. These correlation coefficients range from the 40% for Volkswagen to almost 76% for the Daimler. Moreover, for the three out of five companies, namely BMW, Daimler and Toyota, this correlation coefficient is not lower than 71% which indicates very high correlation

Table 5.2: Correlation Matrix

Company	BMW	DAI	VW	TMC	TTM	DAX	NYSE
BMW	1						
DAI	0.7729	1					
VW	0.3093	0.2451	1				
TMC	0.4243	0.3956	0.1400	1			
TTM	0.3113	0.3346	0.1427	0.4413	1		
DAX	0.7107	0.7556	0.4038	0.5042	0.3523	1	
NYSE	0.5048	0.4992	0.2305	0.7434	0.4561	0.6715	1

Source: author's computations.

and therefore very strong dependence between the stock returns of the markets and these companies. Second of all, the highest correlation coefficient is between the BMW and Daimler with a value of roughly 77%. This shows very strong relationship between the returns of these two producers which could be explained by the fact that they are traded on the same stock exchange, are very much alike and therefore represent the biggest competitor for one another. Next of all, very high correlation is between the two indices with a value approximately 67%. Unsurprisingly, this figure only confirms that the markets are very similar in returns and indicates that the whole financial system is deeply interconnected. This was expected as during the most recent financial crisis the whole world witnessed how the events and turmoil in one country can affect and hit the rest of the world. Last of all, the case of the Volkswagen and Tata Motors is somewhat different from the other producers. It could be noticed that these two companies do not exhibit correlations higher than 40% and 45%, for Volkswagen and Tata Motors respectively. Furthermore, there are two correlation coefficients of value approximately 14%, one of which is just the one between these two companies. These low levels of correlation coefficients indicate that stock returns of these companies followed different paths than the returns of the rest of the companies in the sample. In the case of Volkswagen, it could be explained partly by the dramatic fluctuations that were described above. However, in the case of Tata Motors, there is no definite explanation available.

Based on the results of correlation analysis I decided to divide the companies in two separate groups. In one group there will be BMW, Daimler and Tata Motors and in the other Volkswagen and Toyota Motor Corporation. This

division can be justified not only in terms of the level of correlation between the members of groups but also in terms of types of produced vehicles. The companies in the first group offer somewhat limited range of exclusive models focusing mostly on richer customers while those in second group supply wide range of vehicles for wider variety of purchasers in terms of wealth and these corporations own more marques as well. I will apply this division in the next section when studying the cross-effect of new model introduction on the competition that supplies the closest substitutes to the market.

5.2 CAPM

In this section, I present and discuss the results of the CAPM approach to the studied questions. Firstly, I focus on the direct impact of new model introduction on the introducing company. Secondly, I take a closer look on the cross effect on the rivals of the introducing company, and lastly, I examine the direct impact of earnings announcement on the announcing company.

5.2.1 Direct Effect of New Model Introduction

Here I expect to arrive at conclusion that the new car model introduction has a positive impact on the stock returns of the introducing company. The results of the regressions are in the Table 5.3, where in the brackets are robust standard errors of the estimates, below them are the associated p-values and R^2 is the usual R^2 of the regression.

There are some important remarks and results inferable from the estimated models above. First of all, the estimate of the difference between the market return and risk-free return, i.e. first explanatory variable in all models, is positive for every producer with values between 0.59 and 1.14 that are very statistically significant as the p-values are 0.000 for every estimate. Second of all, I found positive statistically significant estimate of coefficient on the dummy variable, indicating the new model announcement, for the three producers, BMW, Volkswagen and Tata Motors. The p-values of the estimates are 0.000, 0.000 and 0.001 respectively. For both Daimler and Toyota Motor Corporation, I found rather small statistically insignificant impact and so I conclude that there is no impact at all for these two companies.

Table 5.3: Direct Effect of New Model Introduction Using CAPM

Company	*Constant*	$r_M - r_f$	D	R^2
BMW	$9.3 * 10^{-5}$ $(6.7 * 10^{-4})$ 0.890	1.025 (0.052) 0.000	0.0123 (0.001) 0.000	0.506
DAI	$8.7 * 10^{-4}$ $(8.5 * 10^{-4})$ 0.306	1.134 (0.067) 0.000	$-8.9 * 10^{-4}$ (0.001) 0.606	0.568
VW	-0.001 (0.001) 0.496	0.838 (0.154) 0.000	0.014 (0.002) 0.000	0.169
TMC	-0.005 $(2.7 * 10^{-4})$ 0.000	0.597 (0.021) 0.000	-0.002 (0.002) 0.453	0.553
TTM	-0.002 $(7.9 * 10^{-4})$ 0.009	0.683 (0.059) 0.000	0.030 (0.014) 0.030	0.217

Source: author's computations.

These are very important results, as they answer one of the questions of the study. Indeed, the new model introduction has an impact on the stock returns of the introducing company. Even though this result does not hold for all producers included in this study, it is true for the majority of the companies and so I conclude that, overall, the announcement of a new car model has an impact on the introducing producer.

5.2.2 Cross Effect of New Model Introduction

In this subsection, the standard economic thinking implies that a new model introduction should affect the stock returns of rivals in a negative way. The regression results of the cross effect models are in the tables 5.4 and 5.5.

It is immediately visible that vast majority of effects is statistically insignificant. However, there are two statistically significant effects, both at 5%, one of which is quite strange in the sign. The first is the negative effect of a new model introduction by Daimler on BMW. This impact confirms what was expected, i.e. that new car model announcement affects the stock returns of competition in negative way. The second is, surprisingly, the positive effect of a new model introduction by BMW on Daimler. This impact goes against standard thinking and does not make much economic sense either. Therefore, I conclude

Table 5.4: Cross Effect of New Model Introduction on competition Using CAPM for BMW, Daimler and Tata Motors

Company	*Constant*	$r_M - r_f$	D	R^2
Effect of BMW				
on DAI	$8.1 * 10^{-4}$ $(8.4 * 10^{-4})$ 0.337	1.135 (0.067) 0.000	0.005 (0.002) 0.018	0.568
on TTM	-0.002 $(8 * 10^{-4})$ 0.021	0.681 (0.059) 0.000	0.005 (0.003) 0.065	0.209
Effect of DAI				
on BMW	$2.8 * 10^{-4}$ $(6.7 * 10^{-4})$ 0.681	1.023 (0.052) 0.000	-0.005 (0.002) 0.010	0.503
on TTM	-0.002 $(8 * 10^{-4})$ 0.017	0.684 (0.059) 0.000	0.005 (0.006) 0.399	0.209
Effect of TTM				
on BMW	$8.5 * 10^{-4}$ $(7.9 * 10^{-4})$ 0.283	1.041 (0.070) 0.000	0.008 (0.005) 0.158	0.496
on DAI	$(5.5 * 10^{-4}$ $(9.7 * 10^{-4})$ 0.568	1.170 (0.090) 0.000	0.011 (0.009) 0.205	0.577

Source: author's computations.

Table 5.5: Cross Effect of New Model Introduction on competition Using CAPM for Volkswagen and Toyota

Company	*Constant*	$r_M - r_f$	D	R^2
Effect of VW				
on TMC	-0.005 $(2.8 * 10^{-4})$ 0.000	0.596 (0.020) 0.000	$-2.2 * 10^{-4}$ (0.001) 0.828	0.553
Effect of TMC				
on VW	$-6.6 * 10^{-4}$ (0.002) 0.736	0.856 (0.158) 0.000	-0.007 (0.006) 0.269	0.164

Source: author's computations.

that there is no definite cross-effect of new model announcement on the stock returns of the rivals that holds overall for all producers in the sample.

5.2.3 Direct Effect of Earnings Announcement

The standard reasoning suggests that there is no definite impact of earnings announcement on the announcing company as these announcements are all treated the same regardless of their incidence. The regression estimates of the effect of earnings announcement are in the Table 5.6.

Table 5.6: Direct Effect of Earnings Announcement Using CAPM

Company	*Constant*	$r_M - r_f$	D	R^2
BMW	$2.2 * 10^{-4}$ $(6.7 * 10^{-4})$ 0.742	1.023 (0.052) 0.000	$-8.6 * 10^{-4}$ (0.004) 0.835	0.502
DAI	$9 * 10^{-4}$ $(8.5 * 10^{-4})$ 0.286	1.133 (0.067) 0.000	-0.004 (0.005) 0.468	0.568
VW	-0.001 (0.002) 0.577	0.838 (0.154) 0.000	0.009 (0.006) 0.111	0.164
TMC	-0.005 $(2.7 * 10^{-4})$ 0.000	0.597 (0.020) 0.000	$-3.4 * 10^{-4}$ (0.003) 0.901	0.553
TTM	-0.002 $(7.4 * 10^{-4})$ 0.013	0.684 (0.059) 0.000	0.001 (0.018) 0.943	0.209

Source: author's computations.

These results suggest that there is no definite effect of earnings announcement on the stock returns of the concerned company as all estimates on the dummy variables are statistically insignificant. The most significant effect of earnings announcement was for the case of Volkswagen but, statistically, it is not different from zero at 5% significance level. Fortunately, these results might be easily explained as the earnings announcements could affect the returns in positive as well as negative way depending on the fact whether they reported successful growing or insufficient declining figures that did not fulfill expectations. Therefore, no overall unambiguous impact was detected. However, in the next section with the help of GARCH model I model the volatility and

thus I may find an impact of earnings announcement on the volatility of stocks of the announcing company. This is due to the expectation that volatility of stocks is higher during these days regardless of the nature and incidence of the figures.

5.3 GARCH

In this section, which is rather similar to the previous one, I again intend to answer the questions asked by this study. However, as already noted, I use here somewhat different approach and explore these issues from different perspective. To be more specific, I investigate the behavior of volatility rather than the returns of stocks using the GARCH model. Therefore, this approach enables me to conclude whether the new model announcement or the earnings announcement has any impact on stocks of announcing company or its rivals in a sense that the volatility changes. I expect to arrive at more significant, clear and definite effect when compared to the one I found in previous section as in my opinion the release of this kind of information indeed has an impact on the volatility of stocks.

This section is structured very similarly as the section above and it has three individual parts. In the first I focus on the direct effect of new model introduction on announcing company, in the second on the cross-effect on the rivals and, finally, in the third on the direct impact of earnings announcement on the announcing company.

5.3.1 Direct Effect of New Model Introduction

The expectation here is to obtain a positive effect of new model introduction on the volatility of stocks of the introducing company. The results of the GARCH model estimation are in Table 5.7 where $AR(1)$ $C.$ is the AR(1) Constant, $GARCH$ $C.$ is the GARCH constant and D is the dummy variable.

There are several facts noticeable from the table immediately. Firstly, the $AR(1)$ $Constant$ and $AR(1)$ were estimated to be positive for all models but are statistically significant at 5% only for the case of Volkswagen. Respective estimates are 0.001 and 0.071 and associated p-values are 0.001 and 0.008. Secondly, the estimate on $GARCH$ $Constant$ is positive and statistically significant for 4 producers with very small values ranging from $1.6*10^{-6}$ to $9.9*10^{-6}$ and is insignificant for the Tata Motors. Thirdly, moving now to discussing the

Table 5.7: Direct Effect of New Model Introduction Using GARCH

Company	$AR(1)$ $C.$	$AR(1)$	$GARCH$ $C.$	$ARCH$	$GARCH$	D
BMW	$3.2 * 10^{-4}$ $(3.1 * 10^{-4})$ 0.320	0.005 (0.023) 0.816	$1.6 * 10^{-6}$ $(8.2 * 10^{-7})$ 0.047	0.056 (0.012) 0.000	0.941 (0.012) 0.000	$-1.6 * 10^{-5}$ $(2.9 * 10^{-5})$ 0.581
DAI	$8.4 * 10^{-5}$ $(3.3 * 10^{-4})$ 0.799	0.007 (0.024) 0.761	$6.7 * 10^{-6}$ $(2.7 * 10^{-6})$ 0.014	0.083 (0.018) 0.000	0.902 (0.019) 0.000	$-3.8 * 10^{-5}$ $(1.9 * 10^{-5})$ 0.043
VW	0.001 $(3.6 * 10^{-4})$ 0.001	0.071 (0.027) 0.008	$9.9 * 10^{-6}$ $(4.1 * 10^{-6})$ 0.015	0.125 (0.031) 0.000	0.863 (0.031) 0.000	$5.7 * 10^{-6}$ $(3.9 * 10^{-5})$ 0.886
TMC	$1.6 * 10^{-4}$ $(1.7 * 10^{-4})$ 0.352	0.020 (0.024) 0.405	$1.9 * 10^{-6}$ $(7.2 * 10^{-7})$ 0.006	0.099 (0.022) 0.000	0.879 (0.024) 0.000	$1.5 * 10^{-5}$ $(1.7 * 10^{-5})$ 0.376
TTM	$6.8 * 10^{-4}$ $(5.9 * 10^{-4})$ 0.243	0.024 (0.035) 0.495	$4.2 * 10^{-6}$ $(2.5 * 10^{-6})$ 0.098	0.069 (0.018) 0.000	0.928 (0.014) 0.000	$-8.9 * 10^{-5}$ $(4.9 * 10^{-5})$ 0.067

Source: author's computations.

$ARCH$ and $GARCH$ effects estimates, it is interesting that all of the coefficients are very statistically significant with p-values equal to 0.000. Moreover, in all cases the sum of the $ARCH$ and $GARCH$ effect is close to unity which means that the shocks to the conditional variance are highly persistent (Brooks 2008). In addition, the $GARCH$ effect is larger for all producers. The intervals of values for the $ARCH$ and $GARCH$ effects are from 0.056 to 0.125 and from 0.863 to 0.941, respectively. Lastly, focusing on the most important variable in the model, the dummy, it is visible that the estimate is negative and statistically significant only for the Daimler. In all remaining cases the effect is insignificant at 5%. Interpreting the result for Daimler, this estimate suggests that the event of new car model introduction has a negative effect on the volatility of stock of the introducing company which is exactly the opposite of what I was expecting. However, for the rest of the companies, the estimates are insignificant and therefore for these producers there is no detectable impact of new model introduction on the volatility of their stocks.

To sum up, as the dummy variable is insignificant for majority of producers, 4 out of 5 in this study, I conclude that, overall, the new model introduction has no impact the volatility of stocks of the introducing company.

5.3.2 Cross Effect of New Model Introduction

In this particular case, it is not clear what effect is to be arrived at. On the one hand, the introduction of a new model could affect the volatility of stocks of rivals in a negative way because the traders and investors are more interested in the introducing company and trade more with its stocks. On the other hand, this introduction of new model could affect the volatility of stocks of competitors in positive way as traders might focus on the whole automobile industry and trade heavily with stocks of all automotive companies thus increasing the stock volatility of competitors as well. The estimates of the GARCH models are in the tables 5.8 and 5.9.

Table 5.8: Cross Effect of New Model Introduction on competition Using GARCH for BMW, Daimler and Tata Motors

Company	$AR(1)$ $C.$	$AR(1)$	$GARCH$ $C.$	$ARCH$	$GARCH$	D
Effect of BMW						
on DAI	$3.6 * 10^{-5}$ $(3.4 * 10^{-4})$ 0.916	0.006 (0.024) 0.811	$6.2 * 10^{-6}$ $(2.9 * 10^{-6})$ 0.031	0.086 (0.020) 0.000	0.899 (0.022) 0.000	$4.2 * 10^{-6}$ $(5.5 * 10^{-5})$ 0.940
on TTM	$8.3 * 10^{-4}$ $(5.7 * 10^{-4})$ 0.147	0.021 (0.035) 0.542	$3.7 * 10^{-6}$ $(2.1 * 10^{-6})$ 0.069	0.064 (0.019) 0.001	0.933 (0.014) 0.000	$-8.1 * 10^{-5}$ $(4.1 * 10^{-5})$ 0.049
Effect of DAI						
on BMW	$2.9 * 10^{-4}$ $(3.1 * 10^{-4})$ 0.350	0.005 (0.023) 0.812	$1.7 * 10^{-6}$ $(9 * 10^{-7})$ 0.059	0.056 (0.012) 0.000	0.940 (0.012) 0.000	$-7.2 * 10^{-6}$ $(1.9 * 10^{-5})$ 0.709
on TTM	$7.8 * 10^{-4}$ $(5.8 * 10^{-4})$ 0.181	0.021 (0.035) 0.552	$3.6 * 10^{-6}$ $(2.6 * 10^{-6})$ 0.156	0.070 (0.019) 0.000	0.928 (0.014) 0.000	$-8.2 * 10^{-6}$ $(3.2 * 10^{-5})$ 0.799
Effect of TTM						
on BMW	$8.5 * 10^{-4}$ $(5.6 * 10^{-4})$ 0.128	0.011 (0.030) 0.720	$6.4 * 10^{-6}$ $(3.8 * 10^{-6})$ 0.092	0.067 (0.019) 0.000	0.921 (0.022) 0.000	$-1.7 * 10^{-5}$ $(8.5 * 10^{-5})$ 0.837
on DAI	$1.9 * 10^{-4}$ $(5.6 * 10^{-4})$ 0.724	0.033 (0.031) 0.289	$6.2 * 10^{-6}$ $(4.2 * 10^{-6})$ 0.143	0.081 (0.038) 0.031	0.910 (0.040) 0.000	$-2.7 * 10^{-5}$ $(9.4 * 10^{-5})$ 0.774

Source: author's computations.

While looking at these two tables, several important and interesting findings could be spotted. First of all, the coefficient estimates on $AR(1)$ $Constant$ and $AR(1)$ effects are statistically significant for only one cross-model of the effect of Toyota on Volkswagen. For the remaining cross-models these two estimates

Table 5.9: Cross Effect of New Model Introduction on competition Using GARCH for Volkswagen and Toyota

Company	$AR(1)$ $C.$	$AR(1)$	$GARCH$ $C.$	$ARCH$	$GARCH$	D
Effect of VW						
on TMC	$1.8 * 10^{-4}$ $(1.7 * 10^{-4})$ 0.269	0.024 (0.024) 0.328	$1.8 * 10^{-6}$ $(6.8 * 10^{-7})$ 0.009	0.109 (0.026) 0.000	0.871 (0.028) 0.000	$1.2 * 10^{-5}$ $(1.1 * 10^{-5})$ 0.297
Effect of TMC						
on VW	0.001 $(3.6 * 10^{-4})$ 0.001	0.076 (0.026) 0.004	$9.5 * 10^{-6}$ $(3.9 * 10^{-6})$ 0.017	0.121 (0.029) 0.000	0.864 (0.029) 0.000	$1.1 * 10^{-4}$ $(8.8 * 10^{-5})$ 0.221

Source: author's computations.

of the conditional mean equation are insignificant. The *GARCH Constant* estimates are significant at 5% for both cross-models between Toyota and Volkswagen and also for the model of effect of BMW on Daimler. However, for the rest of the cross-models the estimates on *GARCH Constant* are insignificant. Second of all, strong *ARCH* and *GARCH* effects are present in these models as in all of them these effects are estimated to be very statistically significant. Similarly to the previous section, the sum of these effects is again very close to one with the *GARCH* being larger taking values between 0.864 and 0.940. Third of all, only 1 out of 8 estimates on the dummy variable is significant with a negative value of $-8.1 * 10^{-5}$ and p-value equal to 0.049. This impact was detected in the model of effect of BMW on Tata Motors. Its negative value implies that the event of new model introduction by BMW caused the volatility of stocks of Tata Motors to be lower. However, in the all other cases of this cross-effect was estimated to be insignificant meaning that there is no definite impact on the volatility of the competitors' stocks.

In conclusion, the new car model introduction does not have a definite impact on the volatility of stocks of the rival producers as for the vast majority of cases I arrived at insignificant effects.

5.3.3 Direct Effect of Earnings Announcement

As noted earlier, the expectation about the effect here is straightforward and it is that the earnings announcement increases the volatility of stocks of the announcing company. The estimates of the direct effect earnings announcement GARCH model are in the Table 5.10.

Table 5.10: Direct Effect of Earnings Announcement Using GARCH

Company	$AR(1)$ $C.$	$AR(1)$	$GARCH$ $C.$	$ARCH$	$GARCH$	D
BMW	$2.9 * 10^{-4}$ $(3.1 * 10^{-4})$ 0.352	0.005 (0.023) 0.814	$1.4 * 10^{-6}$ $(8,4 * 10^{-7})$ 0.106	0.057 (0.013) 0.000	0.938 (0.014) 0.000	$3.7 * 10^{-5}$ $(3.2 * 10^{-5})$ 0.244
DAI	$1.9 * 10^{-4}$ $(3.4 * 10^{-4})$ 0.559	0.008 (0.024) 0.737	$5.1 * 10^{-6}$ $(2.6 * 10^{-6})$ 0.049	0.092 (0.022) 0.000	0.891 (0.025) 0.000	$1.6 * 10^{-4}$ $(7.7 * 10^{-5})$ 0.048
VW	0.001 $(3.5 * 10^{-4})$ 0.000	0.070 (0.027) 0.008	$8.6 * 10^{-6}$ $(3.8 * 10^{-6})$ 0.023	0.128 (0.030) 0.000	0.857 (0.030) 0.000	$1.9 * 10^{-4}$ $(7.9 * 10^{-5})$ 0.017
TMC	$2.1 * 10^{-4}$ $(1.7 * 10^{-4})$ 0.209	0.025 (0.024) 0.307	$1.5 * 10^{-6}$ $(6.3 * 10^{-7})$ 0.019	0.092 (0.024) 0.000	0.886 (0.027) 0.000	$3.5 * 10^{-5}$ $(1.3 * 10^{-5})$ 0.006
TTM	$7.2 * 10^{-4}$ $(5.8 * 10^{-4})$ 0.213	0.022 (0.035) 0.521	$3.3 * 10^{-6}$ $(2.4 * 10^{-6})$ 0.182	0.073 (0.021) 0.001	0.922 (0.018) 0.000	$8.5 * 10^{-5}$ $(1.2 * 10^{-4})$ 0.453

Source: author's computations.

The results concerning $AR(1)$ *Constant*, $AR(1)$, $GARCH$ *Constant* and $ARCH$ and $GARCH$ effects are very similar to the results obtained in the models of direct effect of new car introduction. Firstly, estimates on $AR(1)$ *Constant* and $AR(1)$ are once again significant and positive only for Volkswagen. Secondly, $GARCH$ *Constant* estimate is significant and positive with very small values not far from zero for three companies, Daimler, Volkswagen and Toyota. Thirdly, as was also the case in preceding models too, it is true for all car-makers that the sum of the $ARCH$ and $GARCH$ effects is close to one, both effects are significant and $GARCH$ effect is larger. Finally, the dummy variable estimate is positive and significant for the three producers, Daimler, Volkswagen and Toyota, the same producers for which the $GARCH$ *Constant* estimate was significant. Therefore, it could be inferred that for majority of cases and thus overall, the event of earnings announcement causes higher volatility of stocks of the involved company. This effect was indeed expected and it can be easily explained as it goes in line with economic and financial theory.

To elaborate, investors are very cautious to earnings announcements as these state how did the company perform during the last quarter. When the presented numbers are at or above the target set by the company, investors tend to be interested in its stocks and drive the price higher. However, when

the reported numbers are unexpectedly low, investors want to get rid of these stocks as the company shows insufficient performance. In the end, regardless of the incidence of the presented figures, both of these effects cause higher volatility of the stocks of announcing company. As can be inferred from the table above, this study provides sufficient evidence in support of this theory.

5.4 Possible Extensions

In this study I use the CAPM and GARCH model for exploring the effect of certain events on stock returns and volatility. However, there are several other models that can be employed for these specific purposes. In this section I shortly present some of these alternatives. Additionally, I also include here the possible extensions with regards to the studied topic, i.e. what other interesting aspects of behavior of stocks during new car announcements could be studied.

Concerning the suitable substitute for the CAPM, the Three-Factor Model should be mentioned. This model was proposed by Fama & French (1993) (interested readers might also refer to the subsequent studies by Fama & French (1995) and Fama & French (1996)) and it is defined as a classical CAPM extended by two explanatory variables. One additional variable is the difference between the rate of return on small stocks portfolio and the rate of return of large stocks portfolio (SMB for short) and the other variable is the difference between the rate of return on high book-to-market stocks portfolio and the rate of return on low book-to-market portfolio (HML for short). The model has altogether three explanatory variables, one from the classical CAPM, which is the difference between the market rate of return and the risk-free rate of return, and then SMB and HML, hence the name Three-Factor Model.

Addressing now the models that could replace the basic GARCH(1,1) model used in this study, I present here briefly GARCH-t and FIGARCH models. GARCH-t model, developed by Bollerslev (1987), differs from the GARCH only in one aspect which is the distribution of disturbances. GARCH assumes conditional normal distribution of disturbances whereas the GARCH-t relaxes this assumption and instead assumes standardized Student's t-distribution of disturbances. As in many applications the standardized residuals do not follow normal distribution and experience heavier tails, GARCH-t model has an advantage over GARCH and therefore seems to be more adequate. Fractionally Integrated GARCH, or FIGARCH for short, was suggested by Baillie *et al.* (1996). It has a desirable property and thus a major advance over the GARCH.

Unlike in the GARCH, where the shocks to the conditional variance die out in a fast exponential manner, in FIGARCH these shocks to the conditional variance fade away in a slow hyperbolic rate of decay. As this phenomenon is quite common and often observed in financial time-series data, it seems that the FIGARCH is somewhat more suitable and thus should be applied instead of the GARCH.

Regarding the subject of this thesis, there are several other interesting features of stock behavior during the event of new car model introduction that could be explored. Firstly, how do the stock returns and volatility behave on the days immediately following the new car announcement? Are the excessive stock returns and high volatility present on these following days as well? In other words, are excessive returns and high volatility persistent? Secondly, are the investors and markets able to predict such an event and thus contain the information earlier? To put it differently, do announcing companies experience high stock returns and volatility even on the days preceding these announcements? These two queries, among many others, still remain to be answered.

Chapter 6

Conclusion

In this study I examined the impacts of new model introduction and earnings announcement on the stocks of selected automobile companies. Most of the hypotheses about evolution and performance of stocks proposed in this study were confirmed by the obtained results.

There were altogether nine studied automobile brands from Europe and Asia that were spread across five corporations traded on stock markets. More specifically, Audi, Volkswagen and Škoda were included in Volkswagen Group, Lexus and Toyota in Toyota Motor Corporation, Jaguar and Land Rover in Tata Motors, Mercedes-Benz in Daimler and for BMW this allocation was straightforward. The data on stock market index for Frankfurt and New York, i.e. DAX and NYSE, respectively, were also used as all involved companies are traded on these exchanges. In this study I focused on the period from January 3 2005 to February 7 2013 with the only exception here being the Tata Motors, where the studied period started on July 1 2008 when the Tata Motors acquired Jaguar and Land Rover.

I used two different approaches to answer the proposed questions, one examining the stock returns and the other examining the volatility of stocks. The former was specified as extended CAPM where the important additional variable was the dummy variable indicating whether the event of interest occurred or not. The latter was specified as the GARCH(1,1) model where the variance equation was extended with the same dummy variable.

Apart from the core results provided by CAPM and GARCH model, I also included the discussion of the stock prices, stock returns and correlation between companies. The results here showed that all of the companies were terribly hit by the financial crisis in 2008-2009 and their stocks suffered from

tremendous decline. Moreover, the volatility of stocks increased during this turmoil and remained high throughout the rest of the studied period. The correlation among the companies and indices was quite strong and the highest correlation coefficient in the sample was between two German car producers, BMW and Daimler.

The CAPM approach yielded the following results. The excess stock return on the day of the introduction of new model was confirmed for 3 companies, BMW, Volkswagen and Tata Motors and for the remaining two, Daimler and Toyota, no significant effect was detected. Concerning the cross effect of new model introduction on the competitors of the announcing company, there were found two significant effects, one positive effect of BMW model introduction on stock returns of Daimler and the other negative effect of Daimler on BMW while the rest of the effects were inconclusive. As in the vast majority of cases no effect was detected and the two found effects were opposite in sign and therefore contradictory, in aggregate the findings suggested no cross effect of new model introduction on the stock returns of competition. With regard to the impact of the earnings announcement on the stock returns, no definite effect was found. This could easily be explained as all these announcements were treated the same. However, some of them might have been satisfactory while other not. Therefore, the overall effect was inconclusive. For further research in this area, it might be worthwhile to distinguish between these announcements according to their incidence. By this extension, the model would probably yield more interesting and definite results.

Employing the GARCH model and considering the volatility rather than the returns of stocks, I arrived at somewhat different results. The direct effect of new model introduction was now confirmed for only one company, Daimler. This effect was negative indicating lower volatility of stock of the announcing company during the days when new vehicles were introduced. As to address the cross effect results of GARCH, they were inconclusive because for all cases but one there was no effect found. Finally, the most interesting finding obtained by GARCH model was that for three companies, Daimler, Volkswagen and Toyota, the earnings announcement increased the volatility of stocks.

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Appendix A

Full List of Models

Table A.1: List of Tata Motors & Toyota Motor Corporation Models

Company	Brand	Model
Tata Motors	Jaguar	F-Type XF XF Sportbrake XK Coupe XJ
	Land Rover	Discovery 4 Freelander 2 Range Rover Range Rover Evoque Range Rover Sport
Toyota	Lexus	CT GS IS LS RX
	Toyota	Auris Avensis GT 86 iQ Land Cruiser Prius Prius+ RAV4 Yaris

Table A.2: List of BMW & Daimler Models

Company	Brand	Model
BMW	BMW	1 3 3 Coupe 3 GT 5 5 GT 6 Cabrio 6 Coupe 6 Gran Coupe 7 X1 X3 X5 X6 Z4
Daimler	Mercedes-Benz	A B C C Coupe CL CL CLS CLS Shooting Brake E E Coupe G GL GLK ML R S SL SLK SLS AMG

Table A.3: List of Volkswagen Group Models

Company	Brand	Model
Volkswagen	Audi	A1 A3 A4 A4 Allroad A5 A5 Sportback A6 A6 Allroad A7 Sportback A8 Q3 Q5 Q7 R8 TT
	Škoda	Fabia Octavia Rapid Roomster Superb Superb Combi
	Volkswagen	Beetle CC Eos Golf Golf Variant Jetta Passat Phaeton Polo Sharan Tiguan Touareg Touran Up!