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# Modeling the Volatility and Forecasting the Stock Price of the German Stock Index (DAX30)

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# Abstract

To analyze the factors affecting the price volatility of stocks, microeconomic and macroeco-nomic elements must be considered. This paper selects elements that are appropriate with the daily data of stock prices to build the GARCH family models. External variables such as global oil prices, consumer price index, short interest rates and the exchange rate between the United States Dollar and the Euro are examined. The GARCH models are developed in order to analyze and forecast the stock price of the companies in the DAX 30, which is Germany's most important stock exchange barometer. The volatility of the residual of the mean function is the important key point in the GARCH approach. This financial application can be extend-ed to analyze other specific shares or stock indexes in any stock market in the world. There-fore, it is necessary to understand the operating procedures of their pricing for risk manage-ment, profitability strategies, cost minimization and, in addition, to construct the optimal port-folio depending on investor's preferences.

Keywords: Heteroscedasticity, GARCH models, Volatility, Portfolio optimization, German stock index.

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# 1. Introduction

The vast improvements due to the time-series models stem from the use of conditional means and conditional variances which change over time. Heteroscedasticity corrections should be considered in the time series data. Engle R. F. (1982) came up with a preferable model called the autoregressive conditional heteroscedasticity (ARCH) model. Using conditional densities, he introduced a linear combination of lagged endogenous and exogenous variables included in the information set with vector unknown parameters. In empirical applications, the ARCH model appears to have some problems with a negative variance parameter and a relatively long lag in the conditional variance equation. The GARCH process (Generalized Autoregressive Conditional Heteroskedasticity) is later worked out by Bollerslev (1986) in which he extends the ARCH class of models to allow both a longer memory and a more flexible lag structure. In the similar manner, an idea was discovered according to Engle R. F. (1995), which was to include the lagged conditional variance terms as autoregressive terms. One of the drawbacks of the ARCH specification was that it looked more like a moving average specification than an autoregression.

Bollerslev (1986) indicated that volatility is a key variable which permeates most financial instruments and plays a central role in many areas of finance. For example, volatility is crucially important in asset pricing models and dynamic hedging strategies, as well as in the determination of option prices. They clarified that the ARCH models can be strongly applicable for stock data. The stock price volatility and the ARCH effects of daily stock prices were also subjected by Baldauf and Santoni (1991). The literature of the GARCH family is then focused upon GARCH, EGARCH, ARCH-M and many other formulations with particular distinctive properties by Bollerslev *et al.* (1994). Engle R. (2001) latterly extended and emphasized the use of ARCH/GARCH models in applied econometrics.

When Engle R. F. (1982) introduced the ARCH regression model, he explained that its ability to predict the future varies depending on one period to another. Andersen and Bollerslev (1998) explicitly stated that the standard volatility models do provide accurate forecasts. Matei (2009) indicated that the GARCH models lead in the assessment of volatility forecasting models. Forecasting volatility is an important assignment and meaningful in making financial decisions in the future. The predicted results can help with risk management, asset allocation to minimize the losses and an estimation of the value or the price for financial assets on the market. Brownlees *et al.* (2011) realized volatility models often demonstrate excellent forecasting performance. Notably, the predictions based on one-day-ahead usually give more exact forecast results. The 2008 crisis could be predicted by the one-day-ahead forecasts in their practical research. The empirical evidences for the variance and return forecasts of Mexican financial series by GARCH models were obtained the accurate forecasts through the study of Villalba-Padilla and Flores-Ortega (2013). With all the attractive features of the GARCH approach, it is a principal modeling instrument for the stocks of 30 German companies trading on the Frankfurt Stock Exchange. They are blue chip stocks which measure the German stock index (DAX 30). The focus of this paper will be on the analysis and the forecast of DAX 30 stock prices.

Stock market volatility change is a significant theory posited by Schwert (1989). This article explained that stock volatility is affected by the macroeconomic volatility, such as interest rates, bond returns, industrial production, inflation, monetary growth, and economic activity such as recessions, stock market trades, and corporate profitability (i.e. dividends, earning yield, financial leverages, etc.). The nature of volatility is linked to the stock, bond, and money markets, which were also investigated by Fleming *et al.* (1998). The evidence of Phylaktis and Ravazzolo (2005) suggested that stock and foreign exchange markets have a positive relation and the US stock market acts as a conduit for these links. However, these links could not be determined by foreign exchange restrictions. Sehgal and Kapur (2012) found the important role of oil prices in global economic development as they affect the import-export structure of almost all world economies. Therefore, the impact of oil price shocks on stock markets is understandable.

The key point for stock volatility analysis is that it could additionally clarify the profitability and risk assessment of shares based on a long-term data history, which would be more sufficient than only concentrating on the financial statement analysis of a specific point in time. Specifically, stock price predicted models can be also used to forecast the profitability and risk movement of stocks. Additionally, understanding how the external elements affect stocks is very useful for their management and investors, to enable them to measure the informational influence of the concerned factors and make more precise managerial and investing decisions. This study can again be confirmed to be in the right direction because the consultation of the distribution of realized stock volatility was examined by Andersen and Bollerslev (2001), which uses daily transaction prices on individual stocks. This study adds to the existing literature that individual stocks are analyzed and forecasted, whereas previous studies almost exclusively focused on the whole stock market in some countries.

# 2. Methodology

# 2.1. Data

According to study by Matei (2009), the observation amount in the GARCH model should be up to more than one thousand observations to give more accurate results. Granger (1992) also showed that the predictability of stock prices or returns can be analyzed based on intensive analysis of a longer timeline. Therefore, 1052 daily stock prices (from June 4, 2012 to July 28, 2016) were collected from the websites of the Frankfurt Stock Market, Foreign Exchange Service, Energy Information Administration, Trading Economics, Bundesrepublik Deutschland Finanzagentur GmbH and Statistisches Bundesamt. The DAX 30 companies' stock prices include company names Adidas, Allianz, BASF, Bayer, Beiersdorf, BMW, Commerzbank, Continental, Daimler, Deutsche Bank, Deutsche Boerse, Lufthansa, Deutsche Post, Deutsche Telekom, E.ON, Fresenius, Fresenius Medical Care, HeidelbergCement, Henkel vz, Infineon, ProSiebenSat1 Media, Linde, Merck, Muenchener Rueck, RWE, SAP, Siemens, Thyssenkrupp, Volkswagen VZ, except that the Vonovia company was collected only 768 daily stock prices because it has been listed on the stock exchange since July 11, 2013 and on the DAX 30 since September 2015.

Additionally, these are numerous elements that should be considered in the evaluation of each individual stock. In this special study, combining the study purposes and the attributes of daily data, the selected database of relevant elements in order to estimate the stock volatilities also have similar kinds of data corresponding to the daily stock price. Therefore oil price shocks, consumer price index, short interest rate and the exchange rate between the U.S. Dollar and the Euro are analyzed in this paper. They are considered to be the impact elements of macroeconomics into the stock volatility and role as the external variables in model functions.

In studying this process, the main data was employed to develop the models for the first difference which is calculated from stock prices. After the first difference is taken, the number of observations is reduced by one for each variable compared to the number of prices or indexes. An exception is Vonovia stock, however, with only 767 observations; the rest of the stocks have 1052 observations which is called the data range of study. The data range will be divided into two parts. The first part includeing 1040 observations is called the in-sample to estimate the models. The rest of the data range of 12 daily stock price observations (from July 17, 2012 to July 28, 2016) can be called out-of sample, and is used for an appreciation of the forecasting ability of GARCH models.

Moreover, the 21 stocks including Allianz, BASF, Bayer, BMW, Commerzbank, Continental, Daimler, Deutsche Boerse, Deutsche Post, Deutsche Telekom, E.ON, Fresenius, Fresenius Medical Care, Infineon, Merck, Muenchener Rueck, RWE, SAP, Siemens, Volkswagen vz and Vonovia, are modeled based on the first difference of stock prices directly. Conversely, the logarithm of the prices of three stocks Deutsche Bank, HeidelbergCement and Linde were firstly applied before the first difference was taken because their prices are dramatically unstable. Logarithms of a database ensure smoothness of data but it does not change the features of the database.

In another way, Adidas, Beiersdorf, Henkel vz, Lufthansa, ProSiebenSat1 Media and Thyssenkrupp stocks have some abnormal observations in the first differencing data string of prices. The abnormal observations probably affect the features of database and cause errors in the modeling estimations. This calls for the need for adjustment in order to develop the appropriate models. The adjustment can be permissive because their proportions which are shown in the *Table 1* are very slight. Furthermore, the adjustment is based on the preservation of raw data and the percent of the adjusted observations is not significant so that the analyzed results from the new data strings should be accepted. In addition, the adjustment percentage could be also considered as the sudden risk level which shows the abnormal behavior of stocks.

		Company	The number of the adjusted observations	The percentage of the adjusted observations
Î	1.	Adidas	2	0.20 %
	2.	Beiersdorf	3	0.29%
	3.	Henkel vz	2	0.20 %
	4.	Lufthansa	2	0.20 %
	5.	ProSiebenSat1 Media	1	0.10%
	6.	Thyssenkrupp	3	0.29%

Table-1. Number and percentage of adjustment of the adjusted stocks

#### **2.2. Theoretical Framework**

First, the basic theory related to the GARCH approach will be summed up sufficiently according to Asteriou and Hall (2015) as follows.

*Stationarity* is a key concept underlying time series processes so that the prerequisite of building up the time series models is that all variables need to be stationary. A stationary series can be defined as one with a constant mean, constant variance and constant autocovariances for each given lag. In its simplest terms, a time series which is denoted by  $Y_t$  is said to be stationary if:

- (i)  $E(Y_t) = \text{constant for all t};$
- (ii)  $Var(Y_t) = constant$  for all t; and
- (iii)  $\text{Cov}(Y_b, Y_{t+k}) = \text{constant}$  for all *t* and all  $k \neq 0$ , of if its mean, variance and covariances remain constant over time.

In contrast to stationarity is a non-stationary time series which is called a unit root process (a random walk). Therefore, the tests for unit roots are necessary in order to determine whether a time series is stationary or not. The early and pioneering work on testing for a unit root in times series was done by Dickey and Fuller (Dickey and Fuller, 1979; Fuller, 1976). As the error term is unlikely to be white noise, the augmented Dickey-Fuller (ADF) test procedure for unit roots, which is extended by an augmented version of the test that includes extra lagged terms of the dependent variable in order to eliminate autocorrelation. The ADF is used for testing stationarity for all variables in this study.

Autoregressive integrated moving average (ARIMA) models are shown according to Box et al. (2015) in three terms deriving from: autoregressive, integrated and moving average.

a) Autoregressive time series AR(p) models

The AR (p) model *i* an autoregressive model of order *p*, which has *p* lagged terms, as in the following:

$$Y_{t} = \alpha_{1} Y_{t-1} + \alpha_{2} Y_{t-2} + \dots + \alpha_{p} Y_{t-p} + u_{t}$$

or, using the summation symbol:

$$Y_t = \sum_{i=1}^p \alpha_i Y_{t-i} + u_t$$

b) Moving average MA(q) models

The general form of the MA models is an MA(q) model of the form:

$$Y_{t} = u_{t} + \beta_{1} u_{t-1} + \beta_{2} u_{t-2} + \dots + \beta_{q} u_{t-q}$$

which can be rewritten as:

$$Y_t = u_t + \sum_{i=1}^q \beta_i u_{t-i}$$

Therein, any MA(q) process is, by definition, an average of q stationary white-noise processes and it follows that every moving average model is stationary, as long as q is finite.

c) Autoregressive moving average (ARMA) models

After presenting the autoregressive and moving average terms, it is very clear that an ARMA(p,q) model is a new series of models, which is combinations of both AR(p) and MA(q) processes. The general form of the ARMA model as follow:

$$Y_t = \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \dots + \alpha_p Y_{t-p} + u_t + \beta_1 u_{t-1} + \beta_2 u_{t-2} + \dots + \beta_q u_{t-q}$$

which can be rewritten, using the summation symbol, as:

$$Y_{t} = \sum_{i=1}^{p} \alpha_{i} Y_{t-i} + u_{t} + \sum_{j=1}^{q} \beta_{i} u_{t-j}$$

d) Integrated processes and the ARIMA models

According to the key of concept underlying time series processes, ARMA models can only be made with time series that are stationary. This means that the mean, variance and covariance of the series are all constant over time. However, most economic and financial databases show trends over time, based on the mean of their time series will be changed through time points. Thus, mean of most economic and financial time series is not constant over time, which indicates that the series are non-stationary. To avoid this problem, and to induce stationarity, the raw data need to be de-trended through a process called differencing. The first differences of a time series  $Y_t$  are given by the equation:

$$\varDelta Y_t = Y_t - Y_{t-1}$$

As most economic and financial time series show trends to some degree, the first differences of the input series are nearly always taken. If, after first differencing, a series is stationary, then the series is also called integrated to order one, and denoted I(1) which completes the abbreviation ARIMA. If the series, even after first differencing, is not stationary, second differences need to be taken. Once stationarity has been achieved, the next step is to identify the *p* and *q* orders of the ARIMA model. The *q* levels for the pure MA(*q*) processes are selected depending on the autocorrelation coefficients (ACF) and the private autocorrelation coefficients (PACF) are used to select the *p* level for the pure AR(p) processes.

A comparison of the sample ACF and PACF to those of various theoretical ARIMA processes may suggest several plausible models. In theory, if the series is non-stationary, the ACF of the series will not die down or show signs of decay at all. As was noted above, a common stationarity-including transformation is to take logarithms and then first differences of the series.

Once stationarity has been achieved, the next step is to identify the p and q orders of the ARIMA model. For a pure MA(q) process, the ACF will tend to show estimates that are significantly different from zero up to q lag and then die down immediately after the qth lag. The PACF for MA(q) will tend to die down quickly either by an exponential decay or by a damped sine wave. In contrast to the MA processes, the pure AR(p) process will have an ACF that will tend to die down quickly, either by an exponential decay or by a damped sine wave, while the PACF will tend to show spikes (significant autocorrelations) for lags up to p and then will die down immediately.

If neither the ACF nor the PACF show a definite cut-off, a mixed process is suggested. In this case, it is difficult but not impossible, to identify the AR and MA orders. We should think of the ACF and PACF of pure AR and MA processes as being superimposed onto one another. *For example*, if both ACF and PACF show signs of exponential decay, an ARMA(1,1) process may be identified. Similarly, if the ACF shows three significant spikes at lags one, two and three and then an exponential decay, an ARMA (3,1) process should be considered. In general, it is difficult to identify mixed processes, so sometimes more than one ARMA (p,q) model might be estimated, which is why the estimation and diagnostic checking stages are both important and necessary. Therefore, some possible combinations of ACF and PACF forms could exist that allow the detection of the order of ARMA processes.

## 2.3. ARCH/GARCH Models

#### a) Testing for ARCH effects

Before estimating ARCH/GARCH models, it is important to check for the possible presence of ARCH effects to know which models require the ARCH/GARCH estimation method. In general, there are two ways of detecting heteroskedasticity. The first, known as the informal way, is by inspection of different graphs, while the second is by applying appropriate tests. The heteroskedasticity test and the ARCH-LM test are mainly used in this paper.

#### b) The ARCH model

The models, which have the ARCH effect, are shown that their variance of the residuals at time *t* depends on the squared error terms from past periods. Engle simply suggested that it is better to model simultaneously the mean and the variance of a series when it is suspected that the conditional variance is not constant. The simple model can be examined in a more detailed way as follows:

$$Y_t = \alpha + \beta' X_t + u_t$$

Where  $X_t$  is a  $k \times 1$  vector of explanatory variables and  $\beta$  is a  $k \times 1$  vector of coefficients. Normally,  $u_t$  is assumed as independently distributed with a zero mean and a constant variance  $\sigma^2$ , or, in mathematical notation:

$$u_t \sim iid N(0, \sigma^2)$$

And, the variance of the residuals ( $\sigma^2$ ) is assumed to depend on history, or to have heteroskedasticity because the variance will change over time. One way to allow for this is to have the variance depend on one lagged period of the squared error terms, as follows:

$$\sigma_t^2 = \gamma_0 + \gamma_1 u_{t-1}^2$$

Which is the basic ARCH(1) process.

In fact, the conditional variance can depend not just on one lagged realization but on more than one, for each case producing a different ARCH process. In general, the ARCH(q) process will be given by:

$$h_{t} = \gamma_{0} + \gamma_{1}u_{t-1}^{2} + \gamma_{2}u_{t-2}^{2} + \dots + \gamma_{q}u_{t-q}^{2}$$
$$= \gamma_{0} + \sum_{j=1}^{q} \gamma_{j}u_{t-j}^{2}$$

Therefore, the ARCH(q) model will simultaneously examine the mean and the variance of a series according to the following specification:

$$Y_t = \alpha + \beta' X_t + u_t$$
  

$$u_t | \Omega_t \sim iid N(0, h_t)$$
  

$$h_t = \gamma_0 + \sum_{j=1}^q \gamma_j u_{t-j}^2,$$

The estimated coefficients of the  $\gamma_s$  have a positive variance.

c) The 
$$GARCH(p,q)$$
 model

The GARCH(p,q) model has the following form

$$Y_t = \alpha + \beta' X_t + u_t$$
$$u_t \mid \Omega_t \sim iid \ N(0, \ h_t)$$

$$h_t = \gamma_0 + \sum_{i=1}^p \delta_i h_{t-i} + \sum_{j=1}^q \gamma_j u_{t-j}^2$$

Which says that the value of the variance scaling parameter  $h_t$  now depends both on past values of the stocks, which are captured by the lagged squared residual terms, and on past values of itself, which are captured by lagged  $h_t$ terms.

It should be clear by now that p = 0 the model reduces to ARCH(q). The simplest form of the GARCH(p,q) model is the GARCH (1,1) model, for which the variance equation has the form:

$$h_t = \gamma_0 + \delta_1 h_{t-1} + \gamma_1 u_{t-1}^2$$

This model specification usually performs very well and is easy to estimate because it has only three unknown parameters:  $\gamma_0$ ,  $\gamma_1$  and  $\delta_1$ .

d) The threshold GARCH (TARCH) model

A major restriction of the ARCH and GARCH specifications above is that they are symmetric. By this we mean that what matters is only the absolute value of the innovation and not its sign (because the residual term is squared). Therefore, in ARCH/GARCH models a large positive shock will have exactly the same effect in the volatility of the series as a large negative shock of the same magnitude. However, for equities it has been observed that negative shocks (or 'bad news') in the market have a larger impact on volatility than do positive shocks (or 'good news') of the same magnitude.

The threshold GARCH model was introduced by the works of Zakoian (1994) and Glosten et al. (1993). The main target of this model is to capture asymmetries in terms of negative and positive shocks. To do this, simply add into the variance equation a multiplicative dummy variable to check whether there is a statistically significant difference when shocks are negative.

The specification of the conditional variance equation for a TARCH(1,1) is given by:

 $h_t = \gamma_0 + \gamma u_{t-1}^2 + \theta u_{t-1}^2 d_{t-1} + \delta_1 h_{t-1}$ Where d<sub>t</sub> take the values of 1 for u<sub>t</sub> < 0, and 0 otherwise. So 'good news' and 'bad news' have different impacts. Good news has an impact of  $\gamma$ , while bad news has an impact of  $\gamma + \theta$ . If  $\theta > 0$  we conclude that there is asymmetry, while if  $\theta = 0$  the news impact is symmetric. TARCH models can be extended to higher order specifications by including more lagged terms, as follows:

$$h_{t} = \gamma_{0} + \sum_{i=1}^{q} (\gamma_{i} + \theta_{i} d_{t-i}) u_{t-i}^{2} + \sum_{j=1}^{p} \delta_{j} h_{t-j}$$

e) The exponential GARCH (EGARCH) model

The exponential GARCH (EGARCH) model was first developed by Nelson (1991), and the variance equation for this model is given by:

$$\log(h_t) = \gamma + \sum_{j=1}^{q} \alpha_j \left| \frac{u_{t-j}}{\sqrt{h_{t-j}}} \right| + \sum_{j=1}^{q} \beta_j \frac{u_{t-j}}{\sqrt{h_{t-j}}} + \sum_{i=1}^{p} \delta_i \log(h_{t-i})$$

Where  $\gamma$ , the  $\alpha_s$ ,  $\beta_s$  and  $\delta_s$  are parameters to be estimated. Note that the left-hand side is the log of the variance series. This makes the leverage effect exponential rather than quadratic, and therefore the estimates of the conditional variance are guaranteed to be non-negative. The EGARCH model allows for the testing of asymmetries as well as the TARCH. To test for asymmetries, the parameters of importance are the  $\beta$ s. If  $\beta_1 = \beta_2 = ... = 0$ , then the model is symmetric. When  $\beta_i < 0$ , then positive shocks (good news) generate less than negative shocks (bad news).

# *f) The criteria of model selection*

A higher  $R^2$  is regardless of the importance of the additional regressor or not. However, the adjusted  $R^2$ , as denoted by  $\overline{R}_2$ , can be taken into account the consistent number of explanatory variables included in each model because it is adjusted for the number of regressors (or adjusted for the degrees of freedom) Since  $R^2 = ESS/TSS = 1 - RSS/TSS$ , the adjusted  $R^2$  is just:

$$\overline{R}_2 = 1 - \frac{RSS(n-1)}{TSS(n-k)}$$

Another method to decide whether the variables X<sub>2</sub> should be included in the model or not is to use information criteria that express the model fit and the number of parameters in a single criterion. The Akaike information criterion (AIC) and Schwarz information criterion (SIC) (also called the Bayes information criterion or BIC) are defined as follows, where p is the number of included regressors and  $s_p^2$  is the maximum likelihood estimator of the error variance in the model with *p* regressors:

$$AIC(p) = \log(s_p^2) + \frac{2p}{n},$$
  
$$SIC(p) = \log(s_p^2) + \frac{p\log(n)}{n}.$$

These criteria involve a penalty term for the number of parameters, to account for the fact that the model fit always increases (that is,  $s_p^2$  decreases) if more explanatory variables are included. The unrestricted model has p = k, and the restricted model obtained by deleting  $X_2$  has p = (k - g). The model with the smallest value of AIC or SIC is chosen. For  $n \ge 8$ , the SIC imposes a stronger penalty on extra variables than AIC, so that SIC is more inclined to choose the smaller model than AIC.

Checking the AIC and SIC together with the adjusted  $R^2$  of the estimated models detects which model is the parsimonious one. That is the one that minimizes AIC and SIC and has the highest adjusted  $R^2$ .

Another useful method for model selection is to compare the predictive performance of the models. For this purpose, the data set is split in two parts, an 'estimation sample' (used to construct the model) and a 'prediction sample' or 'hold-out sample' for predictive evaluation. Thus, models are estimated using only the data in the first subsample, and the estimated models are then used to predict the y-values in the prediction sample. Possible evaluation criteria are the *root mean squared error* (RMSE) and the mean absolute error (MAE). These are defined by

$$RMSE = \left(\frac{1}{n_f} \sum_{i=1}^{n_f} (y_i - \hat{y}_i)^2\right)^{1/2}$$
$$MAE = \frac{1}{n_f} \sum_{i=1}^{n_f} |y_i - \hat{y}_i|$$

Where  $n_f$  denotes the number of observations in the prediction samples and  $\hat{y}_i$  denotes the predicted values.

# 2.4. Orientation

During the testing of experimental models, the oil price shocks, consumer price index, short interest rate and exchange rates acted as the exogenous variables in the variance equation of GARCH models or as the independent variables in mean equation to account for stocks' first difference. The modeling process will be started with selection of mean equations based on the autoregressive integrated moving average (ARIMA) procedures. Nelson (1991) specified that the ARIMA process provides the parsimonious parameterizations which are appropriate in representing conditional mean equations. Then, the ARCH, GARCH, EGARCH and TARCH models will be run by selecting Student's t option. Besides, Student's t-distribution was generalized that it is a marked improvement over the generalized error by Bollerslev et al. (1994), though perhaps not over the usual. Blattberg and Gonedes (1974) previously discussed the statistical distribution of rates of return on common stocks where the t-distribution was evaluated as the most fitting distribution for daily rates of return on common stocks. Furthermore, the Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), root mean squared error (MSE) and mean absolute error (MAE) will be examined to choose the most fitting models for descriptions. The lower values of these criteria show the models and forecasts are more appropriate. In a similar manner, the GARCH models are applied to test volatility in the Nigeria stock market using the Nigeria All Share Index by Atoi (2014). Leverage effect also exists to present the meaning of the Nigeria stock market's volatility which responds more to bad news than it does to equal magnitude of good news. The model in student's t error distribution showed the last twenty-eight days outof-sample forecast as the best prediction.

In brief, the GARCH models are estimated by the external variables such as oil price shocks, consumer price index, short interest rate and exchange rates will be performed in *section 1*. They could model for describing the features or characteristics of stocks and forecasting for the future values of stock prices. The GARCH models which have the most precise descriptions of each stock will be examined later on the stock price predictability in out-of samples in *section 2*. Therein, the forecasted stock price results will be compared with the stock prices in out-of samples in order to evaluate the predictability of individual stock model and general GARCH models in this section.

# **3. Empirical Tests**

The prerequisite of time series models is that all variables must be stationary. Therefore, the unit roots of all variables were firstly tested by Augmented Dickey-Fuller (ADF) tests but the results show that they are not stationary. Therefore, the first difference is taken to induce stationarity for all thirty historical data time series, including: the stock price raw data of twenty-one stocks, the logarithm of stock price of three stocks, the adjusted stock price data of six stocks and the external variables such as oil price shocks, consumer price index, short interest rate and exchange rates. Subsequently, the ADF test was applied again on first differencing data time series. The results show that the stationary variables base on the *probability* values are approximately 0% and the *t-Statistical* values are less than the *test critical values* at 1%, 5% and 10% significance for all variables. The time series models now can be run for analyzing the DAX 30 stocks.

#### **3.1. Generalized GARCH Models with the Participation of the External Variables**

The ARMA procedures which can provide the appropriate parsimonious parameterizations are started in selection of conditional mean equations. Accordingly, the *p* and *q* orders of the ARMA(*p*,*q*) models, which build for mean equations in GARCH models, were obtained to choose by correlogram of level schemas of variables. The autocorrelation coefficients (ACF) are used to select *q* for MA and the private autocorrelation coefficients (PACF) to select *p* for AR. Therein, the levels of AR(q) and MA(p) are selected at the significance level of 5%, by the values of ACF and PACF outside the confidence interval is  $\left(-\frac{1.96}{\sqrt{1040}}; +\frac{1.96}{\sqrt{1040}}\right)$  or (-0.06078; +0.06078). The Vonovia stock is an exception, as it only has 768 observations so that its *q* and *p* lagged terms in ARMA(p,q) model are selected by the values of ACF and PACF outside the confidence interval is  $\left(-\frac{1.96}{\sqrt{758}}; +\frac{1.96}{\sqrt{758}}\right)$  or (-0.0712; +0.0712).

At the same time, the external variables such as the oil price shocks (OIL), consumer price index (CPI), short interest rate (SIR) and exchange rates (EXR) were also examined whether they could contribute in mean equations

of GARCH models. Then, the parsimonious functions which have the minimum AIC and SIC criteria and the maximum adjusted  $R^2$  are selected. In short, the ARMA (p,q) models and external variables which are chosen to build up mean equations are specifically shown in *Table 2*.

	Companies	ARMA orders	GARCH models	External variables	Exogenous factors	Leverage effect
1.	Allianz	(6,12,29;12,29)	EGARCH(1,1)	OIL,CPI		
2.	BASF	(24;24)	EGARCH(1,1)	OIL,CPI		
3.	Bayer	(10,29;29)	EGARCH(1,1)	OIL	SIR	
4.	BMW	(4,20,23;1,4,20,23)	EGARCH(1,1)	OIL,CPI	EXR	
5.	Commerzbank	(2;2)	ARCH(1)	OIL,EXR		
6.	Continental	(4;4)	ARCH(6)	OIL,CPI	SIR	
7.	Daimler	(5,15;5)	GARCH(1,1)	OIL,CPI		
8.	Deutsche Boerse	(5,10,15;4,5,10,15)	GARCH(1,1)	OIL	SIR	
9.	Deutsche Post	(2,29;2,29)	GARCH(1,1)	OIL,CPI, EXR		
10.	Deutsche Telekom	(10,18,32;10,18)	EGARCH(1,1)	OIL	SIR	
11.	E.ON	(29;1,29)	EGARCH(1,1)	OIL,CPI		
12.	Fresenius	(8,12;8,12)	GARCH(1,1)	OIL,EXR		
13.	Fresenius Medical Care	(2,10;2,10)	EGARCH(1,1)	OIL,EXR		
14.	Infineon	(5,6,10,18;6,18,33)	GARCH(1,1)	OIL		
15.	Merck	(4,7,25,29;7,25,29,33)	EGARCH(1,1)	OIL,CPI, EXR		
16.	Muenchener Rueck	(12,22;12,22)	GARCH(1,1)	OIL,CPI	EXR,SIR	
17.	RWE	(17;17,30)	ARCH(1)	OIL,SIR		
18.	SAP	(10;10)	GARCH(1,1)	OIL		
19.	Siemens	(5,29,32,33;5,29,32,33)	EGARCH(1,1)	OIL	CPI,EXR,S IR	yes
20.	Volkswagen vz	(1,24;1,24)	GARCH(2,1)	OIL,CPI		
21.	Vonovia	(6,10;10)	GARCH(1,1)	OIL		
22.	Adidas	(12,22;12,22)	GARCH(1,1)	OIL,CPI		
23.	Beiersdorf	(2,12;12)	GARCH(1,1)	OIL,CPI	SIR,EXR	
24.	Henkel vz	(2,12,20;12,20)	GARCH(1,1)	OIL,CPI, EXR		
25.	Lufthansa	(11;11,34)	GARCH(1,1)	OIL		
26.	ProSiebenSat1 Media	(4;4,35)	EGARCH(1,1)	OIL,CPI		
27.	Thyssenkrupp	(14,36;14,36)	TARCH(1,1)		EXR	
28.	Deutsche Bank	(6,14;6,14)	TARCH(1,1)	OIL	CPI,SIR	yes
29.	HeidelbergCe ment	(4,23;4)	GARCH(2,1)	OIL		
30.	Linde	(4,6,10,20,24,33;4,6, 20,24,33)	TARCH(1,1)	OIL,CPI	SIR,EXR	

Table-2. Description of estimated GARCH models of DAX 30 stocks

Next, two pre-conditions need to be successively examined on the mean equation, the clustering volatility and the ARCH effect in the residuals, to be content with the GARCH models. First, the graphs of the residuals in the mean equations are inspected to determine the sign of ARCH effect. As a general result, the prolonged periods of high volatility and the prolonged periods of low volatility exist interspersed sequentially. On the other hand, the periods of high volatility are almost always followed by the periods of high volatility and the periods of low volatility. This showed that the residual is conditionally heteroscedastic.

Furthermore, the existence of the ARCH effect in the residuals was double verified by the Heteroscedasticity tests which their probabilities of *F-statistic* and *observed R-squared* need to be less than 5% or 10% in some special cases. While the Linde and Thyssenkrupp stocks have ARCH effect at the significance level of 10%, the residuals in mean equations of the rest of the twenty-eight stocks present ARCH effect at the significance level of 5%. That is all DAX 30 stocks can be estimated by GARCH models and this is also content with the orientation of this paper. Then, the GARCH models including the ARCH, GARCH, EGARCH and TARCH are examined for each stock. In the same manner, the exogenous variables such as the OIL, CPI, SIR and EXR were also considered whether they could

contribute in variance equations of GARCH models. The Student's t is chosen to approximate the error distribution of the models.

For the GARCH procedure, the best model of each stock, which has the most appropriate description for stock time series data, are chosen based on the lowest AIC, SIC, MSE and MAE criteria. The MSE and MAE criteria are now joined to detect the best models because these GARCH models will be used to predict the future values. In addition, the probabilities of coefficients, which join in models, are mostly less than 5% with some cases of the probabilities of coefficients being more than 5% but less than 10%. This is equally important when it shows that the external variables are significant and appropriate. If the coefficients of OIL, CPI, SIR and EXR are significant to contribute to the stock price volatility models, it demonstrates the essential of considering the macroeconomic implications such as oil price shocks, consumer price index, short interest rate and exchange rates in stock valuation and risk management. In particular, the external variables which are significant in mean equations display how stock prices directly depend on them. Meanwhile, the exogenous variables which are significant in variance equations will express their influence on risk of stocks. From the estimated results of the models, the GARCH models with the best fit with external factors are deemed the most relevant models in regards to the mean and variance equations of DAX 30 stocks, and are shown in *Table 2*.

In addition, the stocks which are in accordance with TARCH or EGARCH models will be verified for the existence of the leverage effect. Accordingly, determining which one is sensitive to the negative news in the market and economic information will be clarified. The autocorrelation and the ARCH effect in the residuals need to be examined again in order to satisfy the real models with the best fit. Firstly, no serial correlations in the residuals of each model are verified since the probabilities of lags in the correlogram are all higher than 5%. Secondly, the ARCH LM test states that there is no ARCH effect in the residuals because the probabilities of F-statistic and Chi-Square are considerably higher than 10%. No serial correlations and no ARCH effects in the residuals are the positive signs for GARCH procedures. Therefore, the GARCH models is the most appropriate to model the DAX 30 stocks price volatility underlying affections of the external determining factors are oil price shocks, consumer price index, short interest rate and exchange rates.

Finally, many stock price data strings are provided to be considered in analysis, and each stock has its own intrinsic specific characteristics. Therefore, a single perfect approach to building a model does not exist as yet, but instead requires careful and meticulous adjustments on a case by case basis. Accurate models that capture stock movements to a high degree exist, however some models have just satisfied the prerequisites so that they could be accepted. The evaluation of the GARCH approach could be determined through the comparison of the forecast results. Forecasting ability of GARCH models will be examined in the following section.

## 3.2. Evaluating the Predictability of the GARCH Models for DAX 30 Stocks

The appropriate GARCH models of the DAX 30 stocks, which are selected in the above section, will be evaluated and compared based on the accuracy of their forecasts in this section. The out-of sample includes 12 observations from the 1041<sup>st</sup> day to 1052<sup>nd</sup> day of the remaining part of the data range. The forecast samples in which the forecast prices will be estimated rely on the GARCH models with the best fit. The one-day-ahead step is a forecasting method that uses a previous day to predict the day after. It usually gives greater accuracy in forecasting results than two or more day-ahead step methods in experiments, hence the one-day-ahead option is selected to run the forecasting models. Moreover, the greater amount of future days predicted, the larger the forecast errors computed. As such these models should only be implemented for short-term forecasts.

The forecast outcome is given in *first difference* values of the stock price or *logarithm* of the stock price. Then, it is necessary to be returned in forecasting price values in order to coincide with the original orientation that is analyzing and forecasting stock prices of the DAX 30. The price predictability will be returned depending on how the raw data was handled.

In case the first difference was applied, the equation of the first differences definition will be reused to bring the price values back. If the *forecast values of the first differences* of a *forecasted stock price time series*  $Y_{tf}$  are denoted by  $\Delta Y_{tf}$ , they will be defined in a similar equation:

#### $Y_{tf} = Y_{t-1} + \varDelta Y_{tf}$

For the forecast values of logarithm time series, the exponential function will restore the forecast values of stock price time series according to features of the logarithm function by equation:

#### $a^{log_a x} = x$

All predicted prices of DAX 30 stocks and in out-of sample are calculated and graphed together with real stock prices as a line graph in *Appendix 1*. The *blue lines* and the *red lines* were respectively denoted for the *forecast prices*, which are estimated by the selected GARCH models above, and the *real prices* in the stock market of each stock.

On the other hand, the forecast outcome and the real stock prices of 12 observations in the out-of sample will be re-evaluated again in *Appendix 2*. The tables show the different values between predicted and actual prices,  $\Delta d$  therein of the average of different values between predicted and actual prices,  $\overline{\Delta d}$  and the average of actual prices,  $\overline{\Delta P_r}$  are also calculated for each stock. Furthermore, the percent of the average difference values between predicted and actual prices per the average of actual prices p<sub>i</sub> are calculated for all DAX 30 stocks in order to compare the predictability of the GARCH approach as a whole. This is shown in the following equation in which *i* is specified for each stock.

$$\boldsymbol{p}_{i} = \frac{\overline{\Delta d}_{i}}{\overline{\Delta P_{r_{i}}}}$$

There are many levels of stock prices wherein some stocks are priced with a single number such as Commerzbank and E.ON stocks. In contrast, some stocks are priced with up to 3 numbers such as Continental, Adidas, Linde, Allianz, Volkswagen vz and Henkel vz. At the same value of difference between forecast price and real price, the lower priced stock will be determined that its forecast is not so accurate as the higher priced stock in appreciation of models' predictability. *For example*, to evaluate the forecast results between a five Euro stock and a 150 Euro stock, both forecasted outcomes give the different value between the forecast price and the real price that is one Euro. This means the 150 Euro stock has a better predicted estimation than five Euro stock. Therefore,  $p_i$  must be more relevant than  $\overline{\Delta d}$  in order to compare the accuracy in forecast results for all stocks because it measures the *predicted error* for each individual stock underlying a unit system which is expressed as a percentage of prices.

		Average of	Average of	Percent of the average
	Companies	actual prices	different values	difference values
		(1)	(2)	$(2) \times 100$ : (1)
1.	Siemens	94.76	0.42	0.44
2.	Muenchener Rueck	148.02	0.70	0.47
3.	Deutsche Telekom	15.24	0.08	0.50
4.	ProSiebenSat1 Media	40.38	0.20	0.50
5.	Fresenius	67.11	0.37	0.55
6.	HeidelbergCement	71.82	0.43	0.60
7.	Merck	96.12	0.57	0.60
8.	Bayer	92.91	0.56	0.60
9.	Beiersdorf	83.82	0.52	0.62
10.	Fresenius Medical Care	80.34	0.51	0.64
11.	Henkel vz	109.36	0.76	0.70
12.	Deutsche Post	25.87	0.18	0.71
13.	Vonovia	33.66	0.25	0.75
14.	Deutsche Boerse	74.69	0.59	0.79
15.	BASF	71.16	0.57	0.80
16.	SAP	74.62	0.65	0.87
17.	Allianz	127.01	1.15	0.91
18.	Linde	128.40	1.23	0.95
19.	E.ON	8.62	0.09	1.04
20.	Adidas	136.06	1.50	1.10
21.	Daimler	59.26	0.71	1.20
22.	RWE	15.77	0.19	1.23
23.	Thyssenkrupp	19.70	0.25	1.26
24.	BMW	75.41	0.95	1.27
25.	Infineon	14.11	0.18	1.28
26.	Commerzbank	5.83	0.08	1.29
27.	Continental	182.48	2.37	1.30
28.	Lufthansa	10.83	0.14	1.33
29.	Deutsche Bank	12.86	0.23	1.82
30.	Volkswagen vz	120.30	2.37	1.97
	Average	•	0.63	0.94

DAX 30 stocks with  $\overline{\Delta d}$  and  $\overline{\Delta P_r}$  are sorted together by ascending order of  $p_i$  in *Table 3*. The lowest  $p_i$  value corresponds to the stock with the best forecast and similarly the highest  $p_i$  value corresponds to the stock with the most inaccurate forecast of the 30 shares.

Statistical indicators of  $p_i$ , which include mean, median, max and min values, will be calculated later for the general assessment of forecast results. Its graph is also presented adjacent to provide a visual illustration as shown in *Figure 1*.

Figure-1. Statistics of percent of the average difference values



Only two stocks, Deutsche Bank and Volkswagen VZ, have predicted errors  $p_i$  of approximately 2%. In contrast, the remainder of the stocks have predicted error values of less than 1.33% and most of their  $p_i$  values are distributed between 0.4% to 0.84%. Three stocks, Siemens, Muenchener Rueck and Deutsche Telekom, display the lowest predicted errors which are only approximately 0.5%. By comparing with the out-of sample forecast, the graphs of forecast outcomes follow similar trajectories as actual prices for each individual stock and the predicted prices are estimated quite close to real values. These are promising signs about the predictability of the GARCH approach. This paper will not provide any assessment into whether forecast results are accurate. It only implements a comparison of forecast outcomes on basic foundational levels. The analysis and forecast evaluations will depend on the perspective and preference of each investor.

The analysis approach presented should be helpful for investors wishing to manage the risk of their portfolios. Based on the estimated GARCH model of each stock, the shares which have similar and opposite risk movements can be identified. Therefore, risk can be minimized by diversifying investments by combining a portfolio which consists of assets which exhibit opposite risks movements. The investors can enjoy greater certainty and maximize the return to risk. On the other hand, with a consideration of predicted errors and the expected rate of return, investors can conduct the portfolio risks which are under control. Investors have different preferences in risk, required return and preferred markets. This can be dependent but not limited to by their investment characteristics, time horizon of investment, debt leveraging appetite, and amount of capital at their disposal. The reason why modeling effectiveness as shown by distance of the predicted errors (between 0.4% and 2%) will be evaluated based on the individual views of each investor.

In a quite complicated way, investors could calculate limited risk and required return underlying the capital asset pricing model (CAPM) but this calculation must be based on the risk-free rate, beta of the security and expected market return. Or in a simple way, investors could look into the interest rates on government bond and bank loans. For instance, investors could inspect the yield on 9 to 10 year government bonds which was predicted to be around 0.2 % in 2016. The accommodating monetary policy measures of the German government then contributed to a further sharp decline in interest rates so that the expected value of short-term interest rates and the yields on 9 to 10 year government bonds were at a very low level. It is also the same trajectory for the forecast of interest on bank loans and the market expectations regarding future interest rate movements in Germany. With consideration of the predicted errors, the proportion of bonds and stocks could be constructed in accordance with acceptable rate of risk in the portfolios. However, acceptable rate of risk and required rate of return are related to different issues but they are not the focus of research in this paper.

# 4. Discussion of Empirical Results

From the GARCH approach, the features of DAX 30 stocks are expressed more specifically through the coefficients of external variables which are significant in the mean and variance equations. The mean equation's coefficients of GARCH models explain how independent variables impact dependent variables directly. Accordingly, when the price of external variables changes by x units, then the stock price will change by y units. They will change in similar or opposite directions which will depend on the positive or negative sign of the coefficients. This study indicates that almost all DAX 30 stocks are directly affected by oil price shock. A hypothesis that could be confirmed again is oil prices have a great impact on the stock market as a whole.

The Consumer Price Index is found to also have a direct effect on 15 stocks which include: Allianz, BASF, BMW, Continental, Daimler, Deutsche Post, E.ON, Merck, Muenchener Rueck, Volkswagen vz, Adidas, Beiersdorf, Henkel vz, ProSiebenSat1 Media and Linde. The exchange rate is found to have a direct effect on Commerzbank, Deutsche Post, Fresenius, Fresenius Medical Care, Merck and Henkel vz. Only RWE is directly affected by short interest rates. When a stock has high variance, this will lead to strong fluctuations and dramatic increases or decreases in its price. This also indicates the risk of stocks in the market. Therefore, the exogenous variables which have significant coefficients in the variance equation could influence the risk of stocks through variance volatility. The change of exogenous factors accordingly impacts fluctuation of the stock prices.

The volatilities of short interest rates has an extreme influence on the level of risk of nine stocks, namely Bayer, Continental, Deutsche Boerse, Deutsche Telekom, Muenchener Rueck, Siemens, Beiersdorf, Deutsche Bank and Linde; meanwhile, the volatilities of the exchange rate have a significant influence on six stocks: BMW, Muenchener Rueck, Siemens, Beiersdorf, Thyssenkrupp and Linde. It is clear that the exogenous variables of the 19 stocks have no effect on their variance equations. Through the GARCH approach, oil prices, the consumer price index, short interest rates and exchange rates are shown to have important relationships with stock market. Therefore, stock investors should pay attention to volatility of these external factors in order to have an exact and timely evaluation.

TARCH and EGARCH models could specify the stocks which have the leverage effect. That is, undesirable news has a far greater impact than the impact of desirable news from an economic environment. Such news can be related to interest rates, industrial production, inflation, monetary growth, recessions, stock market trades, dividends, earning yield and financial leverages, etc., as proven by Schwert (1989). The information could be from the analysts, institutional investors, and insiders on the incorporation of market, industry, and firm-specific information, as indicated by Piotroski and Roulstone (2004). Or, information about domestic and international macroeconomic variables such as business surveys of manufacturing orders and fluctuation of the other large economic markets in the world have a strong integrating relationship with stock prices, as studied by Nasseh and Strauss (2000). Durnev (2010) also showed that the news of political uncertainty surrounding elections can also affect the stock market. The economic, political and social news always has a certain relevance to the stock markets, so investors need to follow this information adequately. From the model estimations, it indicates that there is existence of leverage effect on Siemens and Deutsche Bank stocks.

Furthermore, the GARCH models with external variables must show more exact forecasts when the relevant factors are found to estimate the predictions sufficiently. The models which could demonstrate a relationship between the stock and external elements are very reasonable and necessary. It is reasonable because the price of a stock is really linked to factors including economic, society, market and internal issues in those listed companies. This has been proven in numerous studies and several studies are presented as evidence in this paper. It is necessary because investment is a rational action that investors require to maximize profits and minimize risks. When the relationship between stocks and external and internal factors are considered in an accurate and realistic model, the investor can utilize a strong tool to aid in analyzing the macro and micro economic factors to build his investment portfolio. Therefore, investors should take into consideration economic and financial news of the listed companies so that they can make well-informed investment decisions.

Further study about other effecting elements in individual stocks could be an expanding direction of this paper, such as the influences of financial statements, inflation or import-export data. Overall, the advantaged features of the GARCH approach are clarified by the way that GARCH models could describe the relationship of external factors and stock returns clearly and specifically. It is more appropriate for understanding how the external elements impact shares.

In addition, many other kinds of extended functions of GARCH models were developed such as PGARCH, Bivariate-GARCH, Stable-GARCH, COGARCH, CCC-GARCH, SVAR-GARCH, RGARCH and M-GARCH models. And, there are some models that could be combined with the GARCH approach in order to create a new function. They could also be examined for modeling and forecasting ability for shares in each specific case. Additionally, research could broadly consider the other forecasting methods such as dynamic methods or x-day-ahead forecasts. Or, forecasts for out-of data range could be also an extended orientation of this study. The expected models should not only predict in out-of-sample evaluation but the forecast of out-of data range cannot be estimated in this paper. The reason is it lacks the daily forecast values of the external variables. The values of the external variables only exist in data range. These are avenues for further research which could extend from this paper.

From the forecasting appreciations, the GARCH models which have the best forecast result for three stocks, Siemens, Muenchener Rueck and Deutsche Telekom, show the impact of the exogenous variables in variance equations. Their raw data stock prices do not need to be adjusted or logarithmized. Adjustment and the logarithm of raw data time series still give the pretty consistent models for analysis and forecast of stocks such as ProSiebenSat1 Media and HeidelbergCement. The Vonovia stock only has 768 observations but it could also give a pertinent model. At the same time, it should be noted that the previous statements have no meaning in the opposite directions. In addition, Siemens and Deutsche Bank stocks have the leverage effect which shows more acutely suffered impact on them from the bad news in the markets.

Investors and managers could base their decisions on the errors of forecasts to prepare risk prevention, profitable strategies and minimize transaction costs. Personal investors have varied risk tolerance levels so as to determine which average levels of forecast errors are acceptable is up to the financial preference of each individual investor. On the other hand, capital asset pricing model is a professional method to identify which limited risk and return ratio requirement that the investors and managers should consider. CAPM should be broadly applied to supply one more important factor for increasing accuracy in effective evaluation of GARCH models. In addition, this paper recommends that the forecasts should be implemented for the days of a close time frame as the predicted values would then be more accurate. However, these models can be also extended to analyze other specific shares and financial assets.

# 5. Conclusion

In conclusion, the outcomes of the DAX 30 stocks' models show that GARCH is the more trustworthy method in order to model the time-series data of the stocks in general. Although there is no existence of a perfect model, it

could be the best-fitting model, but small degrees of errors will always be present. Good models always give good orientations for the investor, but should not be trusted completely. The reasons are the impact factors of dependent variables could not be collected sufficiently and there are many elements which are contingent on the future so that all model functions have the residual or error variable. Furthermore, this paper identifies that the predicting models should not be used for long-term forecasts but instead is more relevant for short-term forecasts. However, investors should always prepare risk contingency plans and risk management. On the whole, the GARCH approach is very appropriate for the modeling of stock data time series. It is necessary to understand the GARCH analysis processes in order to construct the optimal portfolio assets that are consistent with the features of budget for investors and make the right business-financial decisions for managers.

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# Appendix 1





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# Appendix 2

# Valuations of forecast outcomes in out-of sample.

Date         Forecast prices         Real prices         Differences           17/7/16         93.25         93.00         0.25           18/7/16         93.22         93.88         0.66           19/7/16         93.22         93.88         0.66           19/7/16         93.31         94.09         0.28           20/7/16         93.72         93.90         0.18         of           21/7/16         93.67         94.90         1.23         ereration of the second of t	Siemens				-	Muenchen	er Rueck		-
prices         prices         Differences           177/16         93.22         93.88         0.66           197/16         93.81         94.09         0.28           207/16         93.72         93.90         0.18           217/16         94.06         93.37         0.69         148.92         149.17         0.25           147.16         93.67         94.90         1.23         of         differen         147.90         148.80         0.82         of           22/7/16         93.67         94.90         1.23         erger         average         of         red         average         of         red         average         i47.78         148.80         147.11         1.78         cc         price         average         i47.51         148.72         146.82         1.90         of         real           25/7/16         94.78         95.26         0.48         147.50         147.50         0.00         i48.83         0.78         i47.50         0.00         i47.51         147.50         0.00         i47.51         0.42         i48.40         148.40         0.82         o.78         i48.72         i48.40         0.82         i47.50         0.00         <	Date	Forecast	Real	D+66		Forecast	Real	D. 66	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		prices	prices	Differences	-	prices	prices	Differences	
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	17/7/16	93.25	93.00	0.25	-	148.40	148.63	0.23	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	18/7/16	93.22	93.88	0.66	-	148.92	149.17	0.25	
20/7/16         93.72         93.90         0.18         of of g1/7/16         147.90         148.70         0.80         of of g1/7/16           21/7/16         94.06         93.37         0.69         0.69         0.48         0.47.11         1.78         0.80	19/7/16	93.81	94.09	0.28	Average	149.22	148.10	1.12	Average
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	20/7/16	93.72	93.90	0.18	of	147.90	148.70	0.80	of
22/7/16         93.67         94.90         1.23         cc par average average 3/7/16         147.58         148.40         0.82         cc par average average 148.72         146.82         1.90         of real price           24/7/16         94.71         94.79         0.08         price         147.16         147.10         0.06         price         148.72         146.82         1.90         of real         price         147.16         147.10         0.06         price         0.06         price         147.50         147.50         0.00         0.00         147.57         148.35         0.54           26/7/16         96.16         96.40         0.24         147.57         148.35         0.78         147.57         148.35         0.78           28/7/16         96.53         97.00         0.47         147.57         148.40         148.47         0.07         0.47 <b>Deutsche Telekom ProSiebenSat1 Media ProsiebenSat1 Media</b> Japprices         Differences           17/7/16         15.29         15.43         0.15           20/7/16         15.28         15.23         0.05         40.05         40.02	21/7/16	94.06	93.37	0.69	differen	148.89	147.11	1.78	differen
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	22/7/16	93.67	94.90	1.23	ce per	147.58	148.40	0.82	ce per average
24/7/16         94.71         94.79         0.08         price         147.16         147.10         0.06         price           25/7/16         94.78         95.26         0.48         147.31         147.85         0.54           26/7/16         95.45         95.80         0.35         147.50         147.50         0.00         147.57         148.35         0.78           28/7/16         96.53         97.00         0.47         148.40         148.47         0.07         0.47           Average         94.76         0.42         0.44         148.02         0.70         0.47           Deutsche         Forecast         Real         Differences         ProsiebenSat1 Media         ProsiebenSat1 Media           Date         Forecast         Real         Differences         39.41         39.61         0.20           18/7/16         15.13         15.27         0.14         39.75         40.02         0.27           19/7/16         15.28         15.23         0.05         40.05         40.03         0.02           20/7/16         15.28         15.23         0.15         39.99         0.36         40.77           24/7/16         15.17         15.32 <td>23/7/16</td> <td>94.88</td> <td>94.77</td> <td>0.11</td> <td>of real</td> <td>148.72</td> <td>146.82</td> <td>1.90</td> <td>of real</td>	23/7/16	94.88	94.77	0.11	of real	148.72	146.82	1.90	of real
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	24/7/16	94.71	94.79	0.08	price	147.16	147.10	0.06	price
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	25/7/16	94.78	95.26	0.48		147.31	147.85	0.54	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	26/7/16	95.45	95.80	0.35		147.50	147.50	0.00	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	27/7/16	96.16	96.40	0.24		147.57	148.35	0.78	
Average         94.76         0.42         0.44         148.02         0.70         0.47           Deutsche Telekom         ProSiebenSat1 Media           Date         Forecast prices         Real prices         Differences         Forecast         Real prices         Differences           17/7/16         15.08         15.09         0.01         39.41         39.61         0.20           18/7/16         15.13         15.27         0.14         39.75         40.02         0.27           19/7/16         15.29         15.43         0.14         39.98         40.25         0.27           20/7/16         15.28         15.23         0.05         of differen ce per average of real price         40.04         40.26         0.22         of differen ce per average of real price         40.50         40.69         0.42         average of real price         of real price	28/7/16	96.53	97.00	0.47		148.40	148.47	0.07	
Deutsche TelekomProSiebenSat1 MediaDateForecast pricesReal pricesDifferences $17/7/16$ 15.0815.090.01 $18/7/16$ 15.1315.270.14 $19/7/16$ 15.2915.430.14 $20/7/16$ 15.2915.240.05 $21/7/16$ 15.2815.230.05 $22/7/16$ 15.2315.190.04 $23/7/16$ 15.1715.320.15 $24/7/16$ 15.1715.270.03 $25/7/16$ 15.2815.160.12		Average	94.76	0.42	0.44		148.02	0.70	0.47
Deutsche Telekom         ProSiebenSat1 Media           Date         Forecast prices         Real prices         Differences           17/7/16         15.08         15.09         0.01           18/7/16         15.13         15.27         0.14           19/7/16         15.29         15.43         0.14           20/7/16         15.29         15.24         0.05           21/7/16         15.28         15.23         0.05           22/7/16         15.23         0.05         differen ce per 24/7/16         0.15           25/7/16         15.30         15.27         0.03         price         40.50         40.66         0.18           25/7/16         15.28         15.16         0.12         price         0.18         price         0.18									
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	Deutsche	Telekom				ProSieben	Sat1 Med	ia	
DatepricespricesDifferences $17/7/16$ $15.08$ $15.09$ $0.01$ $18/7/16$ $15.13$ $15.27$ $0.14$ $19/7/16$ $15.29$ $15.43$ $0.14$ $20/7/16$ $15.29$ $15.28$ $0.15$ $21/7/16$ $15.28$ $15.23$ $0.05$ $22/7/16$ $15.23$ $15.19$ $0.04$ $23/7/16$ $15.23$ $15.27$ $0.03$ $25/7/16$ $15.28$ $15.27$ $0.03$ $25/7/16$ $15.28$ $15.16$ $0.12$	Date	Forecast	Real			Forecast	Real		
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	Dute	prices	prices	Differences	-	prices	prices	Differences	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	17/7/16	15.08	15.09	0.01	-	39.41	39.61	0.20	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	18/7/16	15.13	15.27	0.14	-	39.75	40.02	0.27	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	19/7/16	15.29	15.43	0.14	4	40.05	40.03	0.02	
21/7/16       15.29       15.24       0.05       Average of differen ce per average of real price       40.35       39.99       0.36       Average of differen ce per average of real price         23/7/16       15.23       15.19       0.04       ce per average of real price       40.73       40.52       0.21       differen average of real price         25/7/16       15.28       15.16       0.12       0.03       price       40.66       40.84       0.18	20/7/16	15.43	15.28	0.15		39.98	40.25	0.27	
22/7/16       15.28       15.23       0.05       of differen ce per       40.04       40.26       0.22       of differen ce per         23/7/16       15.23       15.19       0.04       ce per       40.27       40.69       0.42       ce per         24/7/16       15.17       15.32       0.15       average of real price       of real       40.50       40.68       0.18       price	21/7/16	15.29	15.24	0.05	Average	40.35	39.99	0.36	Average
23/7/16       15.23       15.19       0.04       ce per average of real price       40.27       40.69       0.42       ce per average of real price         24/7/16       15.17       15.32       0.15       average of real price       40.52       0.21       average of real price         25/7/16       15.28       15.16       0.12       0.12       40.66       40.84       0.18	22/7/16	15.28	15.23	0.05	Of differen	40.04	40.26	0.22	of differen
24/7/16         15.17         15.32         0.15         average of real price         40.73         40.52         0.21         average of real price           25/7/16         15.30         15.27         0.03         price         40.66         40.68         0.18         price	23/7/16	15.23	15.19	0.04	ce per	40.27	40.69	0.42	ce per
25/7/16         15.30         15.27         0.03         of real price         40.50         40.68         0.18         of real price           26/7/16         15.28         15.16         0.12         40.66         40.84         0.18         price         40.66         40.84         0.18	24/7/16	15.17	15.32	0.15	average	40.73	40.52	0.21	average
26/7/16 15.28 15.16 0.12 40.66 40.84 0.18	25/7/16	15.30	15.27	0.03	of real	40.50	40.68	0.18	of real
	26/7/16	15.28	15.16	0.12	Price	40.66	40.84	0.18	Price
27/7/16 15.20 15.17 0.03 40.91 40.80 0.11	27/7/16	15.20	15.17	0.03		40.91	40.80	0.11	
28/7/16 15.18 15.18 0.00 40.83 40.84 0.01	28/7/16	15.18	15.18	0.00		40.83	40.84	0.01	
Average 15.24 0.08 0.50 40.38 0.20 0.50		Average	15.24	0.08	0.50		40.38	0.20	0.50
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Date	Forecast	Real	Differences		Forecast	Real	Differences	
17/7/14	prices	prices	Differences		prices	prices	Differences	
17///16	67.71	67.01	0.70		71.62	71.54	0.08	-
18/7/16	67.02	66.83	0.19	-	71.80	72.04	0.24	-
19/7/16	66.88	66.86	0.02	Average	72.04	71.35	0.69	Average
20/7/16	66.95	66.75	0.20	of	71.14	71.83	0.69	of
21/7/16	66.76	66.45	0.31	differen	71.94	71.28	0.66	differen
22/7/16	66.53	67.26	0.73	average	71.34	71.92	0.58	average
23/7/16	67.29	66.62	0.67	of real	71.78	71.40	0.38	of real
24/7/16	66.58	67.11	0.53	price	71.32	71.29	0.03	price
25/7/16	67.07	67.07	0.00	-	71.27	71.31	0.04	4
26/7/16	67.09	67.92	0.83	_	71.28	71.82	0.54	-
27/7/16	67.90	67.72	0.18	_	72.10	72.43	0.33	
28/7/16	67.74	67.77	0.03		72.72	73.58	0.86	
	Average	67.11	0.37	0.55		71.82	0.43	0.60
Merck	<b>-</b>		1		Bayer	1	1	
Date	Forecast prices	Real prices	Differences		Forecast prices	Real prices	Differences	
17/7/16	94.53	94.24	0.29		93.17	92.80	0.37	
18/7/16	94.29	93.70	0.59		93.01	92.75	0.26	
19/7/16	93.85	94.25	0.40		92.87	93.85	0.98	
20/7/16	94.28	94.60	0.32	Average	93.60	92.70	0.90	Average
21/7/16	94.45	94.44	0.01	differen	93.04	91.60	1.44	differen
22/7/16	94.55	96.09	1.54	ce per	91.83	91.83	0.00	ce per
23/7/16	96.08	96 59	0.51	average	92.10	92.15	0.05	average
24/7/16	96.51	97.61	1.10	price	92.06	92.13	0.05	price
25/7/16	97.76	96.90	0.86	1	92.00	92.50	0.50	
26/7/16	97.10	07.88	0.69	-	92.00	93.44	0.00	-
20/7/16	97.19	08 10	0.14		03.42	04 30	0.92	-
29/7/16	98.05	90.19	0.44	1	93.42	94.39	0.97	-
28/7/10	98.30	99.00	0.57	0.60	94.30	94.80	0.24	0.00
	Average	90.12	0.57	0.00		92.91	0.50	0.60
Doiorador	f				Enconing	 Madiaal (		
Deletsuot	Forecast	Real			Forecast	Real		
Date	prices	prices	Differences	_	prices	prices	Differences	-
17/7/16	83.57	83.95	0.38		78.82	78.93	0.11	
18/7/16	84.12	84.04	0.08		78.99	78.63	0.36	
19/7/16	84.08	83.45	0.63		78.64	78.62	0.02	
20/7/16	83.35	84.17	0.82	Average of	78.65	79.81	1.16	Average
21/7/16	84.32	82.99	1.33	differen	79.81	79.12	0.69	differen
22/7/16	83.05	83.82	0.77	ce per	79.14	80.92	1.78	ce per
23/7/16	83.74	83.70	0.04	of real	80.92	80.77	0.15	of real
24/7/16	83.74	83.68	0.06	price	80.75	80.90	0.15	price
25/7/16	83.68	83.61	0.07		80.92	81.01	0.09	
26/7/16	83.56	84.70	1.14		80.99	81.61	0.62	
27/7/16	84.71	83.84	0.87		81.62	81.44	0.18	
28/7/16	83.83	83.93	0.10		81.44	82.28	0.84	

	Average	83.82	0.52	0.62		80.34	0.51	0.64
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Date	Forecast prices	Real prices	Differences		Forecast prices	Real prices	Differences	
17/7/16	109.64	109.30	0.34		25.56	25.36	0.20	
18/7/16	109.38	108.65	0.73		25.46	25.76	0.30	
19/7/16	108.38	109.70	1.32		25.76	25.72	0.04	
20/7/16	109.54	109.60	0.06	Average of	25.65	25.61	0.04	Average of
21/7/16	109.95	108.15	1.80	differen	25.70	25.50	0.20	differen
22/7/16	108.25	108.90	0.65	ce per	25.49	25.76	0.27	ce per
23/7/16	108.45	108.75	0.30	of real	25.81	25.92	0.11	of real
24/7/16	108.82	108.05	0.77	price	25.96	25.76	0.20	price
25/7/16	108.15	109.85	1.70		25.76	26.04	0.28	
26/7/16	109.90	110.44	0.54		26.03	26.06	0.03	
27/7/16	110.35	110.10	0.25		26.08	26.31	0.23	
28/7/16	110.11	110.81	0.70		26.35	26.65	0.30	
	Average	109.36	0.76	0.70		25.87	0.18	0.71
Vonovia		1	1		Deutsche F	Boerse	1	
Date	Forecast prices	Real prices	Differences		Forecast prices	Real prices	Differences	
17/7/16	32.54	32.86	0.32		74.80	74.91	0.11	
18/7/16	32.92	32.92	0.00		75.18	76.03	0.85	
19/7/16	32.97	33.36	0.39		75.49	75.45	0.04	
20/7/16	33.37	33.58	0.21	Average	75.16	76.54	1.38	Average
21/7/16	33.62	33.55	0.07	differen	76.73	75.16	1.57	differen
22/7/16	33.61	33.51	0.10	ce per	74.92	74.81	0.11	ce per
23/7/16	33.52	33.31	0.21	of real	74.88	73.70	1.18	of real
24/7/16	33.33	33.40	0.07	price	73.41	73.22	0.19	price
25/7/16	33.40	33.98	0.58		73.35	73.79	0.44	
26/7/16	34.00	34.23	0.23		73.74	73.53	0.21	
27/7/16	34.26	34.21	0.05		73.62	74.46	0.84	
28/7/16	34.23	35.03	0.80		74.57	74.73	0.16	
	Average	33.66	0.25	0.75		74.69	0.59	0.79
BASF		1	1		SAP	1	1	
Date	Forecast prices	Real prices	Differences		Forecast prices	Real prices	Differences	
17/7/16	68.69	69.09	0.40		70.41	70.43	0.02	
18/7/16	69.36	71.22	1.86	Average	70.65	70.88	0.23	Average
19/7/16	71.28	71.70	0.42	of differen	70.96	71.17	0.21	of
20/7/16	71.55	71.59	0.04	ce per	71.08	71.79	0.71	ce per
21/7/16	71.74	71.10	0.64	average	71.75	71.62	0.13	average
22/7/16	71.19	71.75	0.56	of real price	71.69	75.74	4.05	of real price
23/7/16	71.61	71.79	0.18	Fried	75.64	76.20	0.56	Pile
24/7/16	71.71	71.51	0.20		76.24	76.97	0.73	
25/7/16	71.48	71.67	0.19		77.06	77.04	0.02	

26/7/16	71.73	71.60	0.13		77.08	77.30	0.22	
27/7/16	71.67	70.11	1.56		77.31	78.02	0.71	
28/7/16	70.07	70.75	0.68		78.08	78.29	0.21	
	Average	71.16	0.57	0.80		74.62	0.65	0.87
Allianz	T				Linde		[	
Date	Forecast prices	Real prices	Differences		Forecast prices	Real prices	Differences	
17/7/16	126.98	126.97	0.01	4	125.28	124.66	0.62	
18/7/16	127.39	129.00	1.61	4	124.88	128.30	3.42	
19/7/16	129.05	127.75	1.30	Average	128.39	128.05	0.34	Average
20/7/16	127.66	127.44	0.22	of	127.76	128.75	0.99	of
21/7/16	127.89	125.20	2.69	differen	128.49	127.20	1.29	differen
22/7/16	125.48	126.51	1.03	ce per average	127.44	127.37	0.07	ce per average
23/7/16	126.85	125.16	1.69	of real	127.40	128.33	0.93	of real
24/7/16	125.29	125.53	0.24	price	127.95	128.54	0.59	price
25/7/16	125.65	126.14	0.49	4	128.17	129.32	1.15	
26/7/16	126.14	126.77	0.63	-	129.34	128.84	0.50	
27/7/16	127.33	129.53	2.20	4	128.79	131.45	2.66	
28/7/16	129.76	128.07	1.69		132.13	129.98	2.15	
	Average	127.01	1.15	0.91		128.40	1.23	0.95
E.ON	<b>F</b>	Deal			Adidas	Deel		
Data	Forecast	Kear			Forecast	<b>Real</b>		
Date	prices	prices	Differences		prices	prices	Differences	
17/7/16	prices 8.38	prices 8.63	<b>Differences</b> 0.25		prices 130.42	prices	<b>Differences</b> 0.41	
17/7/16 18/7/16	<b>prices</b> 8.38 8.69	prices           8.63           8.57	Differences           0.25           0.12		prices           130.42           131.02	ncear           prices           130.83           129.92	<b>Differences</b> 0.41 1.10	
Date           17/7/16           18/7/16           19/7/16	prices           8.38           8.69           8.57	prices           8.63           8.57           8.64	Differences           0.25           0.12           0.07		prices           130.42           131.02           129.72	prices           130.83           129.92           131.57	Differences           0.41           1.10           1.85	
Date           17/7/16           18/7/16           19/7/16           20/7/16	prices           8.38           8.69           8.57           8.61	prices           8.63           8.57           8.64           8.65	Differences           0.25           0.12           0.07           0.04	Average	Information           prices           130.42           131.02           129.72           131.42	number         number<	Differences           0.41           1.10           1.85           0.10	Average
Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16	prices           8.38           8.69           8.57           8.61           8.63	prices           8.63           8.57           8.64           8.65           8.48	Differences           0.25           0.12           0.07           0.04           0.15	Average of differen	Forecast           prices           130.42           131.02           129.72           131.42           131.27	nccan           prices           130.83           129.92           131.57           131.32           132.38	Differences           0.41           1.10           1.85           0.10           1.11	Average of differen
Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16	prices           8.38           8.69           8.57           8.61           8.63           8.47	prices           8.63           8.57           8.64           8.65           8.48           8.61	Differences           0.25           0.12           0.07           0.04           0.15           0.14	Average of differen ce per	130.42           131.02           129.72           131.27           132.53	Item           prices           130.83           129.92           131.57           131.32           132.38           136.23	Differences           0.41           1.10           1.85           0.10           1.11           3.70	Average of differen ce per
Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16           23/7/16	prices           8.38           8.69           8.57           8.61           8.63           8.47           8.59	prices           8.63           8.57           8.64           8.65           8.48           8.61           8.60	Differences           0.25           0.12           0.07           0.04           0.15           0.14           0.01	Average of differen ce per average of real	1 orccast           prices           130.42           131.02           129.72           131.42           131.27           132.53           136.24	Item           prices           130.83           129.92           131.57           131.32           132.38           136.23           137.97	Differences           0.41           1.10           1.85           0.10           1.11           3.70           1.73	Average of differen ce per average of real
Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16           23/7/16           24/7/16	prices           8.38           8.69           8.57           8.61           8.63           8.47           8.59           8.60	prices           8.63           8.57           8.64           8.65           8.48           8.61           8.60           8.63	Differences           0.25           0.12           0.07           0.04           0.15           0.14           0.01           0.03	Average of differen ce per average of real price	130.42           131.02           129.72           131.42           131.27           132.53           136.24           137.74	Item           prices           130.83           129.92           131.57           131.32           132.38           136.23           137.97           137.34	Differences           0.41           1.10           1.85           0.10           1.11           3.70           1.73           0.40	Average of differen ce per average of real price
Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16           23/7/16           24/7/16           25/7/16	prices           8.38           8.69           8.57           8.61           8.63           8.47           8.59           8.60           8.58	prices           8.63           8.57           8.64           8.65           8.48           8.61           8.60           8.63	Differences           0.25           0.12           0.07           0.04           0.15           0.14           0.01           0.03           0.02	Average of differen ce per average of real price	130.42           131.02           129.72           131.42           131.27           132.53           136.24           137.74           137.29	Item           prices           130.83           129.92           131.57           131.32           132.38           136.23           137.97           137.34           139.14	Differences           0.41           1.10           1.85           0.10           1.11           3.70           1.73           0.40           1.85	Average of differen ce per average of real price
Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16           23/7/16           24/7/16           25/7/16           26/7/16	prices           8.38           8.69           8.57           8.61           8.63           8.47           8.59           8.60           8.58           8.61	prices           8.63           8.57           8.64           8.65           8.48           8.61           8.60           8.60           8.70	Differences           0.25           0.12           0.07           0.04           0.15           0.14           0.01           0.03           0.02           0.09	Average of differen ce per average of real price	130.42         130.42         131.02         129.72         131.42         131.27         132.53         136.24         137.74         137.29         139.20	Item           prices           130.83           129.92           131.57           131.32           132.38           136.23           137.97           139.14           140.20	Differences           0.41           1.10           1.85           0.10           1.11           3.70           1.73           0.40           1.85           1.00	Average of differen ce per average of real price
Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           23/7/16           24/7/16           25/7/16           26/7/16           27/7/16	prices         8.38         8.69         8.57         8.61         8.63         8.47         8.59         8.60         8.58         8.61         8.63	prices           8.63           8.57           8.64           8.65           8.48           8.61           8.60           8.63           8.60           8.70           8.64	Differences           0.25           0.12           0.07           0.04           0.15           0.14           0.01           0.03           0.02           0.09           0.05	Average of differen ce per average of real price	130.42         131.02         129.72         131.42         131.27         132.53         136.24         137.74         139.20         140.19	Item           prices           130.83           129.92           131.57           131.32           132.38           136.23           137.97           137.34           139.14           140.20           140.83	Differences           0.41           1.10           1.85           0.10           1.11           3.70           1.73           0.40           1.85           1.00           0.64	Average of differen ce per average of real price
Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16           23/7/16           24/7/16           25/7/16           26/7/16           27/7/16           28/7/16	prices           8.38           8.69           8.57           8.61           8.63           8.47           8.59           8.60           8.58           8.61           8.69           8.61	prices           8.63           8.57           8.64           8.65           8.48           8.61           8.60           8.63           8.60           8.70           8.64           8.71	Differences           0.25           0.12           0.07           0.04           0.15           0.14           0.01           0.03           0.02           0.09           0.05           0.10	Average of differen ce per average of real price	130.42         130.42         131.02         129.72         131.42         131.27         132.53         136.24         137.74         139.20         140.19         140.91	Item           prices           130.83           129.92           131.57           131.32           132.38           136.23           137.34           139.14           140.20           140.83           145.03	Differences           0.41           1.10           1.85           0.10           1.11           3.70           1.73           0.40           1.85           1.00           0.64           4.12	Average of differen ce per average of real price
Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           23/7/16           24/7/16           25/7/16           26/7/16           27/7/16           28/7/16	prices         8.38         8.69         8.57         8.61         8.63         8.47         8.59         8.60         8.58         8.61         8.69         8.61         8.62         8.61         8.69         8.61         8.69         8.61	prices           8.63           8.57           8.64           8.65           8.48           8.61           8.60           8.63           8.60           8.70           8.64           8.71           8.62	Differences           0.25           0.12           0.07           0.04           0.15           0.14           0.01           0.03           0.02           0.09           0.10           0.09	Average of differen ce per average of real price	130.42         130.42         131.02         129.72         131.42         131.27         132.53         136.24         137.29         139.20         140.19         140.91	Item           prices           130.83           129.92           131.57           131.32           132.38           136.23           137.97           137.34           139.14           140.20           145.03           136.06	Differences           0.41           1.10           1.85           0.10           1.11           3.70           1.73           0.40           1.85           1.00           0.64           4.12           1.50	Average of differen ce per average of real price
Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16           23/7/16           24/7/16           25/7/16           26/7/16           27/7/16           28/7/16	prices         8.38         8.69         8.57         8.61         8.63         8.47         8.59         8.60         8.58         8.61         8.69         8.61         8.69         8.61         8.69         8.61         8.69         8.61	prices           8.63           8.57           8.64           8.65           8.48           8.61           8.60           8.63           8.60           8.70           8.64           8.71           8.62	Differences           0.25           0.12           0.07           0.04           0.15           0.14           0.01           0.03           0.02           0.09           0.10           0.09	Average of differen ce per average of real price	130.42         131.02         129.72         131.42         131.27         132.53         136.24         137.74         139.20         140.19         140.91	Item           prices           130.83           129.92           131.57           131.32           132.38           136.23           137.97           137.34           139.14           140.20           145.03           136.06	Differences           0.41           1.10           1.85           0.10           1.11           3.70           1.73           0.40           1.85           1.00           0.64           4.12           1.50	Average of differen ce per average of real price
17/7/16         18/7/16         19/7/16         20/7/16         21/7/16         22/7/16         23/7/16         25/7/16         26/7/16         27/7/16         28/7/16         Daimler	prices         8.38         8.69         8.57         8.61         8.63         8.47         8.59         8.60         8.58         8.61         8.69         8.61         8.69         8.61         8.69         8.61         8.69         8.61	prices           8.63           8.57           8.64           8.65           8.48           8.61           8.60           8.63           8.60           8.70           8.64           8.71           8.62	Differences           0.25           0.12           0.07           0.04           0.15           0.14           0.01           0.03           0.02           0.09           0.05           0.10           0.09	Average of differen ce per average of real price	130.42         131.02         129.72         131.42         131.27         132.53         136.24         137.74         137.29         139.20         140.19         140.91	Item           prices           130.83           129.92           131.57           131.32           132.38           136.23           137.97           137.34           139.14           140.83           145.03           136.06	Differences           0.41           1.10           1.85           0.10           1.11           3.70           1.73           0.40           1.85           1.00           0.64           4.12           1.50	Average of differen ce per average of real price
Date         17/7/16         18/7/16         19/7/16         20/7/16         21/7/16         22/7/16         23/7/16         24/7/16         25/7/16         26/7/16         27/7/16         28/7/16         Daimler         Date	prices           8.38           8.69           8.57           8.61           8.63           8.47           8.59           8.60           8.58           8.61           8.69           8.61           8.69           8.61           8.69           8.61           8.69           8.61           Forecast           prices	prices           8.63           8.57           8.64           8.65           8.48           8.61           8.60           8.63           8.60           8.70           8.64           8.70           8.64           8.70           8.64           8.70           8.64           8.71           8.62           Real           prices	Differences           0.25           0.12           0.07           0.04           0.15           0.14           0.01           0.03           0.02           0.09           0.10           0.09           0.10           Differences	Average of differen ce per average of real price	130.42         131.02         129.72         131.42         131.27         132.53         136.24         137.74         139.20         140.19         140.91         RWE         Forecast         prices	Real         prices         130.83         129.92         131.57         131.57         131.32         132.38         136.23         137.97         137.34         139.14         140.20         145.03         136.06	Differences           0.41           1.10           1.85           0.10           1.11           3.70           1.73           0.40           1.85           1.00           0.64           4.12           1.50	Average of differen ce per average of real price
17/7/16         18/7/16         19/7/16         20/7/16         21/7/16         22/7/16         23/7/16         25/7/16         25/7/16         26/7/16         27/7/16         28/7/16         Daimler         Date         17/7/16	prices         8.38         8.69         8.57         8.61         8.63         8.47         8.59         8.60         8.58         8.61         8.69         8.61         8.69         8.61         8.69         8.61         8.69         8.61         57.59	prices           8.63           8.57           8.64           8.65           8.48           8.61           8.60           8.63           8.60           8.70           8.64           8.71           8.62	Differences           0.25           0.12           0.07           0.04           0.15           0.14           0.01           0.03           0.02           0.09           0.05           0.10           0.09           0.25	Average of differen ce per average of real price	130.42         131.02         129.72         131.42         131.27         132.53         136.24         137.74         137.29         139.20         140.19         140.91         RWE         Forecast         prices         15.11	Item           prices           130.83           129.92           131.57           131.32           132.38           136.23           137.97           137.34           139.14           140.20           140.83           145.03           136.06           Prices           15.85	Differences           0.41           1.10           1.85           0.10           1.11           3.70           1.73           0.40           1.85           1.00           0.64           4.12           1.50           Differences           0.74	Average of differen ce per average of real price
Date         17/7/16         18/7/16         19/7/16         20/7/16         21/7/16         22/7/16         23/7/16         24/7/16         25/7/16         26/7/16         27/7/16         28/7/16         Daimler         Date         17/7/16         18/7/16	prices         8.38         8.69         8.57         8.61         8.63         8.47         8.59         8.60         8.58         8.61         8.69         8.61         8.69         8.61         8.69         8.61 <b>Forecast</b> prices         57.59         57.62	prices         8.63         8.57         8.64         8.65         8.48         8.61         8.60         8.63         8.60         8.70         8.64         8.70         8.64         8.71         8.62         Prices         57.34         58.68	Differences           0.25           0.12           0.07           0.04           0.15           0.14           0.01           0.03           0.02           0.09           0.10           0.09           0.10           0.25           1.06	Average of differen ce per average of real price	130.42         131.02         129.72         131.42         131.27         132.53         136.24         137.74         137.29         139.20         140.19         140.91         RWE         Forecast         prices         15.11         15.92	Real         prices         130.83         129.92         131.57         131.57         131.57         131.32         132.38         136.23         137.97         137.34         139.14         140.20         140.83         145.03         136.06         Real         prices         15.85         15.76	Differences           0.41           1.10           1.85           0.10           1.11           3.70           1.73           0.40           1.85           1.00           0.64           4.12           1.50           Differences           0.74           0.16	Average of differen ce per average of real price
Date         17/7/16         18/7/16         19/7/16         20/7/16         21/7/16         22/7/16         23/7/16         24/7/16         25/7/16         26/7/16         27/7/16         28/7/16         Daimler         Date         17/7/16         18/7/16         19/7/16	prices         8.38         8.69         8.57         8.61         8.63         8.47         8.59         8.60         8.58         8.61         8.69         8.61         8.69         8.61         8.69         8.61         8.69         8.61         57.59         57.59         57.62         58.70	prices         8.63         8.57         8.64         8.65         8.48         8.61         8.60         8.63         8.60         8.70         8.64         8.70         8.64         8.70         8.64         8.71         8.62         Prices         57.34         58.68         58.30	Differences           0.25           0.12           0.07           0.04           0.15           0.14           0.01           0.03           0.02           0.09           0.05           0.10           0.09           0.25           1.06           0.40	Average of differen ce per average of real price	130.42         130.42         131.02         129.72         131.42         131.27         132.53         136.24         137.74         137.29         139.20         140.19         140.91         RWE         Forecast         prices         15.11         15.92         15.74	Real           prices           130.83           129.92           131.57           131.57           131.32           132.38           136.23           137.97           137.34           139.14           140.20           140.83           145.03           136.06           Prices           15.85           15.76           15.59	Differences           0.41           1.10           1.85           0.10           1.11           3.70           1.73           0.40           1.85           1.00           0.64           4.12           1.50           Differences           0.74           0.16           0.15	Average of differen ce per average of real price
Date         17/7/16         18/7/16         19/7/16         20/7/16         21/7/16         22/7/16         23/7/16         24/7/16         25/7/16         26/7/16         27/7/16         28/7/16         Daimler         Date         17/7/16         18/7/16         19/7/16         20/7/16	prices         8.38         8.69         8.57         8.61         8.63         8.47         8.59         8.60         8.58         8.61         8.69         8.61         8.69         8.61         8.69         8.61         8.69         8.61         57.59         57.59         57.62         58.70         58.25	prices         8.63         8.57         8.64         8.65         8.48         8.61         8.60         8.63         8.60         8.63         8.60         8.70         8.64         8.70         8.64         8.71         8.62         Prices         57.34         58.68         58.30         58.40	Differences           0.25           0.12           0.07           0.04           0.15           0.14           0.01           0.03           0.02           0.09           0.05           0.10           0.09           0.25           1.06           0.40           0.15	Average of differen ce per average of real price	130.42         130.42         131.02         129.72         131.42         131.27         132.53         136.24         137.74         137.29         139.20         140.19         140.91         RWE         Forecast         prices         15.11         15.92         15.74         15.53	Item         prices         130.83         129.92         131.57         131.57         131.32         132.38         136.23         137.97         137.34         139.14         140.20         140.83         145.03         136.06         Prices         15.85         15.76         15.59         15.86	Differences           0.41           1.10           1.85           0.10           1.11           3.70           1.73           0.40           1.85           1.00           0.64           4.12           1.50           Differences           0.74           0.16           0.15           0.33	Average of differen ce per average of real price
Date         17/7/16         18/7/16         19/7/16         20/7/16         21/7/16         22/7/16         23/7/16         24/7/16         25/7/16         26/7/16         27/7/16         28/7/16         28/7/16         17/7/16         18/7/16         19/7/16         19/7/16         19/7/16         20/7/16         21/7/16	prices           8.38           8.69           8.57           8.61           8.63           8.47           8.59           8.60           8.58           8.61           8.69           8.61           8.69           8.61           8.69           8.61           8.69           8.61           9           8.61           57.59           57.59           57.62           58.70           58.25           58.56	prices         8.63         8.57         8.64         8.65         8.48         8.61         8.60         8.63         8.60         8.70         8.64         8.70         8.62         Prices         57.34         58.68         58.30         58.40         57.57	Differences           0.25           0.12           0.07           0.04           0.15           0.14           0.01           0.03           0.02           0.09           0.05           0.10           0.09           0.25           1.06           0.40           0.15           0.99	Average of differen ce per average of real price	130.42         130.42         131.02         129.72         131.42         131.27         132.53         136.24         137.74         137.29         139.20         140.19         140.91         RWE         Forecast         prices         15.11         15.92         15.74         15.53         15.84	Real         prices         130.83         129.92         131.57         131.32         132.38         136.23         137.97         137.34         139.14         140.20         140.83         145.03         136.06         Prices         15.85         15.76         15.59         15.53	Differences           0.41           1.10           1.85           0.10           1.11           3.70           1.73           0.40           1.85           1.00           0.64           4.12           1.50           Differences           0.74           0.16           0.15           0.33           0.31	Average of differen ce per average of real price

23/7/16	58.54	59.57	1.03		15.56	15.77	0.21	
24/7/16	59.52	59.32	0.20		15.71	15.78	0.07	
25/7/16	59.29	60.05	0.76		15.77	15.76	0.01	
26/7/16	60.13	60.59	0.46		15.76	15.92	0.16	
27/7/16	60.61	61.88	1.27		15.81	15.89	0.08	
28/7/16	61.85	60.80	1.05		15.89	15.89	0.00	
	Average	59.26	0.71	1.20		15.77	0.19	1.23
Thyssenk	rupp				BMW			
Date	Forecast prices	Real prices	Differences		Forecast prices	Real prices	Differences	
17/7/16	19.50	19.30	0.20		73.01	72.90	0.11	
18/7/16	19.26	19.69	0.43		73.12	74.37	1.25	
19/7/16	19.66	19.68	0.02		74.67	74.48	0.19	
20/7/16	19.61	19.75	0.14	Average	74.47	75.10	0.63	Average
21/7/16	19.88	19.42	0.46	differen	75.18	73.54	1.64	differen
22/7/16	19.34	19.53	0.19	ce per	73.59	75.20	1.61	ce per
23/7/16	19.25	19.60	0.35	of real	75.04	76.00	0.96	of real
24/7/16	19.80	19.57	0.23	price	75.70	75.35	0.35	price
25/7/16	19.51	19.83	0.32		75.25	76.27	1.02	
26/7/16	19.88	19.88	0.00		76.18	76.88	0.70	
27/7/16	20.00	19.82	0.18		76.97	78.14	1.17	
28/7/16	19.82	20.27	0.45		78.47	76.65	1.82	
	Average	19.70	0.25	1.26		75.41	0.95	1 27
							0.70	1.27
								1.27
Infineon					Commerzh	ank		1.27
Infineon Date	Forecast prices	Real prices	Differences		Commerzt Forecast prices	ank Real prices	Differences	1.27
<b>Infineon Date</b> 17/7/16	Forecast prices 13.56	Real prices 13.29	Differences 0.27		Commerzh Forecast prices 5.90	ank Real prices 5.84	Differences 0.06	
Infineon Date 17/7/16 18/7/16	Forecast prices 13.56 13.29	<b>Real</b> prices 13.29 13.64	Differences 0.27 0.35		Commerzh Forecast prices 5.90 5.87	ank Real prices 5.84 5.98	<b>Differences</b> 0.06 0.11	
Infineon           Date           17/7/16           18/7/16           19/7/16	<b>Forecast</b> <b>prices</b> 13.56 13.29 13.58	Real           prices           13.29           13.64           13.54	<b>Differences</b> 0.27 0.35 0.04		Commerze Forecast prices 5.90 5.87 5.98	Pank           Real           prices           5.84           5.98           5.93	<b>Differences</b> 0.06 0.11 0.05	
Infineon           Date           17/7/16           18/7/16           19/7/16           20/7/16	Forecast           prices           13.56           13.29           13.58           13.52	Real           prices           13.29           13.64           13.54           13.85	Differences           0.27           0.35           0.04           0.33	Average	Commerzh Forecast prices 5.90 5.87 5.98 5.89	Real           prices           5.84           5.98           5.93           5.94	Differences           0.06           0.11           0.05	Average
Infineon           Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16	Forecast           prices           13.56           13.29           13.58           13.52           13.82	Real           prices           13.29           13.64           13.54           13.85           13.88	Differences           0.27           0.35           0.04           0.33           0.06	Average of differen	Commerzh Forecast prices 5.90 5.87 5.98 5.89 5.89 5.96	Pank           Real           prices           5.84           5.98           5.93           5.94           5.88	Differences           0.06           0.11           0.05           0.05           0.08	Average of differen
Infineon           Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16	Forecast           prices           13.56           13.29           13.58           13.52           13.82           13.97	Real           prices           13.29           13.64           13.54           13.85           13.88           14.16	Differences           0.27           0.35           0.04           0.33           0.06           0.19	Average of differen ce per	Commerzh Forecast prices 5.90 5.87 5.98 5.89 5.89 5.96 5.85	ank           Real           prices           5.84           5.98           5.93           5.94           5.88           5.88           5.89	Differences           0.06           0.11           0.05           0.05           0.08           0.04	Average of differen ce per
Infineon           Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16           23/7/16	Forecast           prices           13.56           13.29           13.58           13.52           13.82           13.97           14.17	Real           prices           13.29           13.64           13.54           13.85           13.88           14.16           14.12	Differences           0.27           0.35           0.04           0.33           0.06           0.19           0.05	Average of differen ce per average of real	Commerzit           Forecast           prices           5.90           5.87           5.98           5.89           5.96           5.85           5.84	Real           prices           5.84           5.98           5.93           5.94           5.88           5.89           5.94	Differences           0.06           0.11           0.05           0.05           0.08           0.04           0.10	Average of differen ce per average of real
Infineon           Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16           23/7/16           24/7/16	Forecast           prices           13.56           13.29           13.58           13.52           13.82           13.97           14.17           14.07	Real           prices           13.29           13.64           13.54           13.85           13.88           14.16           14.12           14.14	Differences           0.27           0.35           0.04           0.33           0.06           0.19           0.05           0.07	Average of differen ce per average of real price	Commerzh Forecast prices 5.90 5.87 5.98 5.89 5.96 5.85 5.85 5.84 5.92	ank           Real           prices           5.84           5.98           5.93           5.94           5.88           5.89           5.94           5.89           5.94	Differences           0.06           0.11           0.05           0.05           0.08           0.04           0.10           0.09	Average of differen ce per average of real price
Infineon           Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16           23/7/16           24/7/16           25/7/16	Forecast           prices           13.56           13.29           13.58           13.52           13.82           13.97           14.17           14.07           14.16	Real           prices           13.29           13.64           13.54           13.85           13.88           14.16           14.12           14.14           14.29	Differences           0.27           0.35           0.04           0.33           0.06           0.19           0.05           0.07           0.13	Average of differen ce per average of real price	Commerzh Forecast prices 5.90 5.87 5.98 5.98 5.98 5.89 5.96 5.85 5.84 5.92 5.81	ank           Real           prices           5.84           5.98           5.93           5.94           5.88           5.89           5.94           5.88           5.89           5.94	Differences           0.06           0.11           0.05           0.05           0.08           0.04           0.10           0.09           0.00	Average of differen ce per average of real price
Infineon           Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16           23/7/16           24/7/16           25/7/16           26/7/16	Forecast           prices           13.56           13.29           13.58           13.52           13.82           13.97           14.17           14.07           14.16           14.27	Real           prices           13.29           13.64           13.54           13.85           13.88           14.16           14.12           14.14           14.29           14.54	Differences           0.27           0.35           0.04           0.33           0.06           0.19           0.05           0.07           0.13           0.27	Average of differen ce per average of real price	Commerzh           Forecast           prices           5.90           5.87           5.98           5.98           5.96           5.85           5.84           5.92           5.81           5.80	Annu           Real           prices           5.84           5.98           5.93           5.94           5.88           5.89           5.94           5.83           5.94           5.81           5.60	Differences           0.06           0.11           0.05           0.05           0.08           0.04           0.10           0.09           0.00           0.20	Average of differen ce per average of real price
Infineon           Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16           23/7/16           25/7/16           25/7/16           26/7/16           27/7/16	Forecast           prices           13.56           13.29           13.58           13.52           13.82           13.97           14.17           14.07           14.16           14.27           14.60	Real           prices           13.29           13.64           13.54           13.85           13.88           14.16           14.12           14.14           14.29           14.54           14.92	Differences           0.27           0.35           0.04           0.33           0.06           0.19           0.05           0.07           0.13           0.27           0.32	Average of differen ce per average of real price	Commerzit           Forecast           prices           5.90           5.87           5.98           5.98           5.96           5.85           5.84           5.92           5.81           5.80           5.59	ank           Real           prices           5.84           5.98           5.93           5.94           5.88           5.89           5.94           5.88           5.89           5.94           5.81           5.60           5.65	Differences           0.06           0.11           0.05           0.05           0.08           0.04           0.10           0.09           0.00           0.20           0.06	Average of differen ce per average of real price
Infineon           Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16           23/7/16           25/7/16           26/7/16           27/7/16           28/7/16	Forecast           prices           13.56           13.29           13.58           13.52           13.82           13.97           14.17           14.07           14.16           14.27           14.60           14.86	Real           prices           13.29           13.64           13.54           13.54           13.85           13.88           14.16           14.12           14.14           14.29           14.54           14.92           14.95	Differences           0.27           0.35           0.04           0.33           0.06           0.19           0.05           0.07           0.13           0.27           0.32           0.09	Average of differen ce per average of real price	Commerzit           Forecast           prices           5.90           5.87           5.98           5.98           5.96           5.85           5.84           5.92           5.81           5.80           5.59           5.64	ank           Real           prices           5.84           5.98           5.93           5.94           5.88           5.89           5.94           5.83           5.81           5.60           5.65           5.71	Differences           0.06           0.11           0.05           0.05           0.08           0.04           0.10           0.09           0.00           0.20           0.06           0.07	Average of differen ce per average of real price
Infineon           Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16           23/7/16           24/7/16           25/7/16           26/7/16           27/7/16           28/7/16	Forecast           prices           13.56           13.29           13.58           13.52           13.82           13.97           14.17           14.07           14.16           14.27           14.60           14.86           Average	Real           prices           13.29           13.64           13.54           13.85           13.88           14.16           14.12           14.14           14.29           14.54           14.92           14.95           14.11	Differences           0.27           0.35           0.04           0.33           0.06           0.19           0.05           0.07           0.13           0.27           0.32           0.09           0.18	Average of differen ce per average of real price	Commerzh           Forecast           prices           5.90           5.87           5.98           5.98           5.96           5.85           5.84           5.92           5.81           5.80           5.59           5.64	ank           Real prices           5.84           5.98           5.93           5.94           5.88           5.89           5.94           5.83           5.81           5.60           5.65           5.71           5.83	Differences           0.06           0.11           0.05           0.05           0.08           0.04           0.10           0.09           0.00           0.20           0.06           0.07           0.08	Average of differen ce per average of real price
Infineon           Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16           23/7/16           25/7/16           26/7/16           27/7/16           28/7/16	Forecast           prices           13.56           13.29           13.58           13.52           13.82           13.97           14.17           14.07           14.16           14.27           14.60           14.86           Average	Real           prices           13.29           13.64           13.54           13.54           13.85           13.88           14.16           14.12           14.14           14.29           14.54           14.92           14.95           14.11	Differences           0.27           0.35           0.04           0.33           0.06           0.19           0.05           0.07           0.13           0.27           0.32           0.09           0.18	Average of differen ce per average of real price	Commerzit           Forecast           prices           5.90           5.87           5.98           5.98           5.96           5.85           5.84           5.92           5.81           5.80           5.59           5.64	ank           Real prices           5.84           5.98           5.93           5.94           5.88           5.89           5.94           5.83           5.81           5.60           5.65           5.71           5.83	Differences           0.06           0.11           0.05           0.05           0.08           0.04           0.10           0.09           0.00           0.20           0.06           0.07           0.08	Average of differen ce per average of real price
Infineon           Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16           23/7/16           25/7/16           26/7/16           28/7/16           28/7/16           Continent	Forecast         prices         13.56         13.29         13.58         13.52         13.82         13.97         14.17         14.07         14.16         14.27         14.60         14.86         Average	Real         prices         13.29         13.64         13.54         13.54         13.85         13.88         14.16         14.12         14.14         14.29         14.54         14.92         14.95         14.11	Differences           0.27           0.35           0.04           0.33           0.06           0.19           0.05           0.07           0.13           0.27           0.32           0.09           0.18	Average of differen ce per average of real price	Commerzh Forecast prices 5.90 5.87 5.98 5.98 5.98 5.96 5.85 5.84 5.92 5.81 5.80 5.59 5.64 Lufthansa	Real           prices           5.84           5.98           5.93           5.94           5.88           5.94           5.88           5.94           5.81           5.60           5.61           5.71           5.83	Differences           0.06           0.11           0.05           0.05           0.08           0.04           0.10           0.09           0.00           0.20           0.06           0.07           0.08	Average of differen ce per average of real price
Infineon           Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16           23/7/16           25/7/16           25/7/16           26/7/16           28/7/16           Continent           Date	Forecast         prices         13.56         13.29         13.58         13.52         13.82         13.97         14.17         14.07         14.16         14.27         14.60         14.86         Average         tal         Forecast         prices	Real         prices         13.29         13.64         13.54         13.85         13.88         14.16         14.12         14.14         14.29         14.54         14.92         14.95         14.11	Differences           0.27           0.35           0.04           0.33           0.06           0.19           0.05           0.07           0.13           0.27           0.32           0.09           0.18	Average of differen ce per average of real price 1.28	Commerzh Forecast prices 5.90 5.87 5.98 5.98 5.96 5.85 5.84 5.92 5.81 5.80 5.59 5.64 5.59 5.64 Lufthansa Forecast prices	ank           Real prices           5.84           5.98           5.93           5.94           5.88           5.89           5.94           5.83           5.81           5.60           5.65           5.71           5.83	Differences           0.06           0.11           0.05           0.05           0.08           0.04           0.10           0.09           0.006           0.020           0.06           0.07           0.08	Average of differen ce per average of real price 1.29
Infineon           Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16           23/7/16           25/7/16           26/7/16           28/7/16           28/7/16           Date           17/7/16	Forecast         prices         13.56         13.29         13.58         13.52         13.82         13.97         14.17         14.07         14.16         14.27         14.60         14.86         Average         tal         Forecast         prices         179.50	Real prices           13.29           13.64           13.54           13.85           13.88           14.16           14.12           14.14           14.29           14.54           14.92           14.95           14.11	Differences           0.27           0.35           0.04           0.33           0.06           0.19           0.05           0.07           0.13           0.27           0.32           0.09           0.18           Differences           3.15	Average of differen ce per average of real price 1.28 1.28 Average of differen	Commerzh Forecast prices 5.90 5.87 5.98 5.98 5.96 5.85 5.84 5.92 5.81 5.80 5.59 5.64 5.59 5.64 <b>Lufthansa</b> Forecast prices 11.33	ank           Real           prices           5.84           5.98           5.93           5.94           5.88           5.89           5.94           5.83           5.81           5.60           5.65           5.71           5.83           Prices           11.25	Differences           0.06           0.11           0.05           0.05           0.08           0.04           0.10           0.09           0.00           0.20           0.06           0.07           0.08	Average of differen ce per average of real price 1.29 1.29 Average of differen
Infineon           Date           17/7/16           18/7/16           19/7/16           20/7/16           21/7/16           22/7/16           23/7/16           25/7/16           25/7/16           26/7/16           27/7/16           28/7/16           Date           17/7/16           18/7/16	Forecast         prices         13.56         13.29         13.58         13.52         13.82         13.97         14.17         14.07         14.16         14.27         14.60         14.86         Average         tal         Forecast         prices         179.50         176.33	Real           prices           13.29           13.64           13.54           13.85           13.88           14.16           14.12           14.14           14.29           14.54           14.92           14.95           14.11           Real           prices           176.35           181.18	Differences           0.27           0.35           0.04           0.33           0.06           0.19           0.05           0.07           0.13           0.27           0.32           0.09           0.18           Differences           3.15           4.85	Average of differen ce per average of real price	Commerzh Forecast prices 5.90 5.87 5.98 5.89 5.96 5.85 5.84 5.92 5.81 5.80 5.59 5.64 5.59 5.64 <b>Lufthansa</b> Forecast prices 11.33 11.29	ank           Real prices           5.84           5.98           5.93           5.94           5.88           5.89           5.94           5.83           5.81           5.60           5.65           5.71           5.83           11.25           11.47	Differences           0.06           0.11           0.05           0.05           0.08           0.04           0.10           0.09           0.006           0.020           0.06           0.07           0.08           0.07           0.08           0.11	Average of differen ce per average of real price

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20/7/16	179.36	181.40	2.04	price	11.41	11.47	0.06	price
21/7/16	181.60	178.31	3.29		11.47	11.15	0.32	
22/7/16	178.53	182.39	3.86		11.14	11.06	0.08	
23/7/16	182.49	182.91	0.42		11.02	10.42	0.60	
24/7/16	183.02	181.50	1.52		10.40	10.29	0.11	
25/7/16	181.73	183.31	1.58		10.30	10.28	0.02	
26/7/16	183.18	186.78	3.60		10.33	10.30	0.03	
27/7/16	186.77	188.44	1.67		10.33	10.46	0.13	
28/7/16	188.56	187.25	1.31		10.43	10.45	0.02	
	Average	182.48	2.37	1.30		10.83	0.14	1.33
Deutsche	Bank				Volkswage	n vz		
Date	Forecast	Real	Difformances		Forecast	Real	Difformances	
	prices	prices	Differences		prices	prices	Differences	
17/7/16	12.75	12.64	0.11		116.50	114.85	1.65	
17/7/16 18/7/16	12.75 12.79	12.64 13.03	0.11 0.24		116.50 115.64	114.85 117.20	1.65           1.56	
17/7/16 18/7/16 19/7/16	12.75           12.79           13.08	12.64 13.03 13.03	0.11           0.24           0.05		prices           116.50           115.64           118.15	prices       114.85       117.20       116.00	Differences           1.65           1.56           2.15	
17/7/16 18/7/16 19/7/16 20/7/16	12.75       12.79       13.08       13.05	prices           12.64           13.03           13.03           13.19	0.11         0.24           0.05         0.14	Average	prices       116.50       115.64       118.15       115.65	prices           114.85           117.20           116.00           116.83	Differences           1.65           1.56           2.15           1.18	Average
17/7/16 18/7/16 19/7/16 20/7/16 21/7/16	12.75       12.79       13.08       13.25	12.64           13.03           13.19           12.74	Onterences           0.11           0.24           0.05           0.14           0.51	Average of differen	prices           116.50           115.64           118.15           115.65           117.07	prices           114.85           117.20           116.00           116.83           115.81	Differences           1.65           1.56           2.15           1.18           1.26	Average of differen
17/7/16         18/7/16         19/7/16         20/7/16         21/7/16         22/7/16	12.75       12.79       13.08       13.05       13.25       12.73	prices           12.64           13.03           13.03           13.19           12.74           12.99	Onterences           0.11           0.24           0.05           0.14           0.51           0.26	Average of differen ce per average	prices           116.50           115.64           118.15           115.65           117.07           115.84	prices           114.85           117.20           116.00           116.83           115.81           122.73	Differences           1.65           1.56           2.15           1.18           1.26           6.89	Average of differen ce per average
17/7/16         18/7/16         19/7/16         20/7/16         21/7/16         22/7/16         23/7/16	12.75       12.79       13.08       13.05       13.25       12.73       12.91	prices       12.64       13.03       13.03       13.19       12.74       12.99       13.12	Differences           0.11           0.24           0.05           0.14           0.51           0.26           0.21	Average of differen ce per average of real	prices           116.50           115.64           118.15           115.65           117.07           115.84           123.35	prices           114.85           117.20           116.00           116.83           115.81           122.73           120.80	Differences       1.65       1.56       2.15       1.18       1.26       6.89       2.55	Average of differen ce per average of real
17/7/16 18/7/16 19/7/16 20/7/16 21/7/16 22/7/16 23/7/16 24/7/16	12.75         12.79         13.08         13.05         13.25         12.73         12.91         13.12	12.64         13.03         13.03         13.19         12.74         12.99         13.12         13.10	Differences           0.11           0.24           0.05           0.14           0.51           0.26           0.21           0.02	Average of differen ce per average of real price	prices           116.50           115.64           118.15           115.65           117.07           115.84           123.35           119.52	prices           114.85           117.20           116.00           116.83           115.81           122.73           120.80           120.67	1.65         1.56         2.15         1.18         1.26         6.89         2.55         1.15	Average of differen ce per average of real price
17/7/16         18/7/16         19/7/16         20/7/16         21/7/16         22/7/16         23/7/16         24/7/16         25/7/16	12.75         12.79         13.08         13.05         13.25         12.73         12.91         13.12         13.10	12.64         13.03         13.03         13.19         12.74         12.99         13.12         13.10         13.17	Differences           0.11           0.24           0.05           0.14           0.51           0.26           0.21           0.02           0.07	Average of differen ce per average of real price	prices           116.50           115.64           118.15           115.65           117.07           115.84           123.35           119.52           121.05	prices           114.85           117.20           116.00           116.83           115.81           122.73           120.80           120.67           121.64	1.65         1.56         2.15         1.18         1.26         6.89         2.55         1.15         0.59	Average of differen ce per average of real price
17/7/16         18/7/16         19/7/16         20/7/16         21/7/16         22/7/16         23/7/16         24/7/16         25/7/16         26/7/16	12.75         12.79         13.08         13.05         13.25         12.73         12.91         13.12         13.19	12.64         13.03         13.03         13.19         12.74         12.99         13.12         13.10         13.17         12.88	Differences           0.11           0.24           0.05           0.14           0.51           0.26           0.21           0.02           0.07           0.31	Average of differen ce per average of real price	prices           116.50           115.64           118.15           115.65           117.07           115.84           123.35           119.52           121.05           121.82	prices           114.85           117.20           116.00           116.83           115.81           122.73           120.67           121.64           125.29	1.65         1.56         2.15         1.18         1.26         6.89         2.55         1.15         0.59         3.47	Average of differen ce per average of real price
17/7/16         18/7/16         19/7/16         20/7/16         21/7/16         23/7/16         24/7/16         25/7/16         26/7/16         27/7/16	12.75         12.79         13.08         13.05         13.25         12.73         12.91         13.12         13.10         13.19         12.87	12.64         13.03         13.03         13.19         12.74         12.99         13.12         13.10         13.17         12.88         12.40	Differences           0.11           0.24           0.05           0.14           0.51           0.26           0.21           0.02           0.07           0.31           0.47	Average of differen ce per average of real price	prices           116.50           115.64           118.15           115.65           117.07           115.84           123.35           119.52           121.05           121.82           125.45	prices           114.85           117.20           116.00           116.83           115.81           122.73           120.80           121.64           125.29           127.35	1.65         1.56         2.15         1.18         1.26         6.89         2.55         1.15         0.59         3.47         1.90	Average of differen ce per average of real price
17/7/16         18/7/16         19/7/16         20/7/16         21/7/16         22/7/16         23/7/16         24/7/16         25/7/16         26/7/16         27/7/16         28/7/16	12.75         12.79         13.08         13.05         13.25         12.73         12.91         13.12         13.10         13.19         12.87         12.44	12.64         13.03         13.03         13.19         12.74         12.99         13.12         13.10         13.17         12.88         12.40         12.00	Differences           0.11           0.24           0.05           0.14           0.51           0.26           0.21           0.02           0.07           0.31           0.47           0.44	Average of differen ce per average of real price	prices           116.50           115.64           118.15           115.65           117.07           115.84           123.35           119.52           121.05           125.45           128.55	prices         114.85         117.20         116.00         116.83         115.81         122.73         120.67         121.64         125.29         127.35         124.39	1.65         1.56         2.15         1.18         1.26         6.89         2.55         1.15         0.59         3.47         1.90         4.16	Average of differen ce per average of real price