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„The impact of implementation of Artificial Intelligence on financial results of "Tech Giants" in relation to stock prices "

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1. Introduction

The term Artificial Intelligence (AI) was first introduced by John McCarthy in 1955.[1] This term has a variety of definitions but is commonly referred to as a computer technology that is able to learn and perform human-like tasks that ordinary computer programs are either unable to perform or require unfeasible amounts of time and resources to perform. AI is a controversial topic that is seen both as a promising and potentially dangerous technology. The possibility of using AI for real-life purposes was for a long time highly limited by technology and information availability as it requires high computational power and large amounts of data to analyze. AI breakthrough happened with rapid developments of computer technologies in the 21st century and the constantly increasing number of internet users and ways of using the World Wide Web, which also led to the aggregation of information on the internet with large data sets, the so-called "Big Data". This opened the door for the commercial use of AI technology. The commercial implementation of AI technology in companies that are analyzed in this study started from 2013 onwards.

The year 2020 is another milestone on the AI map that marks the point that has enough data to observe and analyze the actual financial performance of a meaningful amount of firms (>10) after implementation of AI in their products or services, on a quarterly basis using statistical methods. This data availability restriction is the reason why this study is, to the best of my knowledge, one of the first that evaluates real business results with regard to AI implementation. AI implementation is not the only factor that affects the performance of the company. However, no evidence of any other technological or non-technological factors that could have a long-term impact on sales, products or services of investigated companies without AI participation was found in financial reports, press releases or any other information sources. Thus, AI is deemed to be the main moving force for significant changes in financial performance of these companies over the timeframe of AI development and implementation.

This study gives the opportunity to assess the real-life performance of the AI technology in order to confirm or reject previous assumptions of its potential to generate additional financial yields, based on real observed financial data. Another important aspect that this Master's Thesis takes into account is how financial markets react to these financial results, in the sense that it evaluates

[1] McCarthy, J., Minsky, M. L., Rochester, N., & Shannon, C. E. (2006, Winter). A proposal for the Dartmouth summer research project on artificial intelligence: August 31, 1955. AI Magazine, 27(4), 12+. https://link.gale.com/apps/doc/A157035547/AONE?u=43wien&sid=AONE&xid=84189b50

which financial metrics correlate most with stock prices and whether correlation changes after the company starts implementing AI. To reach the goal of this study, seven companies with an acceptable amount of data available are analyzed in the **3. Numerical Study (Main Group)** section of this Master's Thesis. The Null Hypothesis for this study assumes that there is no critical difference in the financial performance of the company after AI implementation, this hypothesis is tested for all the companies that are included in **3. Numerical Study (Main Group)**. Firstly, regression analysis is performed to find out which financial metric correlates the most with stock prices of the company. Secondly, trends for the selected financial metric are analyzed using the least squares method for pre-AI period and are projected into the following period as if the company continued its activity without significant technological changes. Observed financial data in AI period is then compared with the projected (forecasted) data. Then, a critical region is defined using Student's t-distribution at a 99% confidence level. Finally, $\mathbf{T_{obs}}$ statistic (mean average of the observed financial metric) is derived from the observed data in AI period and is tested for its affiliation to the critical region. The Null Hypothesis cannot be rejected if $\mathbf{T_{obs}}$ falls into the Confidence Interval (CI) of the forecast and is rejected if this value falls into the critical region outside of CI. Seven additional companies with an insufficient amount of data for statistical analysis with chosen statistical test procedures are discussed in the **4. Supporting numerical study** section to complete the picture, although the use of assumptions to normal distribution cannot be justified for these companies.

The results of this study suggest that Alphabet and Amazon have a significantly better performance in AI period compared to the forecast, Apple and IBM have significantly worse performance, whereas the performance of Intel, NICE and Microsoft is not significantly different from the forecast. The supporting numerical study suggests that Salesforce and NVIDIA have notably better results in AI period, Verizon has notably worse results in AI period, and the performance of EBAY, Baidu and Facebook could not be reliably evaluated.

The rest of this study is organized in the following way: the second section provides a deeper technical insight on methodology with an exact description of the research question and methods used to achieve the goals of this study. The third section provides a numerical study for seven selected for the main group companies with a detailed process description in the analysis of the first company (Alphabet) and more concise descriptions for other companies. The third section provides a supporting numerical study analyzing seven companies in the supporting group. Lastly, **Conclusions** section provides a brief summary for the performed analysis.

2. Methodology

This section presents the research goal, used information sources, selection criteria for companies, the null hypothesis and methods used to test it and draw further conclusions.

2.1. Null hypothesis and possible outcomes

Firstly, regression analysis of financial data for $\mathbf{n_1}$+$\mathbf{n_2}$ is performed, a trend is calculated for the financial metric with the highest correlation coefficient for $\mathbf{n_1}$ (pre-AI) period, this trend is projected (forecasted) into $\mathbf{n_2}$ (AI) period and the mean average of the forecast is compared with the mean average of the observed data within the Confidence Interval (CI) in $\mathbf{n_2}$ (AI) period to test the Null Hypothesis.

$\mathbf{H_0}$ or Null Hypothesis for this study is the following:

$\mathbf{H_0}$ There is no significant difference in mean averages of the selected financial for the observed values in $\mathbf{n_2}$ (AI) period and forecasted values for $\mathbf{n_2}$ period based on observed values of $\mathbf{n_1}$ period, $\mathbf{T_{obs}=\mu}$ (see **2.5. Testing Process** on p.12 for details)

The alternative hypothesis ($\mathbf{H_A}$) is:

$\mathbf{H_A}$ There is a significant difference in mean averages of the selected financial metric for the observed values in $\mathbf{n_2}$ (AI) period and forecasted values for $\mathbf{n_2}$ period based on observed values of $\mathbf{n_1}$ period, $\mathbf{T_{obs}\neq\mu}$

If $\mathbf{H_0}$ is rejected, the results are evaluated with 2 possible outcomes considering financials (**FC** - financial conclusions):

$\mathbf{FC_1}$ Financial performance is significantly better in AI period compared to forecasted values based on pre-AI period

$\mathbf{FC_2}$ Financial performance is significantly worse in AI period compared to forecasted values based on pre-AI period

At the same time, three possible outcomes regarding stock prices are possible (**MC** – Market conclusions):

$\mathbf{MC_1}$ Market performance of the company is better in AI period compared to pre-AI period

$\mathbf{MC_2}$ Market performance of the company is worse in AI period compared to pre-AI period

MC_3 There is no notable difference in market performance of the company in AI period compared to pre-AI period

These results are furtherly evaluated based on trend analysis and regression analysis and a conclusion regarding the correlation between Stock Price and the selected financial metric is drawn:

C_1 Stock Prices are in line with financial results and its fluctuations are explained by financial results to a high extent

C_2 Stock Price fluctuations are partly explained by financial results of the company, some amount of fluctuations is caused by technical factors and/or market sentiment

C_3 Financial data does not explain the fluctuations on the stock market – stock prices of the company are not fluctuating according to fundamental financial factors.

For companies with a very strong or strong positive correlation between financials and stock prices **MC_1** and **C_1** automatically follow from **FC_1. MC_2** automatically follows from **FC_2**.

Key methods used to achieve the goals of this master's thesis are interpretation and graphical analysis of financial data, regression and trend analysis.

2.2. Selection criteria and data sources

Companies for the analysis are selected based on the following criteria:

- The company has implemented and actively develops the Artificial Intelligence (AI) technology in its end products and/or business processes – the basis for deciding whether the company fits the criteria is information in notes to financial statements and acquisition of subsidiaries that's core business activity is based on AI
- The company is a "Tech Giant" in the sense that companies with the highest market capitalization and core business activities focused on technology are chosen as they have the most data available on AI and they are the first ones to start implementing AI in their products/services/business processes extensively and globally
- The company releases quarterly financial statements, thus has quarterly financial data available

- The company has been implementing AI for an acceptable amount of periods **(n_2)** and also has data available for an acceptable amount of periods before AI implementation **(n_1). $n_1=n_2 \geq 23$** is considered to be acceptable for this study
- The company has not changed the vector of its core business activity over the observed timeframe

The same criteria apply for the supporting group of companies, however, they have lower amounts of financial quarters in pre-AI and/or AI periods, some of the firms also may have not been listed on financial markets for enough time and have no data considering Stock Price in some financial quarters.

Seven companies fit these criteria and are analyzed in **3. Numerical Study (Main Group):** Alphabet ($n_1=n_2=26$), Intel ($n_1=n_2=27$), NICE Systems ($n_1=n_2=28$), Amazon ($n_1=n_2=23$), Microsoft ($n_1=n_2=29$), IBM ($n_1=n_2=25$), Apple ($n_1=n_2=25$).

Another seven companies partly fit the criteria and are analyzed in **4. Supporting Numerical Study:** Verizon ($n_1=n_2=21$), NVIDIA ($n_1=n_2=21$), EBAY ($n_1=n_2=17$), Salesforce ($n_1=n_2=20$), Oracle ($n_1=n_2=17$), Baidu ($n_1=n_2=25$), Facebook ($n_1=10$, $n_2=32$).

The data used for stock prices is historical, i.e. it is adjusted for stock splits, dividends and distributions. The sources for financial data are financial statements and quarterly financial reports. This data is also adjusted for the time needed for presenting financial reports, which is usually around one month after the reported period, so if Stock Price is with e.g. 30.06.2017 date, it actually is as of 31.07.2017 when the financial report is already available and financial market had time to react to it.

Financial data is gathered from publicly available financial data aggregators: finance.yahoo.com and macrotrends.net. Due to the fact that data for each period is in different financial reports, it was considered unfeasible to use each report as a primary source of information. Data from random periods has been compared for financial aggregators and actual financial reports. The vast majority of data on financial aggregators is exact, however, some periods had slight differences in numbers that might have been caused by different accounting standards, for example, US-GAAP vs. IFRS, and currency exchange rate differences for companies that generate revenue in foreign currency. These differences are insignificant and are considered as such that cannot affect the end result. Historical adjustments change the Stock Price data over time, as time goes and dividends are paid to investors, this data changes for a small amount (usually in

cents). All data for this research was gathered in August 2020 and is consistent for all companies, so these changes over time don't affect the results of this study.

Periods are defined with the help of information from notes to financial statements, firms' official websites, interviews of executive officers, press-releases and mergers and acquisitions' data.

2.3. Regression analysis

Regression analysis is a set of statistical procedures done to estimate the relationship between a dependent variable and an independent variable. Regression analysis is used to investigate causal relationships between variables.

The regression model equation is:

$Y_i = f(X_i, \beta) + \varepsilon_i,$
where:

β – unknown parameters
Y_i – dependent variable
X_i – independent variable
ε_i – error terms

The independent variables **X_i** in this study are financial results of the companies – Revenue, Gross Profit, Gross Profit adjusted for R&D, EBIT. These financial metrics are selected as these are the ones that AI can affect through sales and decreasing costs.
The dependent variable **Y_i** is the stock price.
The error term **ε_i** is market noise.

The outcome of the regression analysis in Microsoft Office Excel® 2013 comes in the following form:

Regression Statistics	
Multiple R	0,978816113
R Square	0,958080982
Adjusted R Square	0,957006136
Standard Error	156,6928116
Observations	41

where:

Multiple R – the Correlation Coefficient that denotes how strong the linear relationship is. It ranges (-1;1) with -1 being perfect negative relation, 0 being no relation at all, and 1 being perfect positive relation. This coefficient is furtherly ranged: 0-0,19 – very weak correlation, 0,2-0,39 – weak correlation, 0,4-0,59 – moderate correlation, 0,6-0,79 – strong correlation, 0,8-0,99 – a very strong correlation.

R Square – the Coefficient of Determination that denotes how many points fall into the regression line. In the example above 0,95 means that 95% of the variation of **Y** – values are explained by **X** values.

Adjusted R Square – adjusts the R Square for the number of terms in the model. Irrelevant for this study as each analysis uses only one **X** variable.

Standard Error – estimated standard deviation of the error.

Observations – Number of observations in the given sample.

2.4. Statistical assumptions

To be able to draw statistically meaningful conclusions, the output of the regression analysis underlies the following assumptions in this study:

- Within a population of financial data samples of size $\mathbf{n_j}$, the distribution of the sample means approximately follows Gaussian (normal) distribution. The sampling distribution of the sample means comes closer to a normal distribution with an increase of $\mathbf{n_j}$[2]
- Financial data (independent variables $\mathbf{X_i}$) contains no errors, i.e. companies present fair and full information in financial statements

[2] Rouaud, Mathieu (2013). Probability, Statistics and Estimation, p.10

- The variance of the noise $\boldsymbol{\varepsilon_i}$ is constant for the whole time series
- Noise $\boldsymbol{\varepsilon_i}$ over time is uncorrelated

2.5. Testing Process

To test the Null Hypothesis, a one sample t-test is used in this study, the sample being observed values of the selected financial metric in AI period. This test is used when the Standard deviation of the sample is known, which is the case with observed financial data used in this study. The observed mean of this sample is defined as $\mathbf{T_{obs}}$ in this study and is compared to a hypothesized value of the mean average of the selected metric in AI period based on the forecast. The forecast is made with the help of the regression analysis by projecting the trend values of the selected financial metric from pre-AI period into AI period with the same slope of the trend line. A t-statistic is then calculated using the formula $t=(\mathbf{T_{obs}} - \boldsymbol{\mu})/(SD/\sqrt{n})$, where $\boldsymbol{\mu}$ in this study is the hypothesized mean average of the observed financial metric in AI period based on the forecast, SD is the standard deviation of the sample, n is the number of observed financial quarters in AI period. The calculated t-statistic is then compared to the critical t-statistic value that is found in a t-distribution table with regard to a selected level of significance (0,99 in this study) and degrees of freedom (**n**-1). If $|t| > t$ critical, the Null Hypothesis is rejected.[3] This process is simplified in this study and a step-by-step calculation is not presented, the values are plotted in Microsoft Office Excel® 2013 for the analysis, and the Confidence Interval is calculated for the mean, whereas it implies, that for all values outside of the Confidence interval it is true that $|t| > t$ critical. Thus, the Null Hypothesis is rejected when the observed mean average of the selected financial metric falls in the critical region outside of the Confidence Interval. The Revenue (Gross Profit-, EBIT-) growth rate is accounted for in forecasted values from the data of pre-AI period.

[3] Ross A., Willson V.L. (2017) One-Sample T-Test. In: Basic and Advanced Statistical Tests. SensePublishers, Rotterdam. https://doi.org/10.1007/978-94-6351-086-8_2

3. Numerical Study (Main Group)

3.1. Alphabet Inc.

3.1.1. General Information

Alphabet Inc. (in further text - Alphabet) is the holding located in California, USA, that owns Google and a variety of companies formerly owned by Google Inc. The market capitalization of Alphabet as of 24.10.2020 is $1.999 trillion.[4] Its first AI acquisition of "DeepMind Technologies" (now Google DeepMind) took place on January 27th, 2014[5], therefore AI period is marked starting from Q1 2014 to Q2 2020 for this study, and pre-AI period is marked Q3 2007 to Q4 2013, implying $\mathbf{n_1}=\mathbf{n_2}=26$.

3.1.2. AI Implementation and Monetization

Alphabet uses AI technology in a vast variety of its products that are not monetized and are free-to-use, including Voice Search, Google Translate, spam filters, the search of pictures on google, gaming bots[6] and other.

There is also a variety of monetized AI products such as Google Health that works under paid subscription conditions, Google Cloud Text-to-Speech that users pay for transposing text to speech per million characters of text. Alphabet also monetizes AI indirectly through decreasing costs of cooling data centers.[7]

3.1.3. Financial Data

Financial metrics in table 1.1. represent quarterly financial results of Alphabet for observed periods $\mathbf{n_1}+\mathbf{n_2}$ and are chosen based on the potential influence of AI implementation, which

[4] Yahoo! Finance, GOOG, retrieved from https://finance.yahoo.com/quote/GOOG?p=GOOG&.tsrc=fin-srch, accessed 24.10.2020
[5] Catherine Shu, Tech Crunch, 2014, Google Acquires Artificial Intelligence Startup DeepMind For More Than $500M, retrieved from https://techcrunch.com/2014/01/26/google-deepmind/, accessed 24.10.2020
[6] Alphabet, 2015 Alphabet Annual Report, p. 5 retrieved from https://abc.xyz/investor/static/pdf/2015_alphabet_annual_report.pdf?cache=40474a1, accessed 10.10.2020
[7] CCNBC, Enterprise, "Google is finding ways to make money from Alphabet's DeepMind A.I. technology", 31.03.2018, retrieved from retrieved from https://www.cnbc.com/2018/03/31/how-google-makes-money-from-alphabets-deepmind-ai-research-group.html, accessed 20.10.2020
*The source for values of Revenue, Gross Profit and EBIT in Table 1.1. and hereafter is a financial data aggregator https://www.macrotrends.net/
**The source for values of Stock Price in Table 1.1. and hereafter is a financial data aggregator https://finance.yahoo.com/

affects Revenue and, as a result, Gross Profit and Earnings Before Interest and Taxes (EBIT) through sales of products or services and might affect EBIT additionally through decreasing operational costs.

Table 1.1. Financial data of n_1+n_2 period, Alphabet

Date	Quarter	Revenue, $Mil. *	Gross Profit, $Mil.*	R&D Expense, $Mil*	Gross Profit adjusted for R&D Expense, $Mil.	EBIT, $Mil*	Stock price$ adjusted**
30.06.2020	Q2_2020	38.297	19.744	6.875	12.869	6.383	1.482,96
31.03.2020	Q1_2020	41.159	22.177	6.820	15.357	7.977	1.348,66
31.12.2019	Q4_2019	46.075	25.055	7.222	17.833	9.266	1.434,23
30.09.2019	Q3_2019	40.499	22.931	6.554	16.377	9.177	1.260,11
30.06.2019	Q2_2019	38.944	21.648	6.213	15.435	9.180	1.216,68
31.03.2019	Q1_2019	36.339	20.327	6.029	14.298	6.608	1.188,48
31.12.2018	Q4_2018	39.276	21.358	6.034	15.324	8.221	1.116,37
30.09.2018	Q3_2018	33.740	19.459	5.232	14.227	8.625	1.076,77
30.06.2018	Q2_2018	32.657	18.774	5.114	13.660	3.045	1.217,26
31.03.2018	Q1_2018	31.146	17.679	5.039	12.640	7.633	1.017,33
31.12.2017	Q4_2017	32.323	18.056	4.306	13.750	7.696	1.169,94
30.09.2017	Q3_2017	27.772	16.624	4.205	12.419	7.782	1.016,64
30.06.2017	Q2_2017	26.010	15.637	4.172	11.465	4.132	930,50
31.03.2017	Q1_2017	24.750	14.955	3.942	11.013	6.568	905,96
31.12.2016	Q4_2016	26.064	15.403	3.622	11.781	6.639	796,79
30.09.2016	Q3_2016	22.451	13.752	3.596	10.156	5.767	784,54
30.06.2016	Q2_2016	21.500	13.370	3.363	10.007	5.968	768,79
31.03.2016	Q1_2016	20.257	12.609	3.367	9.242	5.342	693,01
31.12.2015	Q4_2015	21.329	13.141	3.510	9.631	5.380	742,95
30.09.2015	Q3_2015	18.675	11.638	3.230	8.408	4.708	710,81
30.06.2015	Q2_2015	17.727	11.144	2.789	8.355	4.825	625,61
31.03.2015	Q1_2015	17.258	10.902	2.753	8.149	4.447	537,34
31.12.2014	Q4_2014	18.103	11.182	2.813	8.369	4.399	533,06
30.09.2014	Q3_2014	16.523	9.828	2.655	7.173	3.724	557,55
30.06.2014	Q2_2014	15.955	9.841	2.238	7.603	4.258	570,03
31.03.2014	Q1_2014	15.420	9.459	2.126	7.333	4.115	525,22
31.12.2013	Q4_2013	15.707	9.454	1.933	7.521	4.429	588,28
30.09.2013	Q3_2013	13.754	8.345	1.821	6.524	3.761	513,37
30.06.2013	Q2_2013	13.107	7.912	1.766	6.146	3.465	442,22
31.03.2013	Q1_2013	12.951	7.815	1.617	6.198	3.748	410,75
31.12.2012	Q4_2012	10.283	7.528	1.225	6.303	4.468	376,43
30.09.2012	Q3_2012	13.304	7.349	1.879	5.470	2.740	338,88
30.06.2012	Q2_2012	11.807	7.130	1.538	5.592	3.237	315,30
31.03.2012	Q1_2012	10.645	6.856	1.441	5.415	3.389	301,30
31.12.2011	Q4_2011	10.584	6.882	1.298	5.584	3.507	288,97
30.09.2011	Q3_2011	9.720	6.342	1.404	4.938	3.058	295,21

30.06.2011	Q2_2011	9.026	5.854	1.234	4.620	2.881	300,72
31.03.2011	Q1_2011	8.575	5.639	1.226	4.413	2.296	271,03
31.12.2010	Q4_2010	8.440	5.494	1.052	4.442	2.981	299,06
30.09.2010	Q3_2010	7.286	4.734	994	3.740	2.547	305,70
30.06.2010	Q2_2010	6.820	4.353	898	3.455	2.365	241,52
31.03.2010	Q1_2010	6.775	4.323	818	3.505	2.488	261,87
31.12.2009	Q4_2009	6.674	4.266	735	3.531	2.480	263,98
30.09.2009	Q3_2009	5.945	3.719	758	2.961	2.074	267,06
30.06.2009	Q2_2009	5.523	3.415	708	2.707	1.874	220,70
31.03.2009	Q1_2009	5.509	3.407	642	2.765	1.884	197,25
31.12.2008	Q4_2008	5.701	3.521	733	2.788	1.860	168,63
30.09.2008	Q3_2008	5.541	3.368	705	2.663	1.648	179,01
30.06.2008	Q2_2008	5.367	3.220	682	2.537	1.578	235,99
31.03.2008	Q1_2008	5.186	3.076	673	2.402	1.546	286,07
31.12.2007	Q4_2007	4.827	2.871	631	2.240	1.441	281,10
30.09.2007	Q3_2007	4.231	2.569	549	2.020	1.318	352,18

As AI development costs are assigned to R&D costs, a column with calculated values “Gross Profit adjusted for R&D Expense” derived from extracting R&D Expense from Gross Profit is added to the table. This is done to account for possible overly high R&D Expense that affects the financial performance of the company but is not accounted for in values of Gross Profit.

3.1.4. Regression analysis

Values from column “Stock Price” are plotted into regression analysis in Microsoft Office Excel® 2013 as a dependent $\mathbf{Y_i}$ variable values and values from columns “Revenue”, “Gross Profit”, “Gross Profit adjusted for R&D Expense” and “EBIT” are plotted separately into regression analysis as values of an independent variable $\mathbf{X_i}$. The program performs calculations according to the regression equation for observed 52 data points to evaluate the correlation between Stock Price and separate financial metrics. Table 1.2. represents the output of regression analysis for each of the financial metrics.

Table 1.2. Regression analysis for n_1+n_2 period, Alphabet

Revenue, Stock Price	
Regression Statistics	
Multiple R	0,9817209
R Square	0,963776
Adjusted R Square	0,9630515
Standard Error	73,908846
Observations	52

Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,97674759
R Square	0,95403585
Adjusted R Square	0,95311657
Standard Error	83,2545391
Observations	52

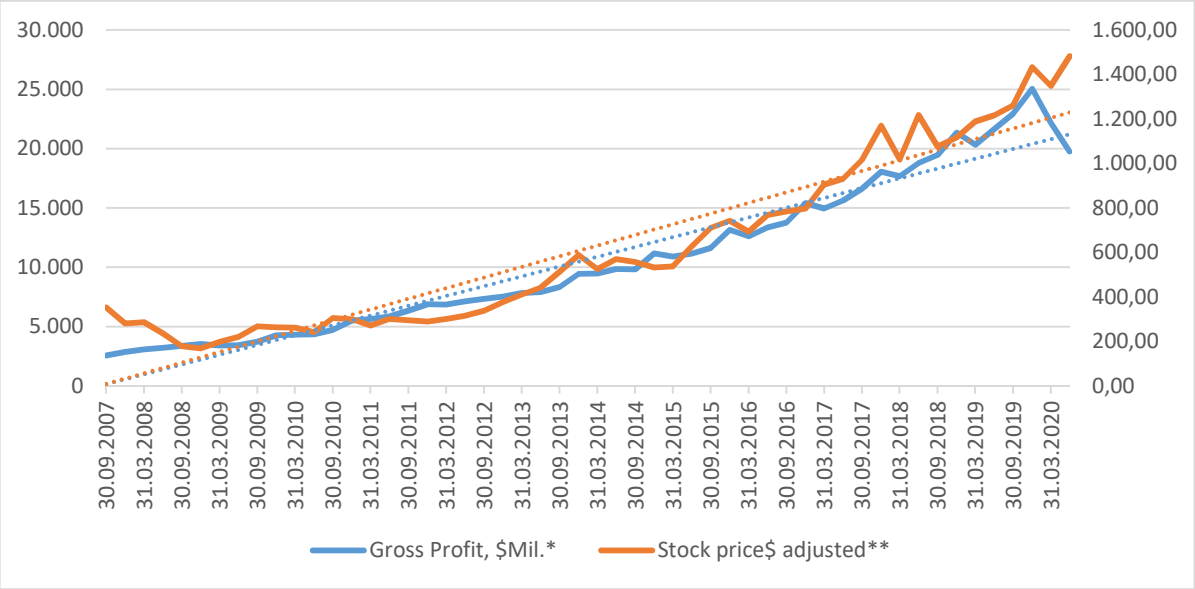
adj. Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,9670317
R Square	0,9351504
Adjusted R Square	0,9338534
Standard Error	98,889913
Observations	52

EBIT, Stock Price	
Regression Statistics	
Multiple R	0,88669614
R Square	0,78623004
Adjusted R Square	0,78195464
Standard Error	179,544309
Observations	52

All financial metrics of Alphabet have a very strong correlation lying above the 0,8 value of the coefficient of correlation, Multiple R. Revenue, Stock Price (X_i, Y_i) has the highest coefficient 0.98. Gross Profit, Stock Price (X_i, Y_i) has a correlation coefficient value of 0.976. As the difference is <1%, the metric Gross Profit, Stock Price (X_i, Y_i) is chosen for the trend analysis for better comparability, as Gross Profit has been found to have the highest correlation to Stock Price from all financial metrics for the majority of selected companies. R Square or Coefficient of Determination returns values 0.96 and 0.95 for Revenue, Stock Price (X_i, Y_i) and Gross Profit, Stock Price (X_i, Y_i) respectively. This means that 96% and 95% of the variance in Stock Price is explained by Revenue and Gross Profit respectively. As values of Multiple R are over 0.8 for all financial metrics, Alphabet has a strong correlation between Stock Price and all financial metrics, Gross Profit in particular. Adjusted R Square and Standard Error values are not taken into further calculations, they are given to present the full output of the analysis in Microsoft Office Excel 2013® and are to be seen as additional information.

Values of Stock Price and Gross Profit are plotted on a graph for visual analysis. Figure 1.3. represents the relationship between Gross Profit and Stock Price graphically.

Figure 1.3. Relationship between Gross Profit and Stock Price, Alphabet



Blue and orange dotted lines represent trend lines for Gross Profit and Stock Price respectively. The graph shows that the development of Stock Price values over time is nearly parallel to values of Gross Profit over time with Stock Price having a slightly higher slope.

Now trends for periods $\mathbf{n_1}$, $\mathbf{n_2}$ separately are calculated using the least squares method. Based on the trend values in pre-AI period a forecast for the trend values in AI period is performed. This forecast is, basically, an extension of the trend of pre-AI period into AI period with the same exact slope. Table 1.4. represents the output of this procedure.

Table 1.4. Gross Profit trend and forecasted trend values, Alphabet

Period	Date	Quarter	Trend (Gross Profit)	Forecasted Trend values
AI period	30.06.2020	Q2_2020	23.341	15.320
	31.03.2020	Q1_2020	22.756	15.062
	31.12.2019	Q4_2019	22.171	14.805
	30.09.2019	Q3_2019	21.586	14.544
	30.06.2019	Q2_2019	21.001	14.283
	31.03.2019	Q1_2019	20.415	14.026
	31.12.2018	Q4_2018	19.830	13.771
	30.09.2018	Q3_2018	19.245	13.510
	30.06.2018	Q2_2018	18.660	13.250
	31.03.2018	Q1_2018	18.075	12.992
	31.12.2017	Q4_2017	17.490	12.737
	30.09.2017	Q3_2017	16.904	12.476
	30.06.2017	Q2_2017	16.319	12.216
	31.03.2017	Q1_2017	15.734	11.958
	31.12.2016	Q4_2016	15.149	11.703
	30.09.2016	Q3_2016	14.564	11.442
	30.06.2016	Q2_2016	13.979	11.182
	31.03.2016	Q1_2016	13.393	10.924
	31.12.2015	Q4_2015	12.808	10.666
	30.09.2015	Q3_2015	12.223	10.406
	30.06.2015	Q2_2015	11.638	10.145
	31.03.2015	Q1_2015	11.053	9.887
	31.12.2014	Q4_2014	10.467	9.632
	30.09.2014	Q3_2014	9.882	9.372
	30.06.2014	Q2_2014	9.297	9.111

	31.03.2014	Q1_2014	8.712	8.853
pre-AI period	31.12.2013	Q4_2013	8.596	
	30.09.2013	Q3_2013	8.338	
	30.06.2013	Q2_2013	8.079	
	31.03.2013	Q1_2013	7.820	
	31.12.2012	Q4_2012	7.562	
	30.09.2012	Q3_2012	7.303	
	30.06.2012	Q2_2012	7.044	
	31.03.2012	Q1_2012	6.786	
	31.12.2011	Q4_2011	6.527	
	30.09.2011	Q3_2011	6.268	
	30.06.2011	Q2_2011	6.010	
	31.03.2011	Q1_2011	5.751	
	31.12.2010	Q4_2010	5.492	
	30.09.2010	Q3_2010	5.234	
	30.06.2010	Q2_2010	4.975	
	31.03.2010	Q1_2010	4.716	
	31.12.2009	Q4_2009	4.458	
	30.09.2009	Q3_2009	4.199	
	30.06.2009	Q2_2009	3.940	
	31.03.2009	Q1_2009	3.682	
	31.12.2008	Q4_2008	3.423	
	30.09.2008	Q3_2008	3.164	
	30.06.2008	Q2_2008	2.906	
	31.03.2008	Q1_2008	2.647	
	31.12.2007	Q4_2007	2.389	
	30.09.2007	Q3_2007	2.130	

3.1.5. H_0 testing

$\mathbf{H_0}$ is tested by performing a one sample t-test based on data from tables 1.1. and 1.4. The $\mathbf{T_{obs}}$ statistic (observed mean average of Gross Profit in $\mathbf{n_2}$ (AI) period) is derived from the observed in $\mathbf{n_2}$ data sample and is compared with the forecasted for $\mathbf{n_2}$ (AI) period mean average of the selected financial metric (Gross Profit for Alphabet). If the value of $\mathbf{T_{obs}}$ falls into the 99% Confidence Interval (CI) of the mean average of the forecast, $\mathbf{H_0}$ is confirmed, otherwise it is rejected. CI is calculated by subtracting the Error Bound (EB) from the mean average of the forecast for the lower bound and adding the EB value for the upper bound. EB is calculated from α=0.01, which is 1-0.99 confidence level used in this study, Standard Deviation (SD) and $\mathbf{n_1}$=$\mathbf{n_2}$=26 for Alphabet.

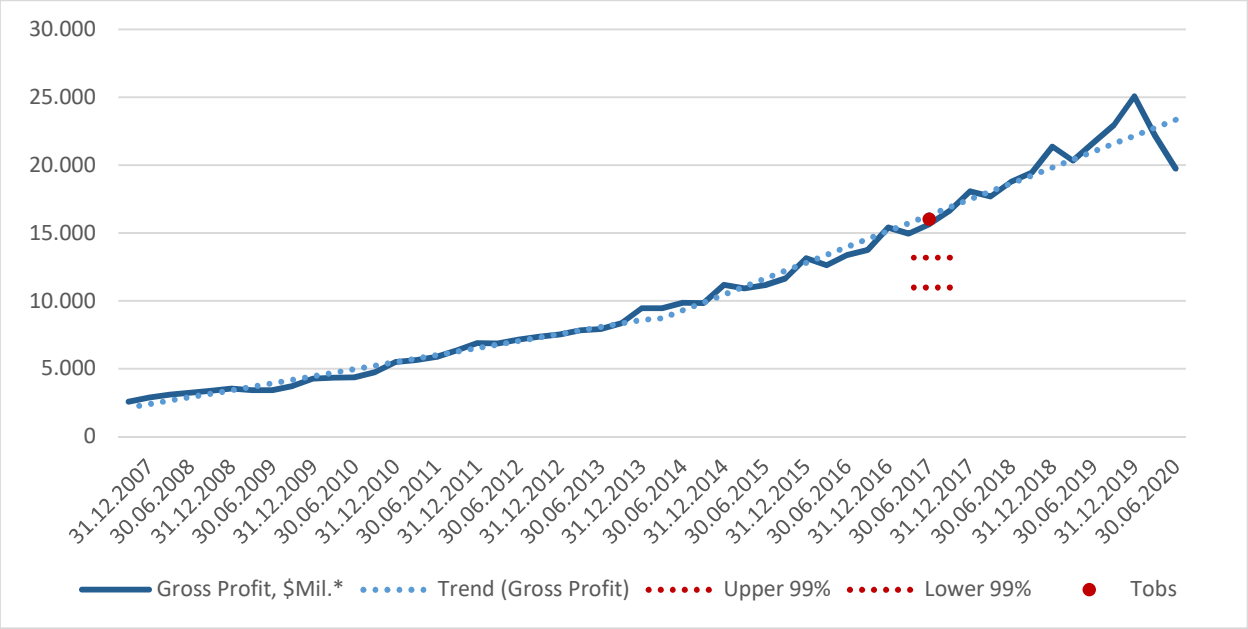
Table 1.5. H_0 test output, Alphabet

Period	Mean	SD	EB	CI	Tobs	H0	Upper or Lower
pre-AI		2009,62	1098,58		16.027	Rejected	Upper
AI forecasted	12.087	n/a		lower 10.989 upper 13.186			-
AI observed	16.027	4615,01					

Columns "H_0" and "Upper or Lower" represent the result of the evaluation of the $\mathbf{T_{obs}}$ and whether it falls into Confidence interval. If $\mathbf{T_{obs}}$ is outside of the Confidence Interval, meaning that it is in the Critical Region, the Null Hypothesis is rejected and this column returns the "Rejected" value. If $\mathbf{H_0}$ is rejected it is also important to define whether $\mathbf{T_{obs}}$ value is above the upper bound or below the lower bound that are given in column CI under "lower" and "upper" respectively. If $\mathbf{T_{obs}}$ is above the upper bound, this column returns the value "Upper", otherwise its value would be "Lower" and if $\mathbf{H_0}$ is confirmed there is "-" shown in this column. In the case of Alphabet, $\mathbf{T_{obs}}$ is above the upper bound, thus $\mathbf{H_0}$ is rejected with the "Upper" value.

Furtherly, the results of the test are shown on a graph. Upper and lower bounds of the Confidence Interval are represented as red dotted lines for better visibility, basically, these are two points. Figure 1.6. represents the $\mathbf{H_0}$ test output graphically together with the observed Gross Profit and its trend in both periods.

Figure 1.6. Observed Gross Profit, T_{obs} and Confidence Interval for the forecasted mean, Alphabet



As the next step, regression analysis is performed separately for each period for Stock Price and the selected financial metric. In the case of Alphabet, it is Gross Profit, Stock Price **(X_i, Y_i)**. Figure 1.7. represents the results of regression analysis separated according to financial data in pre-AI and AI periods.

Figure 1.7. Regression analysis for n_1 and n_2 periods separately. Gross Profit, Stock Price (Xi, Yi), Alphabet

pre-AI period	
Regression Statistics	
Multiple R	0,783923391
R Square	0,614535883
Adjusted R Square	0,598474878
Standard Error	60,97941593
Observations	26

AI period	
Regression Statistics	
Multiple R	0,952822128
R Square	0,907870008
Adjusted R Square	0,904031258
Standard Error	92,85127188
Observations	26

In pre-AI period multiple R of 0,79 and R Square of 0,61 represent a 79% correlation between Gross Profit and Stock Price with 61% of variance explained by the model. In AI period multiple R of 0,95 and R Square of 0,9 represent a 95% correlation between Gross Profit and Stock Price with 90% of variance explained by the model.

3.1.6. Results

For Alphabet, the strongest correlation has been found between its Revenue and Stock Price. Gross Profit, Stock Price (X_i, Y_i) metric has been chosen for better comparability with nearly the same correlation. Results of the analysis show that financial results in AI period significantly overcome the results of the same timeframe in pre-AI period. The observed mean is over 99% confidence interval which leads to rejection of **H_0** for Alphabet.

Furtherly, the following financial and market conclusions are true for Alphabet:

FC_1 Financial performance of Alphabet is significantly better in AI period compared to forecasted values based on pre-AI period

Additionally, based on the observed values and very strong positive correlation between Gross Profit and Stock Price, it is concluded:

MC_1 Market performance of Alphabet is better in the AI period compared to pre-AI period

The correlation between Gross Profit and Stock Price in AI period has increased from strong 79% in pre-AI period to very strong 95% in AI period and is very strong for both periods, therefore:

C_1 Financial data is in line with stock prices and fluctuations are explained with observed financial results to a high extent.

3.2. Intel Corporation

3.2.1. General information

Intel Corporation (in further text - Intel) is a tech corporation that produces microprocessors, motherboard chipsets, graphics chips and other computer components.[8] It is located in Silicon Valley, California, USA. The market capitalization of Intel as of 24.10.2020 is $186.807 billion.[9] Intel's first AI acquisition is Indisys, the company that develops natural language technologies, the acquisition was announced on September 13th, 2013.[10] According to this data, AI period is marked from Q4 2013 to Q2 2020 for this study, and pre-AI period is marked from Q1 2007 to Q3 2013, implying $\mathbf{n_1}=\mathbf{n_2}=27$.

3.2.2. AI Implementation and Monetization

Intel uses AI to analyze data of millions of web pages of public businesses to identify potential customers and use this analysis in sales and marketing.[11] This AI usage is not directly monetized, however it deemed to affect Intel's marketing and sales efficiency.

AI is also indirectly used by Intel for production of hardware for AI purposes. Although AI is not used directly to produce this hardware, AI research is crucial in being able to produce specifically designed hardware for AI needs. In 2019, Intel has expected to generate $3,5 billion in revenue from products related to AI.[12]

[8] Intel, About Intel, retrieved from https://www.intc.com/about-intel, accessed 24.10.2020

[9] Yahoo! Finance, INTC, retrieved from https://finance.yahoo.com/quote/INTC?p=INTC&.tsrc=fin-srch, accessed 24.10.2020

[10] Crunchbase, Acquisitions, retrieved from https://www.crunchbase.com/acquisition/intel-acquires-indisys--64ed3847, accessed 24.10.2020

[11] Intel, How Intel Uses AI to Identify Sales & Marketing Opportunities, retrieved from https://www.intel.com/content/www/us/en/artificial-intelligence/posts/ai-identifies-sales-marketing-opportunities.html, accessed 24.10.2020

[12] Fast Company, Inside Intel's billion-dollar transformation in the age of AI , 2019, retrieved from https://www.fastcompany.com/90425160/inside-intels-billion-dollar-transformation-in-the-age-of-ai, accessed 24.10.2020

3.2.3. Financial Data

Financial metrics in Table 2.1. represent quarterly financial results of Intel chosen on the same basis as for Alphabet (see **3.1.3. Financial data**, p. 13).

Table 2.1. Financial data of n_1+n_2 period, Intel

Date	Quarter	Revenue Mil	Gross Profit Mil.	R&D Expense, $Mil	Gross Profit adj. for R&D	EBIT Mil	Stock price adjusted
31.03.2020	Q2_2020	19.828	12.016	3.354	8.662	5.697	59,24
31.12.2019	Q1_2020	20.209	11.878	3.275	8.603	7.038	62,83
30.09.2019	Q4_2019	19.190	11.295	3.384	7.911	6.797	55,26
30.06.2019	Q3_2019	16.505	9.878	3.208	6.670	6.447	49,08
31.03.2019	Q2_2019	16.061	9.089	3.438	5.651	4.617	49,25
31.12.2018	Q1_2019	18.657	11.227	3.332	7.895	4.174	45,18
30.09.2018	Q4_2018	19.163	12.360	3.433	8.927	6.224	44,67
30.06.2018	Q3_2018	16.962	10.419	3.428	6.991	7.349	45,56
31.03.2018	Q2_2018	16.066	9.731	3.371	6.360	5.273	48,61
31.12.2017	Q1_2018	17.053	10.778	3.311	7.467	4.470	45,03
30.09.2017	Q4_2017	16.149	10.064	3.253	6.811	5.435	42,30
30.06.2017	Q3_2017	14.763	9.096	3.209	5.887	5.141	32,74
31.03.2017	Q2_2017	14.796	9.160	3.262	5.898	3.842	33,12
31.12.2016	Q1_2017	16.374	10.147	3.311	6.836	3.632	33,49
30.09.2016	Q4_2016	15.778	9.983	3.225	6.758	4.785	31,48
30.06.2016	Q3_2016	13.533	7.973	3.069	4.904	4.462	31,23
31.03.2016	Q2_2016	13.702	8.130	3.145	4.985	1.318	26,90
31.12.2015	Q1_2016	14.914	9.590	3.246	6.344	2.568	27,32
30.09.2015	Q4_2015	14.465	9.111	3.119	5.992	4.299	29,61
30.06.2015	Q3_2015	13.195	8.248	2.927	5.321	4.192	25,11
31.03.2015	Q2_2015	12.781	7.730	3.087	4.643	2.896	28,03
31.12.2014	Q1_2015	14.721	9.621	2.995	6.626	2.615	28,24
30.09.2014	Q4_2014	14.554	9.458	2.990	6.468	4.453	28,88
30.06.2014	Q3_2014	13.831	8.917	2.842	6.075	4.540	28,59
31.03.2014	Q2_2014	12.764	7.613	2.859	4.754	3.844	22,33
31.12.2013	Q1_2014	13.834	8.571	2.846	5.725	2.510	20,33
30.09.2013	Q4_2013	13.483	8.414	2.826	5.588	3.549	20,09
30.06.2013	Q3_2013	12.811	7.470	2.742	4.728	3.504	18,97
31.03.2013	Q2_2013	12.580	7.066	2.516	4.550	2.719	19,29
31.12.2012	Q1_2013	13.477	7.817	2.527	5.290	2.519	16,76
30.09.2012	Q4_2012	13.457	8.515	2.629	5.886	3.155	17,06
30.06.2012	Q3_2012	13.501	8.554	2.605	5.949	3.841	20,09
31.03.2012	Q2_2012	12.906	8.265	2.513	5.752	3.832	22,04
31.12.2011	Q1_2012	13.887	8.952	2.401	6.551	3.810	20,34
30.09.2011	Q4_2011	14.233	9.018	2.308	6.710	4.599	18,73
30.06.2011	Q3_2011	13.032	7.902	2.140	5.762	4.785	16,88
31.03.2011	Q2_2011	12.847	7.885	1.986	5.899	3.935	17,36

31.12.2010	Q1_2011	11.457	7.406	1.916	5.490	4.158	15,96
30.09.2010	Q4_2010	11.102	7.321	1.671	5.650	4.023	14,80
30.06.2010	Q3_2010	10.765	7.235	1.675	5.560	4.136	15,09
31.03.2010	Q2_2010	10.299	6.529	1.666	4.863	3.981	16,61
31.12.2009	Q1_2010	10.569	6.840	1.564	5.276	3.448	14,00
30.09.2009	Q4_2009	9.389	5.404	1.603	3.801	2.497	13,68
30.06.2009	Q3_2009	8.024	4.079	1.430	2.649	2.579	13,68
31.03.2009	Q2_2009	7.145	3.238	1.303	1.935	-12	11,12
31.12.2008	Q1_2009	8.226	4.369	1.317	3.052	647	9,00
30.09.2008	Q4_2008	10.217	6.019	1.316	4.703	1.539	11,09
30.06.2008	Q3_2008	9.470	5.249	1.471	3.778	3.098	15,25
31.03.2008	Q2_2008	9.673	5.207	1.468	3.739	2.255	15,21
31.12.2007	Q1_2008	10.712	6.226	1.467	4.759	2.062	14,33
30.09.2007	Q4_2007	10.090	5.171	1.481	3.690	3.047	18,19
30.06.2007	Q3_2007	8.680	4.075	1.521	2.554	2.144	15,90
31.03.2007	Q2_2007	8.852	4.432	1.353	3.079	1.350	14,40
31.03.2007	Q1_2007	8.852	4.432	1.400	3.032	1.675	14,40

3.2.4. Regression analysis

The analysis is performed as in **3.1.4. Regression analysis** for Alphabet (see p. 15). Table 2.2. represents the output of regression analysis for each of financial metrics.

Table 2.2. Regression analysis for n_1+n_2 period, Intel (Xi, Yi)

Revenue, Stock Price	
Regression Statistics	
Multiple R	0,90041
R Square	0,810739
Adjusted R Square	0,807099
Standard Error	6,008349
Observations	54

Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,827777
R Square	0,685215
Adjusted R Square	0,679162
Standard Error	7,74874
Observations	54

adj. Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,768942
R Square	0,591272
Adjusted R Square	0,583411
Standard Error	8,829612
Observations	54

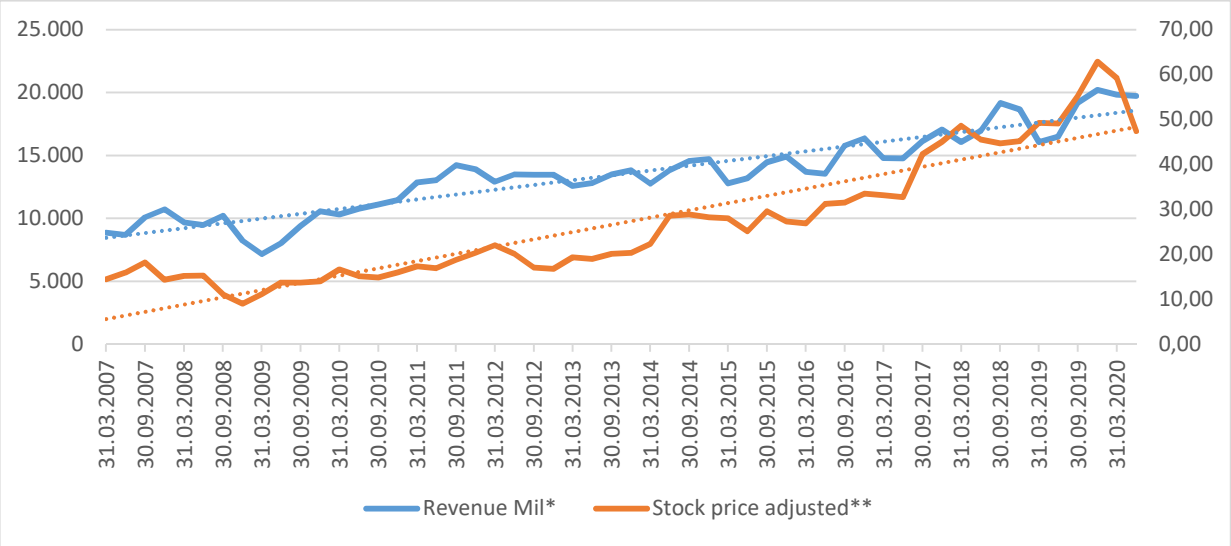
EBIT, Stock Price	
Regression Statistics	
Multiple R	0,768052
R Square	0,589904
Adjusted R Square	0,582017
Standard Error	8,844375
Observations	54

All financial metrics of Intel have strong to a very strong correlation lying above the 0,6 value of the coefficient of correlation, Multiple R. Revenue, Stock Price (X_i, Y_i) has the highest coefficient 0.9. R Square or Coefficient of Determination returns the value 0.81 for Revenue, Stock Price (X_i,

Y_i). This means that 81% of the variance in Stock Price is explained by Revenue fluctuations. As values of Multiple R are over 0.6 for all financial metrics, Intel has a strong correlation between Stock Price and all financial metrics and a very strong correlation to Stock Price for the selected metric, Revenue.

Values of Stock Price and Revenue are plotted on a graph for visual analysis. Figure 2.3. represents the relationship between Gross Profit and Stock Price graphically.

Figure 2.3 Relationship between Revenue and Stock Price, Intel



The graph shows that the development of Stock Price values over time is visually very close to the development of Revenue, with Stock Price having a slightly higher slope. Blue and orange dotted lines represent trend lines for Revenue and Stock Price respectively.

Now, trends for periods n_1, n_2 separately are calculated using the least squares method. Based on the trend values in pre-AI period a forecast for the trend values in AI period is performed. Table 2.4. represents the output of this procedure.

Table 2.4. Revenue trend and forecasted trend values, Intel

Period	Date	Quarter	Trend (Revenue)	Forecasted Trend values
AI period	30.06.2020	Q2_2020	19.212	19.746
	31.03.2020	Q1_2020	18.958	19.532
	31.12.2019	Q4_2019	18.704	19.317
	30.09.2019	Q3_2019	18.450	19.101
	30.06.2019	Q2_2019	18.196	18.884

	31.03.2019	Q1_2019	17.942	18.670
	31.12.2018	Q4_2018	17.688	18.458
	30.09.2018	Q3_2018	17.434	18.241
	30.06.2018	Q2_2018	17.180	18.024
	31.03.2018	Q1_2018	16.926	17.810
	31.12.2017	Q4_2017	16.672	17.598
	30.09.2017	Q3_2017	16.418	17.381
	30.06.2017	Q2_2017	16.164	17.165
	31.03.2017	Q1_2017	15.910	16.950
	31.12.2016	Q4_2016	15.656	16.738
	30.09.2016	Q3_2016	15.402	16.522
	30.06.2016	Q2_2016	15.148	16.305
	31.03.2016	Q1_2016	14.894	16.091
	31.12.2015	Q4_2015	14.640	15.876
	30.09.2015	Q3_2015	14.386	15.660
	30.06.2015	Q2_2015	14.132	15.443
	31.03.2015	Q1_2015	13.878	15.229
	31.12.2014	Q4_2014	13.624	15.017
	30.09.2014	Q3_2014	13.370	14.800
	30.06.2014	Q2_2014	13.116	14.583
	31.03.2014	Q1_2014	12.863	14.369
	31.12.2013	Q4_2013	12.609	14.157
pre-AI period	30.09.2013	Q3_2013	13.940	
	30.06.2013	Q2_2013	13.725	
	31.03.2013	Q1_2013	13.510	
	31.12.2012	Q4_2012	13.295	
	30.09.2012	Q3_2012	13.080	
	30.06.2012	Q2_2012	12.865	
	31.03.2012	Q1_2012	12.650	
	31.12.2011	Q4_2011	12.434	
	30.09.2011	Q3_2011	12.219	
	30.06.2011	Q2_2011	12.004	
	31.03.2011	Q1_2011	11.789	
	31.12.2010	Q4_2010	11.574	
	30.09.2010	Q3_2010	11.359	
	30.06.2010	Q2_2010	11.144	
	31.03.2010	Q1_2010	10.929	
	31.12.2009	Q4_2009	10.714	
	30.09.2009	Q3_2009	10.499	
	30.06.2009	Q2_2009	10.283	
	31.03.2009	Q1_2009	10.068	
	31.12.2008	Q4_2008	9.853	
	30.09.2008	Q3_2008	9.638	
	30.06.2008	Q2_2008	9.423	
	31.03.2008	Q1_2008	9.208	
	31.12.2007	Q4_2007	8.993	
	30.09.2007	Q3_2007	8.778	
	30.06.2007	Q2_2007	8.563	

	31.03.2007	Q1_2007	8.348

3.2.5. H_0 testing

H_0 is tested by performing the same procedure as in **3.1.5. H_0 testing** (**Alphabet**, see p. 18). The **T_{obs}** statistic for Intel is the observed mean average of Revenue in **n_2** (AI) period. Sample size is **n_1=n_2**=27 for Intel.

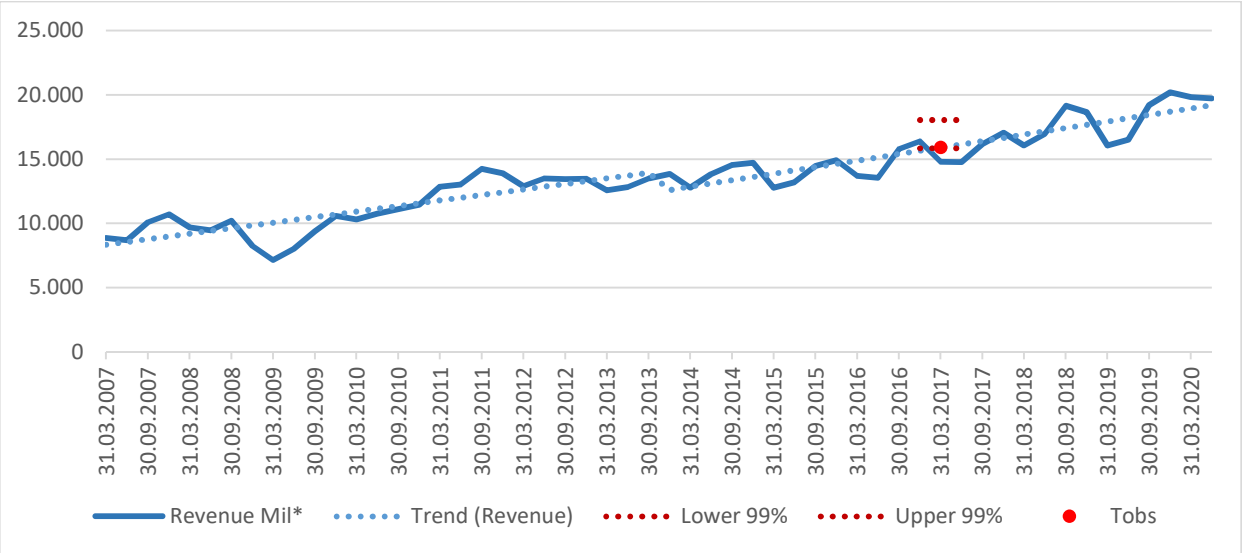
Table 2.5. H_0 test output, Intel

Period	Mean	SD	EB	CI		Tobs	H0	Upper or Lower
pre-AI	11.144	2060,17	1101,71			15.910	Cannot be rejected	-
AI forecasted	16.951	n/a		lower	15.849			
				upper	18.052			-
AI observed	15.910	2282,93						

The value of **T_{obs}** falls within the CI, therefore **H_0** cannot be rejected for Intel. For a detailed description of the output see **3.1.5. H_0 testing** for Alphabet (p.19).

Furtherly, results of the test are plotted on a graph. Upper and lower bounds of the Confidence Interval are represented as red dotted lines for better visibility, basically, these are two points. Figure 2.6. represents the **H_0** test output graphically together with the observed Revenue and its trend in both periods.

Figure 2.6. Observed Revenue, T_{obs} and Confidence Interval for the forecasted mean, Intel



As the next step, regression analysis is performed for Revenue, Stock Price **(X_i, Y_i)** for each period separately. Table 2.7. represents the output of regression analysis.

Table 2.7. Regression analysis for n_1 and n_2 periods separately. Revenue, Stock Price (Xi, Yi), Intel

pre-AI period	
Regression Statistics	
Multiple R	0,787890781
R Square	0,620771882
Adjusted R Square	0,605602757
Standard Error	1,928978247
Observations	27

AI period	
Regression Statistics	
Multiple R	0,888633847
R Square	0,789670113
Adjusted R Square	0,781256918
Standard Error	5,499296606
Observations	27

In **n_1** (pre-AI) period multiple R of 0,79 and R Square of 0,62 represent a 79% correlation between Revenue and Stock Price with 62% of the variance in Stock Price being explained by fluctuations of Revenue. In AI period multiple R of 0,89 and R Square of 0,79 represent a 89% correlation between Revenue and Stock Price with 79% of the variance in Stock Price being explained by fluctuations of Revenue.

3.2.6. Results

For Intel, the strongest correlation has been found between its Revenue and Stock Price. Results of the analysis show that financial results in AI period are not significantly different from pre-AI values with the trend line being within the 99% CI. Therefore, **H_0** for Intel cannot be rejected. Further conclusions considering market performance (**MC**s) are not applicable when **H_0** cannot be rejected, as for Intel the correlation between Stock Price and Revenue is very strong, which implies that Stock Prices develop with approximately same pace as in pre-AI period.

The coefficient of correlation has increased from 79% in pre-AI period to 89% in AI period. As this correlation is strong in pre-AI period and very strong in AI period, it is concluded:

C_1 Stock Prices are in line with financial results and its fluctuations are explained by financial results to a high extent.

3.3. NICE Systems Ltd.

3.3.1. General information

NICE Systems Ltd. (in further text - NICE) is a company based in Raanana, Israel. The company specializes in providing IT solutions for customer experience, ensuring compliance, fighting financial crime and public safety.[13] The market capitalization of NICE as of 24.10.2020 is $14.133 billion.[14] First AI acquisition of NICE took place on August 7th, 2013, when a company specializing in Big Data analytics and machine learning Causata was acquired.[15] Thus, AI period is marked starting from Q3 2013 to Q2 2020 and pre-AI is marked from Q3 2006 to Q2 2013, implying $\mathbf{n_1}=\mathbf{n_2}=28$.

3.3.2. AI Implementation and Monetization

AI is directly monetized through sales of products that NICE offers to its clients such as NICE Interactive Voice Response Optimization (IVRO) version 8.0[16], Omilia Omnichannel Virtual Assistant[17] and other.

3.3.3. Financial Data

Financial metrics in Table 3.1. represent quarterly financial results of NICE chosen on the same basis as for Alphabet (see Alphabet, Financial data, p. 13).

[13] NICE, Company Overview, retrieved from https://www.nice.com/about-nice/company-overview/, accessed 23.10.2020
[14] Yahoo! Finance, NICE, retrieved from https://finance.yahoo.com/quote/NICE?p=NICE&.tsrc=fin-srch, accessed 23.10.2020
[15] NICE, Press Releases, NICE to Acquire Causata to Enable a Seamless Customer Experience across the Web and Contact Center, retrieved from https://www.nice.com/press-releases/NICE-to-Acquire-Causata-to-Enable-a-Seamless-Customer-Experience-across-the-Web-and-Contact-Center-155/, accessed 23.10.2020
[16] NICE, Press Releases, NICE Revolutionizes IVR Optimization with Advanced Artificial Intelligence, retrieved from https://www.nice.com/engage/press-releases/NICE-Revolutionizes-IVR-Optimization-with-Advanced-Artificial-Intelligence-691/, accessed 23.10.2020
[17] NICE, Press Releases, NICE inContact CXone Expands Artificial Intelligence Apps with Speech-Enabled Virtual Assistants and AI Chatbots from Omilia, retrieved from https://www.nice.com/engage/press-releases/NICE-inContact-CXone-Expands-Artificial-Intelligence-Apps-with-SpeechEnabled-Virtual-Assistants-and-AI-Chatbots-from-Omilia-605/

Table 3.1. Financial data of n_1+n_2 period, NICE

Date	Quarter	Revenue Mil	Gross Profit Mil.	R&D Expense, $Mil	Gross Profit adj. for R&D	EBIT Mil	Stock price adjusted
30.06.2020	Q2_2020	393	257	54	203	56	205,24
31.03.2020	Q1_2020	410	270	53	217	59	164,30
31.12.2019	Q4_2019	430	293	52	241	78	172,30
30.09.2019	Q3_2019	386	254	49	205	56	157,79
30.06.2019	Q2_2019	380	250	46	204	53	152,72
31.03.2019	Q1_2019	377	246	47	199	52	137,86
31.12.2018	Q4_2018	411	275	47	228	70	109,95
30.09.2018	Q3_2018	356	233	48	185	47	105,94
30.06.2018	Q2_2018	342	223	43	180	46	109,40
31.03.2018	Q1_2018	335	217	46	171	34	95,17
31.12.2017	Q4_2017	392	268	50	218	63	91,10
30.09.2017	Q3_2017	323	207	45	162	33	83,31
30.06.2017	Q2_2017	312	198	43	155	26	74,66
31.03.2017	Q1_2017	306	190	43	147	28	67,45
31.12.2016	Q4_2016	324	221	41	180	37	70,02
30.09.2016	Q3_2016	237	159	34	125	36	66,16
30.06.2016	Q2_2016	229	146	35	111	24	68,17
31.03.2016	Q1_2016	226	151	33	118	37	63,09
31.12.2015	Q4_2015	274	192	36	156	64	59,65
30.09.2015	Q3_2015	221	147	32	115	38	60,76
30.06.2015	Q2_2015	216	142	30	112	31	63,30
31.03.2015	Q1_2015	217	143	30	113	33	58,54
31.12.2014	Q4_2014	294	250	38	212	134	47,74
30.09.2014	Q3_2014	207	131	31	100	17	39,54
30.06.2014	Q2_2014	239	145	37	108	15	38,27
31.03.2014	Q1_2014	229	139	37	102	17	41,64
31.12.2013	Q4_2013	270	233	39	194	128	37,87
30.09.2013	Q3_2013	230	139	35	104	16	37,45
30.06.2013	Q2_2013	225	139	31	108	19	36,88
31.03.2013	Q1_2013	224	138	32	106	19	33,62
31.12.2012	Q4_2012	238	149	32	117	19	34,98
30.09.2012	Q3_2012	219	131	30	101	13	31,52
30.06.2012	Q2_2012	212	126	29	97	9	34,12
31.03.2012	Q1_2012	210	123	30	93	5	36,41
31.12.2011	Q4_2011	214	132	29	103	15	34,08
30.09.2011	Q3_2011	199	122	27	95	20	33,89
30.06.2011	Q2_2011	195	119	27	92	15	33,81
31.03.2011	Q1_2011	185	114	26	88	8	36,15
31.12.2010	Q4_2010	186	116	26	90	17	31,01
30.09.2010	Q3_2010	175	108	25	83	13	31,74
30.06.2010	Q2_2010	169	101	23	78	13	27,17
31.03.2010	Q1_2010	160	95	22	73	6	30,15
31.12.2009	Q4_2009	159	94	21	73	11	27,59

30.09.2009	Q3_2009	145	85	19	66	5	29,35
30.06.2009	Q2_2009	140	84	18	66	12	25,95
31.03.2009	Q1_2009	139	83	18	65	10	24,27
31.12.2008	Q4_2008	163	102	21	81	16	18,19
30.09.2008	Q3_2008	162	100	20	80	16	21,19
30.06.2008	Q2_2008	154	95	19	76	10	28,02
31.03.2008	Q1_2008	144	88	19	69	6	30,18
31.12.2007	Q4_2007	144	87	19	68	6	29,01
30.09.2007	Q3_2007	132	80	14	66	12	37,37
30.06.2007	Q2_2007	126	76	14	62	11	31,48
31.03.2007	Q1_2007	116	69	13	56	7	34,74
31.12.2006	Q4_2006	117	70	13	57	9	30,01
30.09.2006	Q3_2006	107	60	12	48	6	29,16

3.3.4. Regression analysis

The analysis is performed as in **3.1.4. Regression analysis** for Alphabet (see p. 15). Table 3.2. represents the output of regression analysis for each of financial metrics.

Table 3.2. Regression analysis for n_1+n_2 period, NICE (Xi, Yi)

Revenue, Stock Price	
Regression Statistics	
Multiple R	0,876856
R Square	0,768876
Adjusted R Square	0,764596
Standard Error	21,29445
Observations	56

Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,840069
R Square	0,705715
Adjusted R Square	0,700266
Standard Error	24,02858
Observations	56

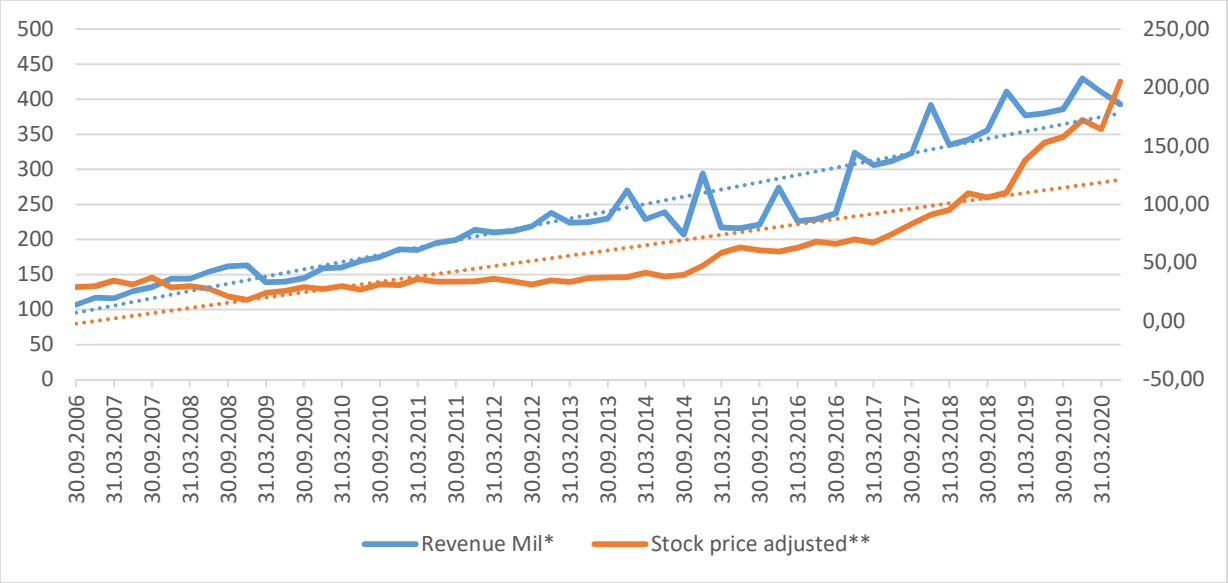
adj. Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,833971
R Square	0,695508
Adjusted R Square	0,689869
Standard Error	24,44175
Observations	56

EBIT, Stock Price	
Regression Statistics	
Multiple R	0,544004
R Square	0,295941
Adjusted R Square	0,282902
Standard Error	37,16627
Observations	56

Revenue, Gross Profit and Gross Profit adj. of NICE have a very strong correlation with Stock Price, lying above the 0,8 value of the coefficient of correlation, Multiple R. EBIT has moderate correlation with Stock Price, lying above the 0,4 value of the coefficient of correlation. Revenue has the strongest correlation with Stock Price with a 0.88 value of the coefficient of correlation. R Square or Coefficient of Determination returns the value 0.77 for Revenue, Stock Price ($\mathbf{X_i}$, $\mathbf{Y_i}$). This means that 77% of the variance in Stock Price is explained by Revenue fluctuations. Values

of Stock Price and Revenue are plotted on a graph for visual analysis. Figure 3.3. represents the relationship between Revenue and Stock Price graphically.

Figure 3.3 Relationship between Revenue and Stock Price, NICE



Blue and orange dotted lines represent trend lines for Revenue and Stock Price respectively. The graph shows that the development of Stock Price values over time is visually close to the development of Revenue with the trend line of Stock Price having a lower slope but a large upward tendency in last periods.

Now, trends for periods $\mathbf{n_1}$, $\mathbf{n_2}$ separately are calculated using the least squares method. Based on the trend values in pre-AI period a forecast for the trend values in AI period is performed. Table 3.4. represents the output of this procedure.

Table 3.4. Revenue trend and forecasted trend values, NICE

Period	Date	Quarter	Trend (Revenue)	Forecasted Trend values
AI period	30.06.2020	Q2_2020	412	350
	31.03.2020	Q1_2020	404	346
	31.12.2019	Q4_2019	396	341
	30.09.2019	Q3_2019	389	337
	30.06.2019	Q2_2019	381	333
	31.03.2019	Q1_2019	373	328
	31.12.2018	Q4_2018	365	324
	30.09.2018	Q3_2018	357	320

	30.06.2018	Q2_2018	349	315
	31.03.2018	Q1_2018	341	311
	31.12.2017	Q4_2017	333	307
	30.09.2017	Q3_2017	326	302
	30.06.2017	Q2_2017	318	298
	31.03.2017	Q1_2017	310	294
	31.12.2016	Q4_2016	302	289
	30.09.2016	Q3_2016	294	285
	30.06.2016	Q2_2016	286	281
	31.03.2016	Q1_2016	278	276
	31.12.2015	Q4_2015	271	272
	30.09.2015	Q3_2015	263	268
	30.06.2015	Q2_2015	255	263
	31.03.2015	Q1_2015	247	259
	31.12.2014	Q4_2014	239	255
	30.09.2014	Q3_2014	231	250
	30.06.2014	Q2_2014	223	246
	31.03.2014	Q1_2014	215	242
	31.12.2013	Q4_2013	208	237
	30.09.2013	Q3_2013	200	233
pre-AI period	30.06.2013	Q2_2013	229	
	31.03.2013	Q1_2013	225	
	31.12.2012	Q4_2012	220	
	30.09.2012	Q3_2012	216	
	30.06.2012	Q2_2012	212	
	31.03.2012	Q1_2012	207	
	31.12.2011	Q4_2011	203	
	30.09.2011	Q3_2011	198	
	30.06.2011	Q2_2011	194	
	31.03.2011	Q1_2011	190	
	31.12.2010	Q4_2010	185	
	30.09.2010	Q3_2010	181	
	30.06.2010	Q2_2010	177	
	31.03.2010	Q1_2010	172	
	31.12.2009	Q4_2009	168	
	30.09.2009	Q3_2009	163	
	30.06.2009	Q2_2009	159	
	31.03.2009	Q1_2009	155	
	31.12.2008	Q4_2008	150	
	30.09.2008	Q3_2008	146	
	30.06.2008	Q2_2008	141	
	31.03.2008	Q1_2008	137	
	31.12.2007	Q4_2007	133	
	30.09.2007	Q3_2007	128	
	30.06.2007	Q2_2007	124	
	31.03.2007	Q1_2007	119	
	31.12.2006	Q4_2006	115	
	30.09.2006	Q3_2006	111	

3.3.5. H_0 testing

H_0 is tested by performing the same procedure as in **3.1.5. H_0 testing** for Alphabet (see p. 18). The **T_{obs}** statistic for Nice is the observed mean average of Revenue in **n_2** (AI) period. Sample size is **n_1=n_2**=28 for NICE. Table 3.5. represents the output of the test procedure.

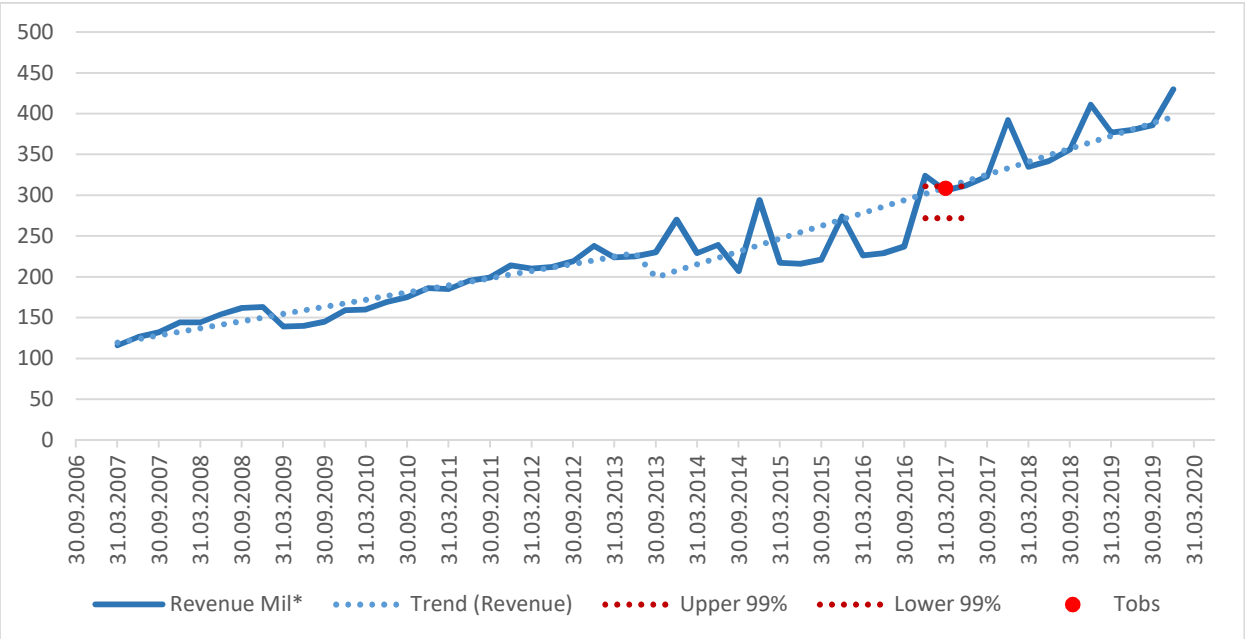
Table 3.5. H_0 test output, NICE

Period	Mean	SD	EB	CI	Tobs	H0	Upper or Lower
pre-AI	169,96	37,39	19,58		308,74	Cannot be rejected	-
AI forecasted	291,54	n/a		lower 271,96 upper 311,11			-
AI observed	305,93	72,82					

The value of **T_{obs}** falls within the CI, although very close to the upper bound, therefore **H_0** cannot be rejected for NICE. For a detailed description of the output see **3.1.5. H_0 testing** for Alphabet (p.19).

Furtherly, results of the test are shown on a graph. Upper and lower bounds of the Confidence Interval are represented as red dotted lines for better visibility, basically, these are two points. Figure 3.6. represents the **H_0** test output graphically together with the Revenue and its trend in both periods.

Figure 3.6. Observed Revenue, T_{obs} and Confidence Interval for the forecasted mean, NICE



As the next step, regression analysis is performed for Revenue, Stock Price **(X_i, Y_i)** for each period separately. Table 3.7. represents the output of regression analysis.

Table 3.7. Regression analysis for periods n_1 and n_2 separately. Revenue, Stock Price (X_i,Y_i), NICE

pre-AI period		AI period	
Regression Statistics		*Regression Statistics*	
Multiple R	0,410284957	Multiple R	0,844479989
R Square	0,168333746	R Square	0,713146452
Adjusted R Square	0,136346583	Adjusted R Square	0,702113623
Standard Error	4,313320975	Standard Error	25,4382767
Observations	28	Observations	28

In **n_1** (pre-AI) period multiple R of 0,41 and R Square of 0,16 represent a 41% correlation between Revenue and Stock Price with 16% of the variance in Stock Price being explained by fluctuations of Revenue. In AI period multiple R of 0,84 and R Square of 0,71 represent a 84% correlation between Gross Profit and Stock Price with 79% of the variance in Stock Price being explained by fluctuations of Revenue.

3.3.6. Results

For NICE, the strongest correlation has been found between its Revenue and Stock Price. Results of the analysis show that financial results in AI period are not significantly different from pre-AI values with the **T_{obs}** being within the 99% CI. Therefore, **H_0** for NICE cannot be rejected. Further conclusions considering market performance (**MC**s) are not applicable when **H_0** cannot be rejected, as for NICE the correlation between Stock Price and Revenue is very strong, which implies that Stock Prices develop insignificantly different from pre-AI period.

The coefficient of correlation has increased from moderate 41% in pre-AI period to very strong 84% in AI period. As this correlation is very strong for the whole observed **(n_1+n_2)** period and very strong in AI period, it is concluded:

C_1 Stock Prices are in line with financial results and its fluctuations are explained by financial results to a high extent.

3.4. Amazon.com, Inc.

3.4.1. General information

Amazon.com, Inc. (in further text – Amazon) is an online retailer and provider of web services based in Seattle, USA.[18] The market capitalization of Amazon as of 24.10.2020 is $1.605 trillion.[19] The company released its first AI product, Amazon Echo on November 6th, 2014***, thus AI period is marked form Q4 2014 to Q2 2020 and pre-AI period is marked from Q1 2009 to Q3 2014, implying $\mathbf{n_1}=\mathbf{n_2}=23$.

3.4.2. AI Implementation and Monetization

Amazon monetizes AI directly through Amazon Web Services (AWS) and sales of Amazon Echo products that are connected to an AI virtual personal assistant Alexa.

Also, Amazon monetizes AI indirectly through using it for suggesting relevant products to potential customers and increasing sales. The company is also working on AI-powered robots to use in fulfillment centers and drones to perform commercial deliveries[20], which has potential to substantially reduce storage and transportation costs.

3.4.3. Financial Data

Financial metrics in Table 4.1. represent quarterly financial results of Amazon chosen on the same basis as for Alphabet (see **3.1.5. Financial data**, p.13).

Table 4.1. Financial data of n_1+n_2 period, Amazon

Date	Quarter	Revenue, $Mil.	Gross Profit, $Mil.	R&D Expense, $Mil	Gross Profit adj. for R&D Expense, $Mil.	EBIT, $Mil	Stock price$ adjusted
30.06.2020	Q2_2020	88.912	36.252	10.388	25.864	5.843	3.164,68
31.03.2020	Q1_2020	75.452	31.195	9.325	21.870	3.989	2.474,00
31.12.2019	Q4_2019	87.437	33.460	9.739	23.721	3.880	2.008,72

[18] Encyclopedia Britannica, Amazon.com, Inc., retrieved from https://www.britannica.com/topic/Amazoncom, accessed 24.10.2020

[19] Yahoo! Finance, AMZN, retrieved from https://finance.yahoo.com/quote/AMZN?p=AMZN&.tsrc=fin-srch, accessed on Oct 12, 2020

[20] Stephanie Condon, ZDNet, Amazon shares how it leverages AI throughout the businessretrieved from https://www.zdnet.com/article/amazon-shares-how-it-leverages-ai-throughout-the-business/, accessed 22.10.2020

***According to Wikipedia.org, no other source with the exact release date was found

30.09.2019	Q3_2019	69.981	28.679	9.200	19.479	3.157	1.776,66
30.06.2019	Q2_2019	63.404	27.067	9.065	18.002	3.084	1.866,78
31.03.2019	Q1_2019	59.700	25.780	7.927	17.853	4.420	1.926,52
31.12.2018	Q4_2018	72.383	27.597	7.669	19.928	3.787	1.718,73
30.09.2018	Q3_2018	56.576	23.573	7.162	16.411	3.724	1.598,01
30.06.2018	Q2_2018	52.886	22.254	7.247	15.007	2.983	1.777,44
31.03.2018	Q1_2018	51.042	20.307	6.759	13.548	1.927	1.566,13
31.12.2017	Q4_2017	60.453	21.959	6.314	15.645	2.126	1.450,89
30.09.2017	Q3_2017	43.744	16.195	5.944	10.251	347	1.105,28
30.06.2017	Q2_2017	37.955	14.504	5.549	8.955	628	987,78
31.03.2017	Q1_2017	35.714	13.274	4.813	8.461	1.005	924,99
31.12.2016	Q4_2016	43.741	14.782	4.544	10.238	1.255	823,48
30.09.2016	Q3_2016	32.714	11.454	4.135	7.319	575	789,82
30.06.2016	Q2_2016	30.404	11.224	3.880	7.344	1.285	758,81
31.03.2016	Q1_2016	29.128	10.262	3.526	6.736	1.071	659,59
31.12.2015	Q4_2015	35.746	11.405	3.569	7.836	1.108	587,00
30.09.2015	Q3_2015	25.358	8.603	3.197	5.406	406	625,90
30.06.2015	Q2_2015	23.185	8.025	3.020	5.005	464	536,15
31.03.2015	Q1_2015	22.717	7.322	2.754	4.568	255	421,78
31.12.2014	Q4_2014	29.328	8.657	2.635	6.022	591	354,53
30.09.2014	Q3_2014	20.579	5.952	2.423	3.529	-544	305,46
30.06.2014	Q2_2014	19.340	5.941	2.226	3.715	-15	312,99
31.03.2014	Q1_2014	19.741	5.686	1.991	3.695	146	304,13
31.12.2013	Q4_2013	25.586	6.781	1.862	4.919	510	358,69
30.09.2013	Q3_2013	17.092	4.726	1.734	2.992	-25	364,03
30.06.2013	Q2_2013	15.704	4.495	1.586	2.909	79	301,22
31.03.2013	Q1_2013	16.070	4.269	1.383	2.886	181	253,81
31.12.2012	Q4_2012	21.268	5.131	1.345	3.786	405	265,50
30.09.2012	Q3_2012	13.806	3.487	1.192	2.295	-28	232,89
30.06.2012	Q2_2012	12.834	3.346	1.082	2.264	107	233,30
31.03.2012	Q1_2012	13.185	3.158	945	2.213	192	231,90
31.12.2011	Q4_2011	17.431	3.601	863	2.738	260	194,44
30.09.2011	Q3_2011	10.876	2.551	769	1.782	79	213,51
30.06.2011	Q2_2011	9.913	2.388	698	1.690	201	222,52
31.03.2011	Q1_2011	9.857	2.249	579	1.670	322	195,81
31.12.2010	Q4_2010	12.947	2.630	518	2.112	474	169,64
30.09.2010	Q3_2010	7.560	1.774	442	1.332	268	165,23
30.06.2010	Q2_2010	6.566	1.609	408	1.201	270	117,89
31.03.2010	Q1_2010	7.131	1.630	366	1.264	394	137,10
31.12.2009	Q4_2009	9.520	1.977	351	1.626	475	125,41
30.09.2009	Q3_2009	5.449	1.273	315	958	251	118,81
30.06.2009	Q2_2009	4.651	1.133	299	834	159	85,76
31.03.2009	Q1_2009	4.889	1.148	275	873	244	80,52

3.4.4. Regression analysis

The analysis is performed as in **3.1.4. Regression analysis** for Alphabet (see p.15). Table 4.2. represents the output of regression analysis for each of financial metrics.

Table 4.2. Regression analysis for n_1+n_2 period, Amazon (Xi, Yi)

Revenue, Stock Price	
Regression Statistics	
Multiple R	0,9635902
R Square	0,928506
Adjusted R Square	0,9268811
Standard Error	202,38722
Observations	46

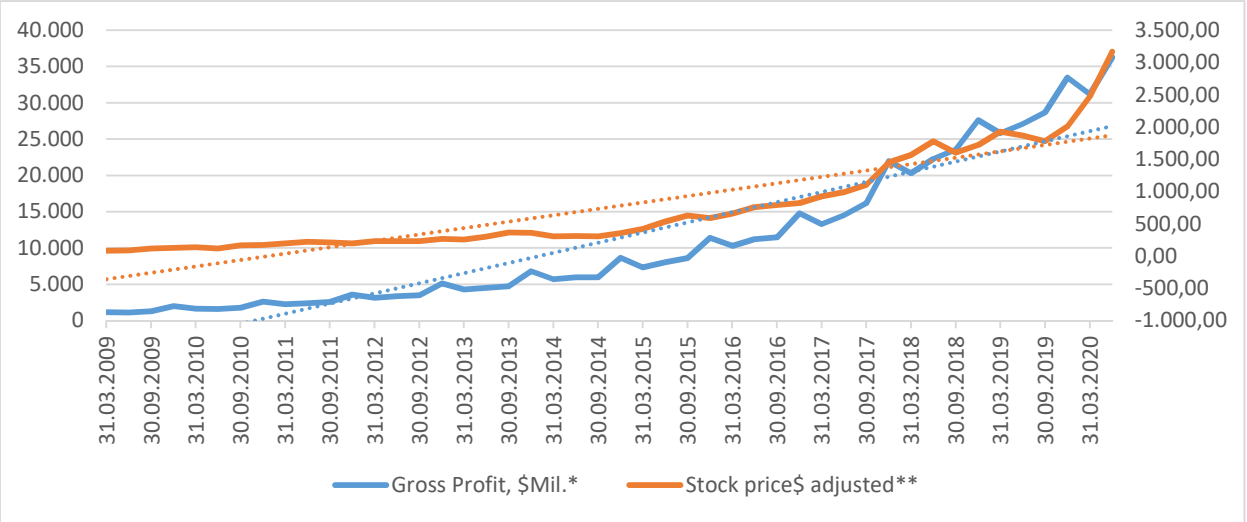
Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,9804525
R Square	0,961287
Adjusted R Square	0,9604072
Standard Error	148,92804
Observations	46

adj. Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,9795838
R Square	0,9595844
Adjusted R Square	0,9586658
Standard Error	152,16786
Observations	46

EBIT, Stock Price	
Regression Statistics	
Multiple R	0,9469631
R Square	0,8967391
Adjusted R Square	0,8943922
Standard Error	243,2295
Observations	46

All financial metrics of Amazon have a very strong correlation with Stock Price, lying above the 0,8 value of the coefficient of correlation, Multiple R. Gross Profit has the strongest correlation with Stock Price with a 0.98 value of the coefficient of correlation. R Square or Coefficient of Determination returns the value 0.96 for Gross Profit, Stock Price (X_i, Y_i). This means that 96% of the variance in Stock Price is explained by Revenue fluctuations. Values of Stock Price and Gross Profit are plotted on a graph for visual analysis. Figure 4.3. represents the relationship between Gross Profit and Stock Price graphically.

Figure 4.3 Relationship between Gross Profit and Stock Price, Amazon



Blue and orange dotted lines represent trend lines for Gross Profit and Stock Price respectively. The graph shows that the development of Stock Price values over time is visually similar to the development of Gross Profit with the trend line of Stock Price having a lower slope but a large upward spike in the last point.

Now, trends for periods $\mathbf{n_1}$, $\mathbf{n_2}$ separately are calculated using the least squares method. Based on the trend values in pre-AI period a forecast for the trend values in AI period is performed. Table 4.4. represents the output of this procedure.

Table 4.4. Gross Profit trend and forecasted trend values, Amazon

Period	Date	Quarter	Trend (Gross Profit)	Forecasted Trend values
AI period	30.06.2020	Q2_2020	33.088	16.642
	31.03.2020	Q1_2020	31.795	16.232
	31.12.2019	Q4_2019	30.502	15.821
	30.09.2019	Q3_2019	29.209	15.406
	30.06.2019	Q2_2019	27.915	14.991
	31.03.2019	Q1_2019	26.622	14.581
	31.12.2018	Q4_2018	25.329	14.175
	30.09.2018	Q3_2018	24.035	13.760
	30.06.2018	Q2_2018	22.742	13.345
	31.03.2018	Q1_2018	21.449	12.935
	31.12.2017	Q4_2017	20.155	12.529
	30.09.2017	Q3_2017	18.862	12.114
	30.06.2017	Q2_2017	17.569	11.699
	31.03.2017	Q1_2017	16.276	11.289
	31.12.2016	Q4_2016	14.982	10.883
	30.09.2016	Q3_2016	13.689	10.468
	30.06.2016	Q2_2016	12.396	10.053
	31.03.2016	Q1_2016	11.102	9.642
	31.12.2015	Q4_2015	9.809	9.232
	30.09.2015	Q3_2015	8.516	8.817
	30.06.2015	Q2_2015	7.222	8.402
	31.03.2015	Q1_2015	5.929	7.992
	31.12.2014	Q4_2014	4.636	7.586
pre-AI period	30.09.2014	Q3_2014	6.027	
	30.06.2014	Q2_2014	5.784	
	31.03.2014	Q1_2014	5.540	
	31.12.2013	Q4_2013	5.296	
	30.09.2013	Q3_2013	5.052	
	30.06.2013	Q2_2013	4.808	

	31.03.2013	Q1_2013	4.564
	31.12.2012	Q4_2012	4.320
	30.09.2012	Q3_2012	4.077
	30.06.2012	Q2_2012	3.833
	31.03.2012	Q1_2012	3.589
	31.12.2011	Q4_2011	3.345
	30.09.2011	Q3_2011	3.101
	30.06.2011	Q2_2011	2.857
	31.03.2011	Q1_2011	2.613
	31.12.2010	Q4_2010	2.370
	30.09.2010	Q3_2010	2.126
	30.06.2010	Q2_2010	1.882
	31.03.2010	Q1_2010	1.638
	31.12.2009	Q4_2009	1.394
	30.09.2009	Q3_2009	1.150
	30.06.2009	Q2_2009	906
	31.03.2009	Q1_2009	663

3.4.5. H_0 testing

H_0 is tested by performing the same procedure as in **3.1.5. H_0 testing** for Alphabet (see p.18). The **T_{obs}** statistic for Amazon is the observed mean average of Gross Profit in **n_2** (AI) period. Sample size is **n_1=n_2**=23. The output of the testing procedure is represented in table 4.5.

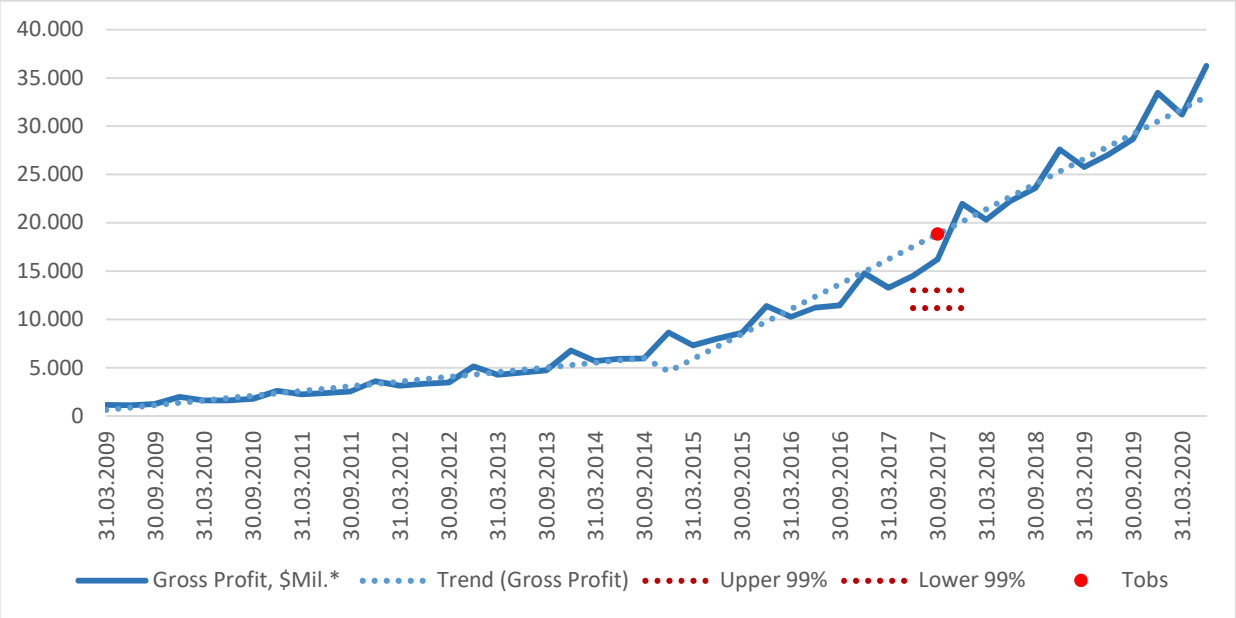
Table 4.5. H_0 test output, Amazon

Period	Mean	SD	EB	CI		Tobs	H0	Upper or Lower
pre-AI	3.345	1729,19						
AI forecasted	12.113	n/a	924,71	lower upper	11.188 13.037	18.862	Rejected	Upper
AI observed	18.862	8988,91						-

The value of **T_{obs}** falls above the upper bound outside of CI, therefore **H_0** is rejected for Amazon. For a detailed description of the output see **3.1.5. H_0 testing** for Alphabet (p.19).

Furtherly, results of the test are plotted on a graph. Upper and lower bounds of the Confidence Interval are represented as red dotted lines for better visibility, basically, these are two points. Figure 4.6. represents the **H_0** test output graphically together with the observed Gross Profit and its trend in both periods.

Figure 4.6. Observed Gross Profit, T_{obs} and Confidence Interval of the forecasted mean, Amazon



As the next step, regression analysis is performed for Gross Profit, Stock Price **(X_i, Y_i)** for each period separately. Table 4.7. represents the output of regression analysis.

Table 4.7. Regression analysis for periods n_1 and n_2 separately. Gross Profit, Stock Price (X_i,Y_i), Amazon

pre-AI period	
Regression Statistics	
Multiple R	0,926827211
R Square	0,859008679
Adjusted R Square	0,852294806
Standard Error	32,14197869
Observations	23

AI period	
Regression Statistics	
Multiple R	0,96316687
R Square	0,92769042
Adjusted R Square	0,92424711
Standard Error	199,529069
Observations	23

In **n_1** (pre-AI) period multiple R of 0,93 and R Square of 0,86 represent a 93% correlation between Gross Profit and Stock Price with 86% of the variance in Stock Price being explained by fluctuations of Gross Profit. In AI period multiple R of 0,96 and R Square of 0,93 represent a 96% correlation between Gross Profit and Stock Price with 93% of the variance in Stock Price being explained by fluctuations of Gross Profit. This correlation is very strong for both periods with coefficients of correlation being above 0,8 for both periods.

3.4.6. Results

For Amazon, the strongest correlation has been found between its Gross Profit and Stock Price. Results of the analysis show that financial results in AI period are significantly different from pre-AI values with the $\mathbf{T_{obs}}$ being above the upper bound of the 99% CI. Therefore, $\mathbf{H_0}$ for Amazon is rejected with the following Financial Conclusion:

$\mathbf{FC_1}$ Financial performance of Amazon is significantly better in AI period compared to forecasted values based on pre-AI period

As Stock Prices have a very strong correlation with Gross Profit in both periods, further conclusions are made for Amazon:

$\mathbf{MC_1}$ Market performance of the company is better in the AI period compared to pre-AI period

$\mathbf{C_1}$ Stock Prices are in line with financial results and its fluctuations are explained by financial results to a high extent.

3.5. Microsoft Corporation

3.5.1. General information

Microsoft Corporation (in further text - Microsoft) is an IT company producing software and offering cloud services, based in Redmond, Washington, USA. The market capitalization of Microsoft as of 24.10.2020 is $1.617 billion.[21] First AI acquisition by Microsoft took place on March 19th, 2013, when a company specializing in social media monitoring using AI, Netbreeze, was acquired.[22] Thus, AI period is marked starting from Q2 2013 to Q2 2020 and pre-AI is marked from Q1 2006 to Q1 2013, implying $\mathbf{n_1}$=$\mathbf{n_2}$=29.

3.5.2. AI Implementation and Monetization

Microsoft offers a big variety of AI-based products like Cognitive Services, Bing Autosuggest, Form Recognizer and others on a "Pay only for what you use" basis with different $ per 1000 transactions fees. Additionally, a variety of Microsoft products like Microsoft Office, Skype, Cortana, Bing Search and others have embedded AI features that are not distinctively monetized,

[21] Yahoo! Finance, MSFT, retrieved from https://finance.yahoo.com/quote/MSFT?p=MSFT&.tsrc=fin-srch, accessed on 20.10.2020

[22] Crunchbase, Netbreeze acquired by Microsoft, retrieved from https://www.crunchbase.com/acquisition/microsoft-acquires-netbreeze--40d0f88d, accessed 23.10.2020

but enhance the quality of the product and make it more attractive for the customers gaining competitive advantage. Therefore, AI in Microsoft is partly monetized both directly and indirectly and participates in creating and increasing revenue for the company through increasing sales.[23]

3.5.3. Financial Data

Financial metrics in Table 5.1. represent quarterly financial results of Microsoft chosen on the same basis as for Alphabet (see **3.1.3. Financial data**, p.13).

Table 5.1. Financial data of n_1+n_2 period, Microsoft

Date	Quarter	Revenue, $Mil.	Gross Profit, $Mil.	R&D Expense, $Mil	Gross Profit adj. for R&D	EBIT, $Mil	Stock price$ adjusted
30.06.2020	Q2_2020	38.033	25.694	5.214	20.480	13.407	205,01
31.03.2020	Q1_2020	35.021	24.046	4.887	19.159	12.975	178,71
31.12.2019	Q4_2019	36.906	24.548	4.603	19.945	13.891	169,29
30.09.2019	Q3_2019	33.055	22.649	4.565	18.084	12.686	142,10
30.06.2019	Q2_2019	33.717	23.305	4.513	18.792	12.405	134,61
31.03.2019	Q1_2019	30.571	20.401	4.316	16.085	10.341	128,54
31.12.2018	Q4_2018	32.471	20.048	4.070	15.978	10.258	102,34
30.09.2018	Q3_2018	29.084	19.179	3.977	15.202	9.955	104,23
30.06.2018	Q2_2018	30.085	20.343	3.933	16.410	10.379	103,12
31.03.2018	Q1_2018	26.819	17.550	3.715	13.835	8.292	90,51
31.12.2017	Q4_2017	28.918	17.854	3.504	14.350	8.679	91,53
30.09.2017	Q3_2017	24.538	16.260	3.574	12.686	7.708	79,73
30.06.2017	Q2_2017	25.605	17.149	3.514	13.635	7.682	69,32
31.03.2017	Q1_2017	23.212	15.152	3.355	11.797	6.723	64,90
31.12.2016	Q4_2016	25.826	15.925	3.062	12.863	7.905	60,92
30.09.2016	Q3_2016	21.928	14.084	3.106	10.978	6.715	56,08
30.06.2016	Q2_2016	26.448	18.469	3.146	15.323	8.976	52,72
31.03.2016	Q1_2016	20.531	12.809	2.980	9.829	5.283	46,07
31.12.2015	Q4_2015	23.796	13.924	2.900	11.024	6.026	50,52
30.09.2015	Q3_2015	20.379	13.172	2.962	10.210	5.793	47,95
30.06.2015	Q2_2015	22.180	14.712	3.094	11.618	-2.053	42,26
31.03.2015	Q1_2015	21.729	14.568	2.984	11.584	6.594	43,74
31.12.2014	Q4_2014	26.470	16.334	2.903	13.431	7.776	36,07
30.09.2014	Q3_2014	23.201	14.928	3.065	11.863	5.844	41,66
30.06.2014	Q2_2014	23.382	15.749	3.123	12.626	6.482	38,06
31.03.2014	Q1_2014	20.403	14.425	2.743	11.682	6.974	35,37
31.12.2013	Q4_2013	24.519	16.197	2.748	13.449	7.969	32,88
30.09.2013	Q3_2013	18.529	13.384	2.767	10.617	6.334	30,54
30.06.2013	Q2_2013	19.896	14.158	2.783	11.375	6.073	27,27

[23] Microsoft, Microsoft Azure, Azure Cognitive Services, retrieved from https://azure.microsoft.com/ru-ru/services/cognitive-services/, accessed 23.10.2020

31.03.2013	Q1_2013	20.489	15.702	2.640	13.062	7.612	28,15
31.12.2012	Q4_2012	21.456	15.764	2.528	13.236	7.171	23,15
30.09.2012	Q3_2012	16.008	11.840	2.460	9.380	5.308	23,88
30.06.2012	Q2_2012	18.059	13.896	2.594	11.302	192	24,49
31.03.2012	Q1_2012	17.407	13.455	2.517	10.938	6.374	26,44
31.12.2011	Q4_2011	20.885	15.247	2.371	12.876	7.994	24,22
30.09.2011	Q3_2011	17.372	13.595	2.329	11.266	7.203	21,68
30.06.2011	Q2_2011	17.367	13.659	2.393	11.266	6.171	22,17
31.03.2011	Q1_2011	16.428	12.531	2.269	10.262	5.709	20,83
31.12.2010	Q4_2010	19.953	15.120	2.185	12.935	8.165	22,16
30.09.2010	Q3_2010	16.195	13.056	2.196	10.860	7.116	21,18
30.06.2010	Q2_2010	16.039	12.869	2.350	10.519	5.930	20,39
31.03.2010	Q1_2010	14.503	11.748	2.220	9.528	5.173	24,02
31.12.2009	Q4_2009	19.022	15.394	2.079	13.315	8.513	22,06
30.09.2009	Q3_2009	12.920	10.078	2.065	8.013	4.482	21,61
30.06.2009	Q2_2009	13.099	10.513	2.225	8.288	3.987	18,23
31.03.2009	Q1_2009	13.648	10.834	2.212	8.622	4.438	15,60
31.12.2008	Q4_2008	16.629	12.722	2.290	10.432	5.939	13,08
30.09.2008	Q3_2008	15.061	12.213	2.283	9.930	5.999	16,96
30.06.2008	Q2_2008	15.837	12.971	2.407	10.564	5.679	19,46
31.03.2008	Q1_2008	14.454	11.940	2.035	9.905	4.290	21,50
31.12.2007	Q4_2007	16.367	12.824	1.885	10.939	6.453	24,48
30.09.2007	Q3_2007	13.762	11.087	1.837	9.250	5.849	27,55
30.06.2007	Q2_2007	13.371	10.134	1.948	8.186	3.903	21,62
31.03.2007	Q1_2007	14.398	12.258	1.750	10.508	6.589	22,26
31.12.2006	Q4_2006	12.542	8.922	1.637	7.285	3.472	22,86
30.09.2006	Q3_2006	10.811	9.115	1.786	7.329	4.474	21,20
30.06.2006	Q2_2006	11.804	9.674	1.861	7.813	3.881	17,70
31.03.2006	Q1_2006	10.900	8.872	1.617	7.255	3.888	17,70

3.5.4. Regression analysis

The analysis is performed as in **3.1.4. Regression analysis** for Alphabet (see p.15). Table 5.2. represents the output.

Table 5.2. Regression analysis for n_1+n_2 period, Microsoft (Xi, Yi)

Revenue, Stock Price	
Regression Statistics	
Multiple R	0,9024737
R Square	0,8144588
Adjusted R Square	0,8111456
Standard Error	19,583487
Observations	58

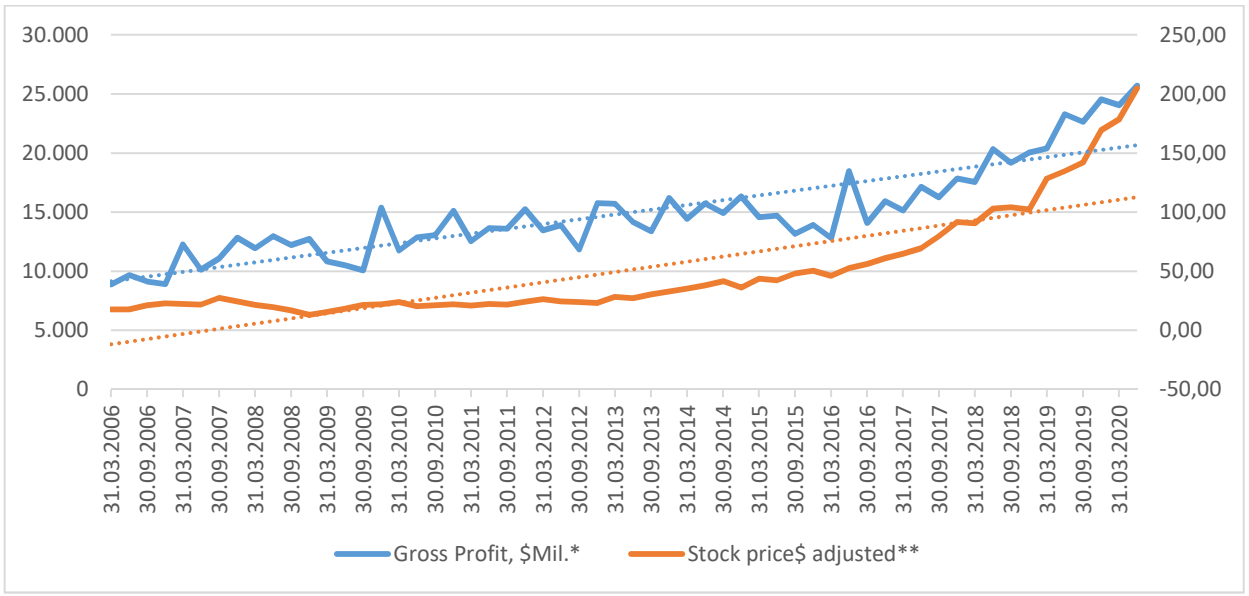
Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,9049989
R Square	0,8190231
Adjusted R Square	0,8157913
Standard Error	19,341113
Observations	58

adj. Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,8743335
R Square	0,7644591
Adjusted R Square	0,760253
Standard Error	22,064956
Observations	58

EBIT, Stock Price	
Regression Statistics	
Multiple R	0,7846452
R Square	0,6156681
Adjusted R Square	0,6088051
Standard Error	28,185325
Observations	58

Revenue, Gross Profit and Gross Profit adj. of Microsoft have a very strong correlation to Stock Price with a value of 0,9 lying above the 0,8 value of the coefficient of correlation, Multiple R. EBIT has a strong correlation to Stock Price. Revenue, Stock Price (X_i, Y_i) and Gross Profit, Stock Price (X_i, Y_i) both have the highest coefficient 0,9. Gross Profit, Stock Price (X_i, Y_i) is chosen for further analysis for better comparability with other analyzed companies. R Square or Coefficient of Determination returns a 0.82 value for Gross Profit, Stock Price (X_i, Y_i). This means that 82% of the variance in Stock Price is explained by fluctuations of Revenue and Gross Profit respectively. Values of Stock Price and Gross Profit are plotted on a graph for visual analysis. Figure 5.3. represents the relationship between Gross Profit and Stock Price graphically.

Figure 5.3 Relationship between Gross Profit and Stock Price, Microsoft



Blue and orange dotted lines represent trend lines for Gross Profit and Stock Price respectively. The graph shows that the development of Stock Price values over time is visually similar to the development of Gross Profit with trend lines being parallel.

Now, trends for periods $\mathbf{n_1}$, $\mathbf{n_2}$ separately are calculated. Based on the trend values in pre-AI period a forecast for the trend values in AI period is performed. Table 5.4. represents the output of this procedure.

Table 5.4. Gross Profit trend and forecasted trend values, Microsoft

Period	Date	Quarter	Trend (Gross Profit)	Forecasted Trend values
AI period	30.06.2020	Q2_2020	22.709	20.203
	31.03.2020	Q1_2020	22.336	20.021
	31.12.2019	Q4_2019	21.963	19.838
	30.09.2019	Q3_2019	21.589	19.654
	30.06.2019	Q2_2019	21.216	19.470
	31.03.2019	Q1_2019	20.843	19.288
	31.12.2018	Q4_2018	20.470	19.108
	30.09.2018	Q3_2018	20.096	18.924
	30.06.2018	Q2_2018	19.723	18.740
	31.03.2018	Q1_2018	19.350	18.558
	31.12.2017	Q4_2017	18.976	18.378
	30.09.2017	Q3_2017	18.603	18.194
	30.06.2017	Q2_2017	18.230	18.010
	31.03.2017	Q1_2017	17.857	17.827
	31.12.2016	Q4_2016	17.483	17.647
	30.09.2016	Q3_2016	17.110	17.463
	30.06.2016	Q2_2016	16.737	17.279
	31.03.2016	Q1_2016	16.363	17.097
	31.12.2015	Q4_2015	15.990	16.915
	30.09.2015	Q3_2015	15.617	16.731
	30.06.2015	Q2_2015	15.244	16.547
	31.03.2015	Q1_2015	14.870	16.365
	31.12.2014	Q4_2014	14.497	16.185
	30.09.2014	Q3_2014	14.124	16.000
	30.06.2014	Q2_2014	13.750	15.816
	31.03.2014	Q1_2014	13.377	15.634
	31.12.2013	Q4_2013	13.004	15.454
	30.09.2013	Q3_2013	12.631	15.270
	30.06.2013	Q2_2013	12.257	15.086
pre-AI period	31.03.2013	Q1_2013	14.904	
	31.12.2012	Q4_2012	14.721	
	30.09.2012	Q3_2012	14.539	
	30.06.2012	Q2_2012	14.356	
	31.03.2012	Q1_2012	14.173	
	31.12.2011	Q4_2011	13.990	
	30.09.2011	Q3_2011	13.808	
	30.06.2011	Q2_2011	13.625	

	31.03.2011	Q1_2011	13.442
	31.12.2010	Q4_2010	13.260
	30.09.2010	Q3_2010	13.077
	30.06.2010	Q2_2010	12.894
	31.03.2010	Q1_2010	12.711
	31.12.2009	Q4_2009	12.529
	30.09.2009	Q3_2009	12.346
	30.06.2009	Q2_2009	12.163
	31.03.2009	Q1_2009	11.981
	31.12.2008	Q4_2008	11.798
	30.09.2008	Q3_2008	11.615
	30.06.2008	Q2_2008	11.432
	31.03.2008	Q1_2008	11.250
	31.12.2007	Q4_2007	11.067
	30.09.2007	Q3_2007	10.884
	30.06.2007	Q2_2007	10.702
	31.03.2007	Q1_2007	10.519
	31.12.2006	Q4_2006	10.336
	30.09.2006	Q3_2006	10.153
	30.06.2006	Q2_2006	9.971
	31.03.2006	Q1_2006	9.788

3.5.5. H_0 testing

H_0 is tested by performing the same procedure as in **3.1.5. H_0 testing** for Alphabet (see p.18). The **T_{obs}** statistic for Microsoft is the observed mean average of Gross Profit in **n_2** (AI) period. Sample size is **n_1=n_2**=29 for Microsoft. Table 5.5. represents the output of this test.

Table 5.5. H_0 test output, Microsoft

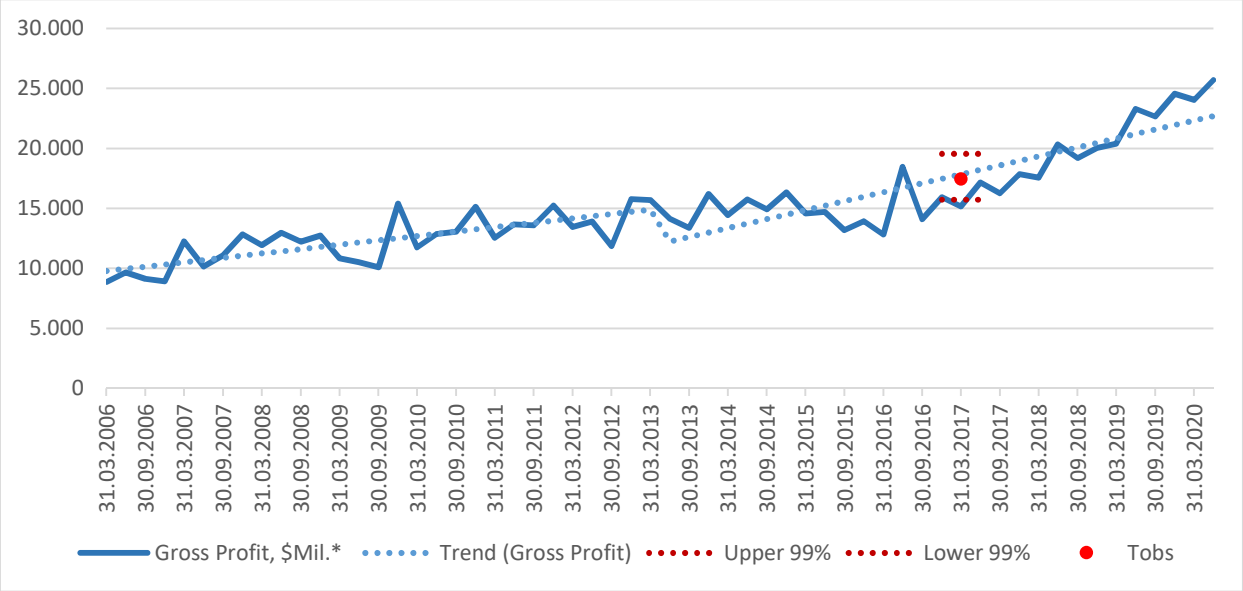
Period	Mean	SD	EB	CI	Tobs	H0	Upper or Lower
pre-AI	17.483	3723,80	1910,78		17.483	Cannot be rejected	-
AI forecasted	17.645	n/a		lower 15.734 upper 19.556			-
AI observed	17.483	3723,80					

The value of **T_{obs}** falls within the CI, therefore **H_0** cannot be rejected for Microsoft. For a detailed description of the output see **3.1.5. H_0 testing** for Alphabet (p.19).

Furtherly, results of the test are plotted on a graph. Upper and lower bounds of the Confidence Interval are represented as red dotted lines for better visibility, basically, these are two points.

Figure 5.6. represents the H_0 test output graphically together with the Gross Profit and its trend in both periods.

Figure 5.6. Observed Gross Profit, T_{obs} and Confidence Interval for the forecasted mean, Microsoft



As the next step, regression analysis is performed for Gross Profit, Stock Price **(X_i, Y_i)** for each period separately. Table 5.7. represents the output of regression analysis.

Table 5.7. Regression analysis for periods n_1 and n_2 separately. Gross Profit, Stock Price (X_i,Y_i), Microsoft

pre-AI period	
Regression Statistics	
Multiple R	0,36745255
R Square	0,13502138
Adjusted R Square	0,10298513
Standard Error	3,20409761
Observations	29

AI period	
Regression Statistics	
Multiple R	0,9398413
R Square	0,8833017
Adjusted R Square	0,8789795
Standard Error	16,992134
Observations	29

In n_1 (pre-AI) period multiple R of 0,37 and R Square of 0,14 represent weak 37% correlation between Gross Profit and Stock Price with 14% of the variance in Stock Price being explained by fluctuations of Revenue. In n_2 (AI) period, multiple R increased to 0,94 and R Square to 0,88 representing a very strong 94% correlation.

3.5.6. Results

For Microsoft, the strongest correlation has been found between its Revenue/ Gross Profit and Stock Price. Results of the analysis show that financial results in AI period are not significantly different from the results of forecasted values based on the observed data of pre-AI period. Actual results are within the 99% confidence interval, therefore $\mathbf{H_0}$ cannot be rejected for Microsoft. Further conclusions considering market performance (**MC**s) are not applicable when $\mathbf{H_0}$ cannot be rejected, as for Microsoft the correlation between Stock Price and Gross Profit is very strong in AI period, which implies that Stock Prices develop insignificantly different from the forecasted development, same as Gross Profit.

The correlation between Gross Profit and Stock Price in AI period has changed to very strong compared to weak in pre-AI period. As the correlation with Stock Price is also strong to very strong for all financial metrics, the following conclusion is made for Microsoft:

$\mathbf{C_1}$ Stock Prices are in line with financial results and its fluctuations are explained by financial results to a high extent**.**

3.6. Apple Inc.

3.6.1. General information

Apple Inc. (in further text – Apple) is an IT company producing both computer and mobile hardware and software[24] with headquarters in California, USA. The market capitalization of Apple as of 24.10.2020 is $1.991 trillion.[25] First AI acquisition by Apple apparently took place in 2013, when Novauris, a company focused on speech recognition, was acquired with exact date being unknown. Apple reported this acquisition on April 4th, 2014[26] and this date marks the start of AI period for Apple in this study. The goal of this acquisition was to empower Apple's virtual assistant Siri. Siri was considered a preprogrammed "weak AI" and its participation in the business of Apple is not considered AI-based before 2014. Thus, AI period for Apple starts from Q2 2014 to Q2 2020 and pre-AI is marked from Q1 2008 to Q1 2014, implying $\mathbf{n_1}$=$\mathbf{n_2}$=25.

[24] Apple, Apple at Work, retrieved from https://www.apple.com/business/, accessed 24.10.2020
[25] Yahoo! Finance, AAPL, retrieved from https://finance.yahoo.com/quote/AAPL?p=AAPL&.tsrc=fin-srch, accessed 23.10.2020
[26] Sarah Perez, Tech Crunch, 2014, Speech Recognition Pioneer Novauris Bought By Apple, Team Now Works On Siri, retrieved from https://techcrunch.com/2014/04/03/speech-recognition-pioneer-novauris-bought-by-apple-team-now-works-on-siri/, accessed 23.10.2020

3.6.2. AI Implementation and Monetization

AI is used in a variety of ways in products of Apple that are directly sold, thus being directly monetized. Apple doesn't disclose a lot of information to its AI implementation, but is reported to use AI in the IPhone, Apple Watch and IPad, which are all directly sold products. [27]

3.6.3. Financial Data

Financial metrics in Table 3.1. represent quarterly financial results of Apple chosen on the same basis as for Alphabet (see **3.1.3. Financial data**, p.13). Financial data of Apple is subject to seasonality, for this reason smoothing is performed and an additional column Revenue TFQ (Trailing Four Quarters) is introduced. Table 6.1. represents the financial data of Apple.

Table 6.1. Financial data of n_1+n_2 period, Apple

Date	Quarter	Revenue, $Mil.	Gross Profit, $Mil.	Revenue TFQ	R&D Exp., $Mil	Gross Profit adj., $Mil.	EBIT, $Mil	Stock price$ adj.
30.06.2020	Q2_2020	59.685	22.680	68.464	4.758	17.922	13.091	424,28
31.03.2020	Q1_2020	58.313	22.370	66.995	4.565	17.805	12.853	292,48
31.12.2019	Q4_2019	91.819	35.217	66.921	4.451	30.766	25.569	307,39
30.09.2019	Q3_2019	64.040	24.313	65.044	4.110	20.203	15.625	246,32
30.06.2019	Q2_2019	53.809	20.227	64.759	4.257	15.970	11.544	210,15
31.03.2019	Q1_2019	58.015	21.821	64.623	3.948	17.873	13.415	197,19
31.12.2018	Q4_2018	84.310	32.031	65.403	3.902	28.129	23.346	162,85
30.09.2018	Q3_2018	62.900	24.084	66.399	3.750	20.334	16.118	213,40
30.06.2018	Q2_2018	53.265	20.421	63.819	3.701	16.720	12.612	184,89
31.03.2018	Q1_2018	61.137	23.422	61.854	3.378	20.044	15.894	159,96
31.12.2017	Q4_2017	88.293	33.912	59.794	3.407	30.505	26.274	161,40
30.09.2017	Q3_2017	52.579	19.931	57.309	2.997	16.934	13.120	162,37
30.06.2017	Q2_2017	45.408	17.488	55.877	2.937	14.551	10.768	142,30
31.03.2017	Q1_2017	52.896	20.591	55.114	2.776	17.815	14.097	136,87
31.12.2016	Q4_2016	78.351	30.176	54.530	2.871	27.305	23.359	115,13
30.09.2016	Q3_2016	46.852	17.813	53.910	2.570	15.243	11.761	107,17
30.06.2016	Q2_2016	42.358	16.106	55.072	2.560	13.546	10.105	97,83
31.03.2016	Q1_2016	50.557	19.921	56.884	2.511	17.410	13.987	87,47
31.12.2015	Q4_2015	75.872	30.423	58.747	2.404	28.019	24.171	90,34
30.09.2015	Q3_2015	51.501	20.548	58.429	2.220	18.328	14.623	110,43
30.06.2015	Q2_2015	49.605	19.681	56.084	2.034	17.647	14.083	111,59
31.03.2015	Q1_2015	58.010	23.656	53.041	1.918	21.738	18.278	114,65

[27] Samuel Axon, arstechnica, Here's why Apple believes it's an AI leader—and why it says critics have it all wrong, 2020, retrieved from https://arstechnica.com/gadgets/2020/08/apple-explains-how-it-uses-machine-learning-across-ios-and-soon-macos/#h2, accessed 23.10.2020

31.12.2014	Q4_2014	74.599	29.741	49.950	1.895	27.846	24.246	106,91
30.09.2014	Q3_2014	42.123	16.009	45.699	1.686	14.323	11.165	98,13
30.06.2014	Q2_2014	37.432	14.735	44.536	1.603	13.132	10.282	86,43
31.03.2014	Q1_2014	45.646	17.947	44.009	1.422	16.525	13.593	75,79
31.12.2013	Q4_2013	57.594	21.846	43.498	1.330	20.516	17.463	63,91
30.09.2013	Q3_2013	37.472	13.871	42.728	1.168	12.703	10.030	66,35
30.06.2013	Q2_2013	35.323	13.024	42.351	1.178	11.846	9.201	57,06
31.03.2013	Q1_2013	43.603	16.349	42.276	1.119	15.230	12.558	55,47
31.12.2012	Q4_2012	54.512	21.060	41.172	1.010	20.050	17.210	56,73
30.09.2012	Q3_2012	35.966	14.401	39.127	906	13.495	10.944	73,81
30.06.2012	Q2_2012	35.023	14.994	37.203	876	14.118	11.573	75,40
31.03.2012	Q1_2012	39.186	18.564	35.590	841	17.723	15.384	72,09
31.12.2011	Q4_2011	46.333	20.703	31.960	758	19.945	17.340	56,35
30.09.2011	Q3_2011	28.270	11.380	27.062	645	10.735	8.710	49,97
30.06.2011	Q2_2011	28.571	11.922	25.081	628	11.294	9.379	48,20
31.03.2011	Q1_2011	24.667	10.218	21.863	581	9.637	7.874	43,22
31.12.2010	Q4_2010	26.741	10.298	19.071	575	9.723	7.827	41,89
30.09.2010	Q3_2010	20.343	7.512	16.306	494	7.018	5.447	37,16
30.06.2010	Q2_2010	15.700	6.136	14.272	464	5.672	4.234	31,76
31.03.2010	Q1_2010	13.499	5.625	12.781	426	5.199	3.979	32,23
31.12.2009	Q4_2009	15.683	6.411	11.677	398	6.013	4.725	23,71
30.09.2009	Q3_2009	12.207	5.105	10.726	358	4.747	3.684	23,27
30.06.2009	Q2_2009	9.734	3.983	10.901	341	3.642	2.632	20,17
31.03.2009	Q1_2009	9.084	3.627	10.334	319	3.308	2.323	15,53
31.12.2008	Q4_2008	11.880	4.507	9.941	315	4.192	3.101	11,13
30.09.2008	Q3_2008	12.907	4.791	9.373	298	4.493	3.494	13,28
30.06.2008	Q2_2008	7.464	2.600	7.843	292	2.308	1.392	19,62
31.03.2008	Q1_2008	7.512	2.474	7.330	273	2.201	1.315	21,47

3.6.4. Regression analysis

The analysis is performed as in **3.1.4. Regression analysis** for Alphabet (see p.15). Table 6.2. represents the output.

Table 6.2. Regression analysis for n_1+n_2 period, Apple (Xi, Yi)

Revenue , Stock Price	
Regression Statistics	
Multiple R	0,6979061
R Square	0,4870729
Adjusted R Square	0,4763869
Standard Error	61,841291
Observations	50

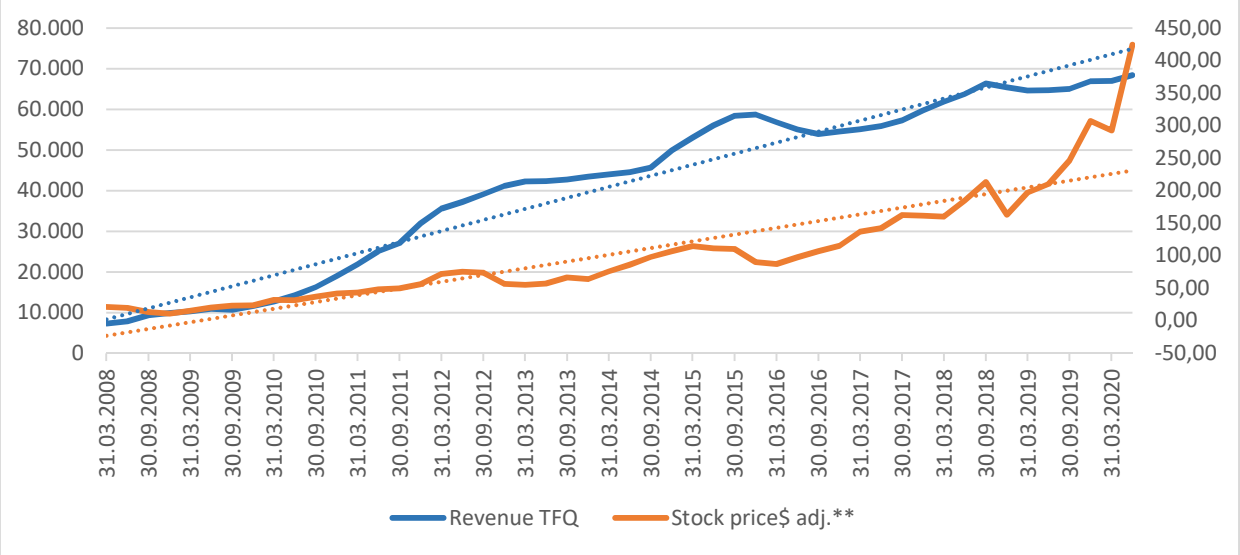
Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,6757039
R Square	0,4565758
Adjusted R Square	0,4452545
Standard Error	63,653194
Observations	50

adj. Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,5962069
R Square	0,3554627
Adjusted R Square	0,3420348
Standard Error	69,322584
Observations	50

EBIT, Stock Price	
Regression Statistics	
Multiple R	0,5245719
R Square	0,2751757
Adjusted R Square	0,2600752
Standard Error	73,513499
Observations	50

Revenue and Gross Profit of Apple have strong correlation with Stock Price with the coefficient of correlation lying in a 0,6-0,79 range. Revenue, Stock Price (X_i, Y_i) has the highest coefficient of correlation with a value of 0,7 implying 70% correlation between Revenue and Stock Price. R Square or coefficient of determination returns the value of 0,49 for Revenue, Stock Price (X_i, Y_i). This means that 49% of the variance in Stock Price is explained by Revenue fluctuations. Values of Stock Price and Revenue are plotted on a graph for visual analysis. As Apple's financial data is subject to seasonality, smoothing over trailing four quarters was performed for this graph (Revenue TFQ is represented instead of actual Revenue). Figure 6.3. represents the relationship between Gross Profit and Stock Price graphically.

Figure 6.3. Relationship between Revenue TFQ and Stock Price, Apple



Blue and orange dotted lines represent trend lines for Revenue and Stock Price respectively. The graph shows that the development of Revenue TFQ values over time is not visually similar to the development of Stock Price values, with the trend of Stock Price having a lower slope but a big upward spike towards last periods.

Now, trends for periods n_1, n_2 separately are calculated. Based on the trend values in pre-AI period a forecast for the trend values in AI period is performed.

Table 6.4. Gross Profit trend and forecasted trend values, Apple

Period	Date	Quarter	Trend (Revenue)	Forecasted Trend values
AI period	30.06.2020	Q2_2020	68.696	98.355
	31.03.2020	Q1_2020	67.950	96.433
	31.12.2019	Q4_2019	67.205	94.511
	30.09.2019	Q3_2019	66.459	92.568
	30.06.2019	Q2_2019	65.714	90.624
	31.03.2019	Q1_2019	64.968	88.702
	31.12.2018	Q4_2018	64.222	86.801
	30.09.2018	Q3_2018	63.477	84.858
	30.06.2018	Q2_2018	62.731	82.914
	31.03.2018	Q1_2018	61.986	80.992
	31.12.2017	Q4_2017	61.240	79.091
	30.09.2017	Q3_2017	60.495	77.148
	30.06.2017	Q2_2017	59.749	75.205
	31.03.2017	Q1_2017	59.004	73.283
	31.12.2016	Q4_2016	58.258	71.381
	30.09.2016	Q3_2016	57.513	69.438
	30.06.2016	Q2_2016	56.767	67.495
	31.03.2016	Q1_2016	56.021	65.573
	31.12.2015	Q4_2015	55.276	63.651
	30.09.2015	Q3_2015	54.530	61.707
	30.06.2015	Q2_2015	53.785	59.764
	31.03.2015	Q1_2015	53.039	57.842
	31.12.2014	Q4_2014	52.294	55.941
	30.09.2014	Q3_2014	51.548	53.998
	30.06.2014	Q2_2014	50.803	52.054
pre-AI period	31.03.2014	Q1_2014	50.137	
	31.12.2013	Q4_2013	48.209	
	30.09.2013	Q3_2013	46.280	
	30.06.2013	Q2_2013	44.352	
	31.03.2013	Q1_2013	42.424	
	31.12.2012	Q4_2012	40.495	
	30.09.2012	Q3_2012	38.567	
	30.06.2012	Q2_2012	36.639	
	31.03.2012	Q1_2012	34.710	
	31.12.2011	Q4_2011	32.782	
	30.09.2011	Q3_2011	30.854	

	30.06.2011	Q2_2011	28.925
	31.03.2011	Q1_2011	26.997
	31.12.2010	Q4_2010	25.068
	30.09.2010	Q3_2010	23.140
	30.06.2010	Q2_2010	21.212
	31.03.2010	Q1_2010	19.283
	31.12.2009	Q4_2009	17.355
	30.09.2009	Q3_2009	15.427
	30.06.2009	Q2_2009	13.498
	31.03.2009	Q1_2009	11.570
	31.12.2008	Q4_2008	9.642
	30.09.2008	Q3_2008	7.713
	30.06.2008	Q2_2008	5.785
	31.03.2008	Q1_2008	3.857

3.6.5. H_0 testing

H_0 is tested by performing the same procedure as in **3.1.5. H_0 testing** for Alphabet (see p.18). The **T_{obs}** statistic for Apple is the observed mean average of Revenue in **n_2** (AI) period. Sample size is **n_1**=**n_2**=25. Table 6.5. represents the output of **H_0** testing.

Table 6.5. H_0 test output, Apple

Period	Mean	SD	EB	CI	Tobs	H0	Upper or Lower
pre-AI	26.997	15385	8606,17		59.749	Rejected	-
AI forecasted	75.213	n/a		lower 66.607 upper 83.819			Lower
AI observed	59.749	14756					

.

The value of **T_{obs}** falls outside of the CI in the lower critical region, therefore **H_0** is rejected for Apple. For a detailed description of the output see **3.1.5. H_0 testing** for Alphabet (p.19).

Furtherly, results of the test are plotted on a graph. Upper and lower bounds of the Confidence Interval are represented as red dotted lines for better visibility, basically, these are two points. Figure 6.6. represents the **H_0** test output graphically together with the observed Revenue and its trend in both periods.

Figure 6.6. Revenue, T_{obs} and Confidence Interval for the forecasted mean, Apple

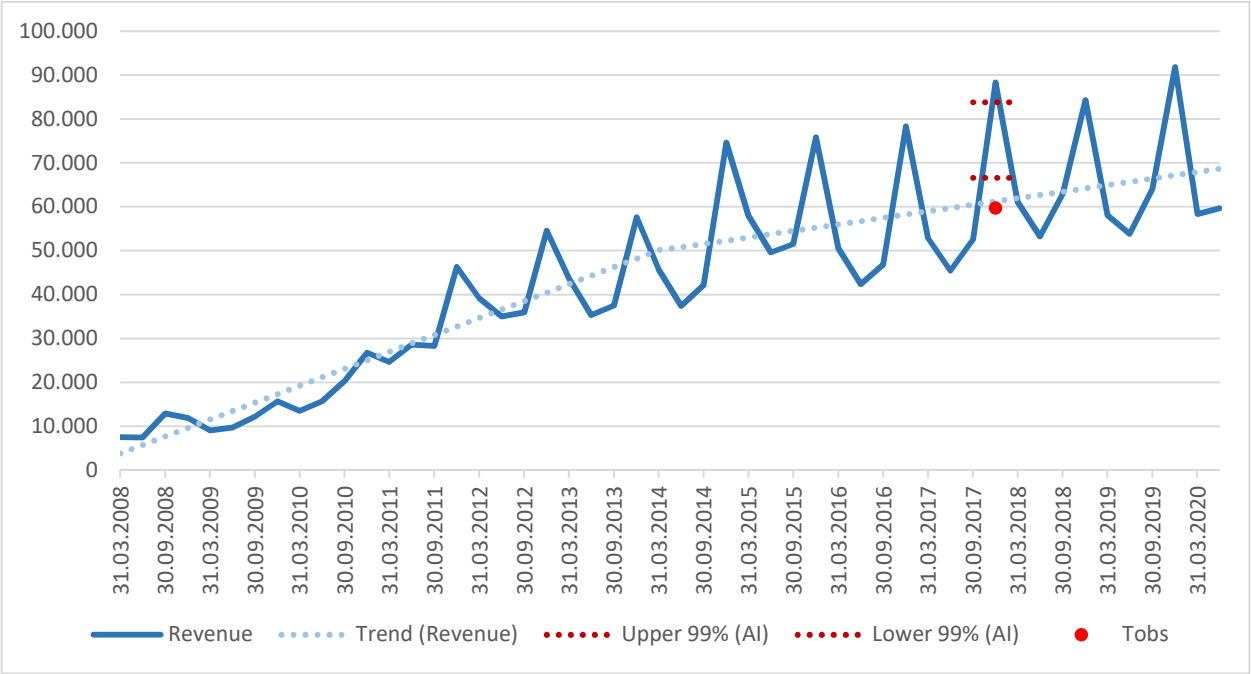


Table 6.7. Regression analysis for periods n_1 and n_2 separately. Revenue TFQ, Stock Price (X_i,Y_i), Apple

pre-AI period	
Regression Statistics	
Multiple R	0,93439615
R Square	0,87309616
Adjusted R Square	0,86757861
Standard Error	7,76148633
Observations	25

AI period	
Regression Statistics	
Multiple R	0,7782098
R Square	0,6056105
Adjusted R Square	0,5884631
Standard Error	52,680684
Observations	25

In **n_1** (pre-AI) period multiple R of 0,93 and R Square of 0,87 represent a very strong 93% correlation between Revenue TFQ and Stock Price with 87% of the variance in Stock Price being explained by fluctuations of Revenue TFQ. In AI period multiple R decreased to 0,78 and R Square to 0,6 representing a strong 78% correlation.

3.6.6. Results

For Apple, the strongest correlation has been found between its Revenue and Stock Price. Line smoothing over trailing four quarters was performed and this correlation for Revenue TFQ and Stock Price was found to be very strong in pre-AI period and strong in AI period. Results of the analysis show that financial results in AI period are significantly different from pre-AI values with the **T_{obs}** value falling below the lower bound the 99% CI. Therefore, **H_0** for Apple is rejected. Further conclusions considering market and financial performance are made:

FC_2 Financial performance of Apple is significantly worse in AI period compared to forecasted values based on pre-AI period

Visual and numerical analysis (Figures 6.6., 6.1) shows that the development of Stock Price declines notably upwards in AI period. As Stock Price is not subject to reliable forecasting, the observed values cannot be compared with the forecast and no statistically meaningful statements can be made to whether Stock Price development in AI period is significantly better. It can be stated, however, that Stock Price increased to 560% in the last quarter of AI period compared to the last quarter of pre-AI period.

The coefficient of correlation has decreased from very strong 93% in pre-AI period to strong 78% for Revenue TFQ and Stock Price in AI period. As the correlation between Revenue and Stock Price is strong for the whole observed **(n_1+n_2)** period and is strong in AI period for Revenue TFQ and Stock Price, it is concluded:

C_1 Stock Prices are in line with financial results and its fluctuations are explained by financial results to a high extent.

3.7. IBM

3.7.1. General information

IBM (International Business Machines) is a company located in Armonk, New York, USA. IBM is one of the biggest computer manufacturers in USA[28] with $103.307 billion in The market capitalization as of 24.10.2020.[29] IBM announced the acquisition of an AI startup Cognea on May 19th, 2014. Thus, AI period is marked starting from Q2 2014 to Q2 2020 and pre-AI is marked from Q1 2008 to Q1 2014, implying **n_1=n_2**=25.

[28] Encyclopedia Britannica, IBM, retrieved from https://www.britannica.com/topic/International-Business-Machines-Corporation, accessed 24.10.2020

[29] Yahoo! Finance, IBM, retrieved from https://finance.yahoo.com/quote/IBM?p=IBM&.tsrc=fin-srch, accessed 23.10.2020

3.7.2. AI Implementation and Monetization

IBM monetizes AI directly through a paid subscription to cloud services of its supercomputer IBM Watson. The company also offers free subscription for this services with capacity constraints,[30] so AI in IBM is, to some extent, directly monetized.

3.7.3. Financial Data

Financial metrics in Table 7.1. represent quarterly financial results of IBM chosen on the same basis as for Alphabet (see 3.1.3. Financial data, p.13)

Table 7.1. Financial data of n_1+n_2 period, IBM

Date	Quarter	Revenue, $Mil.	Gross Profit, $Mil.	R&D Expense, $Mil	Gross Profit adj. for R&D	EBIT, $Mil	Stock price$ adjusted
30.06.2020	Q2_2020	18.123	8.699	1.582	7.117	1.869	121,35
31.03.2020	Q1_2020	17.571	7.923	1.625	6.298	343	122,30
31.12.2019	Q4_2019	21.776	11.099	1.596	9.503	4.070	138,55
30.09.2019	Q3_2019	18.028	8.336	1.553	6.783	1.759	127,40
30.06.2019	Q2_2019	19.161	9.011	1.407	7.604	2.148	139,58
31.03.2019	Q1_2019	18.182	8.043	1.433	6.610	1.919	130,53
31.12.2018	Q4_2018	21.760	10.688	1.358	9.330	4.629	123,64
30.09.2018	Q3_2018	18.756	8.804	1.252	7.552	3.189	104,84
30.06.2018	Q2_2018	20.003	9.199	1.364	7.835	2.978	130,23
31.03.2018	Q1_2018	19.072	8.246	1.405	6.841	1.396	128,82
31.12.2017	Q4_2017	22.542	11.048	1.379	9.669	4.655	144,06
30.09.2017	Q3_2017	19.153	8.982	1.291	7.691	3.085	134,23
30.06.2017	Q2_2017	19.289	8.968	1.436	7.532	2.499	124,74
31.03.2017	Q1_2017	18.155	7.945	1.484	6.461	1.434	136,87
31.12.2016	Q4_2016	21.771	11.116	1.406	9.710	4.934	147,85
30.09.2016	Q3_2016	19.226	9.013	1.397	7.616	2.884	129,03
30.06.2016	Q2_2016	20.238	9.702	1.465	8.237	2.888	133,69
31.03.2016	Q1_2016	18.684	8.686	1.458	7.228	1.216	119,17
31.12.2015	Q4_2015	22.058	11.406	1.362	10.044	4.886	100,87
30.09.2015	Q3_2015	19.280	9.436	1.287	8.149	3.418	112,18
30.06.2015	Q2_2015	20.813	10.390	1.300	9.090	3.911	128,65
31.03.2015	Q1_2015	19.590	9.452	1.298	8.154	2.792	133,99
31.12.2014	Q4_2014	24.113	12.862	1.320	11.542	5.508	119,09
30.09.2014	Q3_2014	22.397	10.874	1.354	9.520	4.239	126,83
30.06.2014	Q2_2014	24.047	12.043	1.361	10.682	5.089	147,00
31.03.2014	Q1_2014	22.236	10.628	1.402	9.226	2.954	149,81
31.12.2013	Q4_2013	26.697	14.444	1.195	13.249	7.315	133,99

[30] IBM, AI Services, retrieved from https://cloud.ibm.com/catalog?category=ai#services, accessed 23.10.2020

30.09.2013	Q3_2013	23.338	11.430	1.356	10.074	4.814	135,18
30.06.2013	Q2_2013	24.924	12.132	1.548	10.584	3.904	146,39
31.03.2013	Q1_2013	23.408	10.678	1.644	9.034	3.457	151,31
31.12.2012	Q4_2012	27.671	15.229	1.094	14.135	8.303	151,07
30.09.2012	Q3_2012	24.747	11.732	1.534	10.198	4.290	144,08
30.06.2012	Q2_2012	25.783	12.281	1.587	10.694	4.857	144,54
31.03.2012	Q1_2012	24.673	11.119	1.601	9.518	3.632	152,09
31.12.2011	Q4_2011	29.486	14.723	1.556	13.167	7.091	140,91
30.09.2011	Q3_2011	26.157	12.173	1.546	10.627	4.965	134,54
30.06.2011	Q2_2011	26.666	12.384	1.569	10.815	4.785	131,93
31.03.2011	Q1_2011	24.607	10.858	1.587	9.271	3.445	123,21
31.12.2010	Q4_2010	29.018	14.226	1.578	12.648	6.698	116,55
30.09.2010	Q3_2010	24.271	11.001	1.464	9.537	4.388	102,85
30.06.2010	Q2_2010	23.724	10.810	1.475	9.335	4.274	91,51
31.03.2010	Q1_2010	22.857	9.976	1.509	8.467	2.790	91,47
31.12.2009	Q4_2009	27.231	13.147	1.460	11.687	6.127	86,40
30.09.2009	Q3_2009	23.566	10.628	1.446	9.182	4.169	84,74
30.06.2009	Q2_2009	23.250	10.581	1.434	9.147	4.032	82,49
31.03.2009	Q1_2009	21.711	9.430	1.480	7.950	2.686	71,82
31.12.2008	Q4_2008	27.006	12.936	1.529	11.407	5.574	63,43
30.09.2008	Q3_2008	25.302	10.959	1.579	9.380	3.736	63,99
30.06.2008	Q2_2008	26.820	11.600	1.660	9.940	3.651	87,74
31.03.2008	Q1_2008	24.502	10.166	1.569	8.597	2.977	82,41

3.7.4. Regression analysis

The analysis is performed as in **3.1.4. Regression analysis** for Alphabet (see p.15). Table 7.2. represents the output of regression analysis for each of financial metrics.

Table 7.2. Regression analysis for n_1+n_2 period, IBM (Xi, Yi)

Revenue, Stock Price	
Regression Statistics	
Multiple R	0,13642548
R Square	0,01861191
Adjusted R Square	-0,0018337
Standard Error	24,1937074
Observations	50

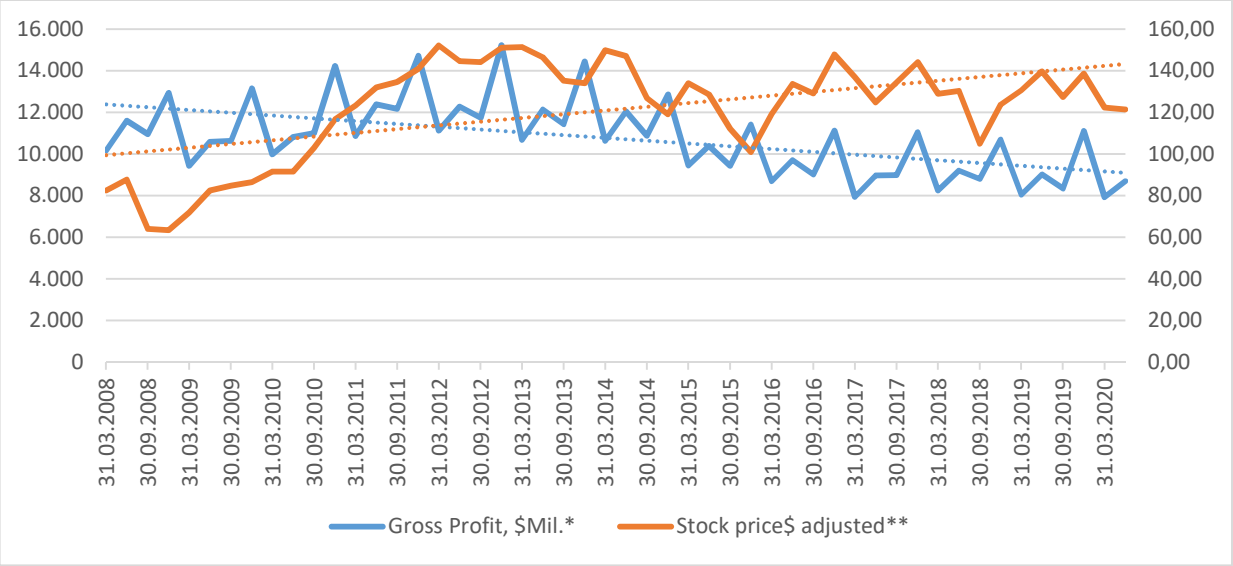
Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,05242676
R Square	0,00274857
Adjusted R Square	-0,0180275
Standard Error	24,3884594
Observations	50

adj. Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,06335926
R Square	0,0040144
Adjusted R Square	-0,0167353
Standard Error	24,3729762
Observations	50

EBIT, Stock Price	
Regression Statistics	
Multiple R	0,03995754
R Square	0,00159661
Adjusted R Square	-0,0192035
Standard Error	24,4025414
Observations	50

All financial metrics of IBM have no correlation with Stock Price with the coefficient of correlation being below 0,19 for all of them. Gross Profit is chosen for further analysis for comparability with other investigated companies. Values of Stock Price and Gross Profit are plotted on a graph for visual analysis. Figure 7.3. represents the relationship between Gross Profit and Stock Price graphically.

Figure 7.3 Relationship between Gross Profit and Stock Price, IBM



Blue and orange dotted lines represent trend lines for Gross Profit and Stock Price respectively. The graph shows that the development of Stock Price values over time is visually different from the development of Gross Profit with trend lines being going in opposite directions. As also seen on the graph, financial metrics of IBM are subject to seasonality. For this reason smoothing over trailing 4 quarters was attempted, whereas moving averages for trailing four quarters instead of actual values were plotted, but this procedure didn't affect the results of the regression analysis with the coefficient of correlation also being below 0,19, and further analysis is performed without smoothing.

Now, trends for periods $\mathbf{n_1}$, $\mathbf{n_2}$ separately are calculated using the least squares method. Based on the trend values in pre-AI period a forecast for the trend values in AI period is performed. Table 7.4. represents the output of this procedure.

Table 7.4. Gross Profit trend and forecasted trend values, IBM

Period	Date	Quarter	Trend (Gross Profit)	Forecasted Trend values
AI period	30.06.2020	Q2_2020	8.496	14.180
	31.03.2020	Q1_2020	8.594	14.116
	31.12.2019	Q4_2019	8.693	14.051
	30.09.2019	Q3_2019	8.791	13.987
	30.06.2019	Q2_2019	8.890	13.922
	31.03.2019	Q1_2019	8.989	13.858
	31.12.2018	Q4_2018	9.087	13.795
	30.09.2018	Q3_2018	9.186	13.730
	30.06.2018	Q2_2018	9.284	13.665
	31.03.2018	Q1_2018	9.383	13.601
	31.12.2017	Q4_2017	9.482	13.538
	30.09.2017	Q3_2017	9.580	13.473
	30.06.2017	Q2_2017	9.679	13.408
	31.03.2017	Q1_2017	9.777	13.344
	31.12.2016	Q4_2016	9.876	13.281
	30.09.2016	Q3_2016	9.975	13.216
	30.06.2016	Q2_2016	10.073	13.151
	31.03.2016	Q1_2016	10.172	13.087
	31.12.2015	Q4_2015	10.270	13.023
	30.09.2015	Q3_2015	10.369	12.958
	30.06.2015	Q2_2015	10.468	12.893
	31.03.2015	Q1_2015	10.566	12.829
	31.12.2014	Q4_2014	10.665	12.766
	30.09.2014	Q3_2014	10.763	12.701
	30.06.2014	Q2_2014	10.862	12.637
pre-AI period	31.03.2014	Q1_2014	12.696	
	31.12.2013	Q4_2013	12.623	
	30.09.2013	Q3_2013	12.549	
	30.06.2013	Q2_2013	12.475	
	31.03.2013	Q1_2013	12.401	
	31.12.2012	Q4_2012	12.327	
	30.09.2012	Q3_2012	12.254	
	30.06.2012	Q2_2012	12.180	
	31.03.2012	Q1_2012	12.106	
	31.12.2011	Q4_2011	12.032	
	30.09.2011	Q3_2011	11.958	
	30.06.2011	Q2_2011	11.885	
	31.03.2011	Q1_2011	11.811	
	31.12.2010	Q4_2010	11.737	
	30.09.2010	Q3_2010	11.663	
	30.06.2010	Q2_2010	11.589	

	31.03.2010	Q1_2010	11.516
	31.12.2009	Q4_2009	11.442
	30.09.2009	Q3_2009	11.368
	30.06.2009	Q2_2009	11.294
	31.03.2009	Q1_2009	11.221
	31.12.2008	Q4_2008	11.147
	30.09.2008	Q3_2008	11.073
	30.06.2008	Q2_2008	10.999
	31.03.2008	Q1_2008	10.925

3.7.5. H_0 testing

H_0 is tested by performing the same procedure as in **3.1.5. H_0 testing** for Alphabet (see p.18). The **T_{obs}** statistic for IBM is the observed mean average of Gross Profit in **n_2** (AI) period. Sample size is **n_1**=**n_2**=25 for IBM. Table 7.5. represents the output of the testing procedure.

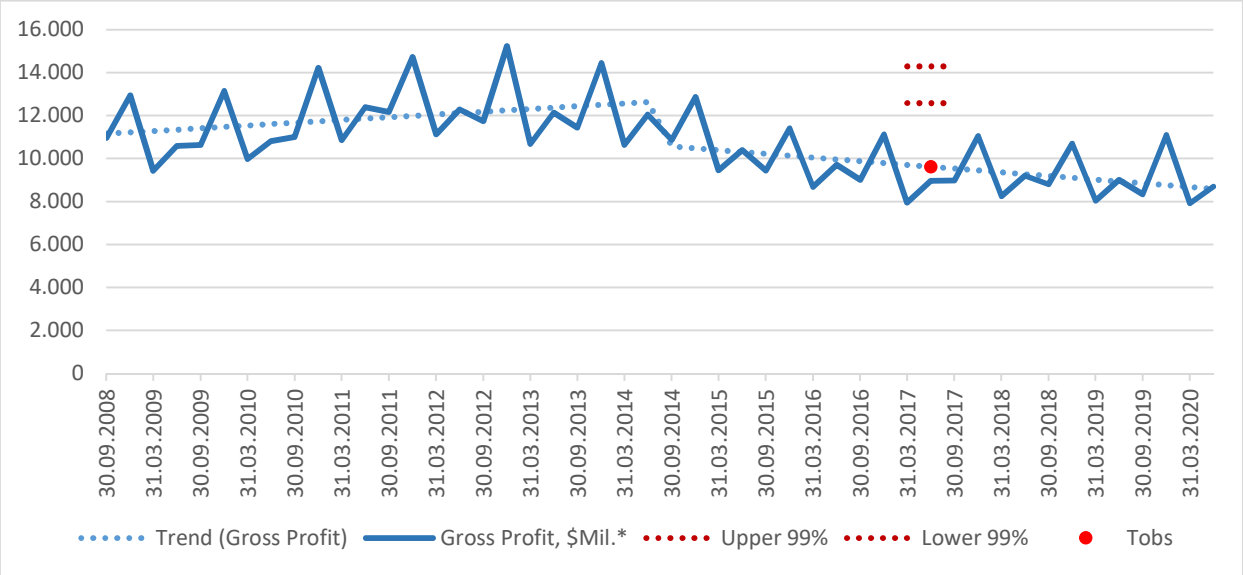
Table 7.5. H_0 test output, IBM

Period	Mean	SD	EB	CI		Tobs	H0	Upper or Lower
pre-AI	11.820	1555,45						-
AI forecasted	13.408	n/a	870,10	lower upper	12.538 14.278	9.679	Rejected	Lower
AI observed	9.679	1371,86						

The value of **T_{obs}** falls below the lower bound of the CI, therefore **H_0** is rejected for IBM. For a detailed description of the output see **3.1.5. H_0 testing** for Alphabet (p.19).

Results of the test are plotted on a graph. Upper and lower bounds of the Confidence Interval are represented as red dotted lines for better visibility, basically, these are two points. Figure 7.6. represents the **H_0** test output graphically together with the observed Gross Profit and its trend in both periods.

Figure 7.6. Observed Gross Profit, T_{obs} and Confidence Interval for the forecasted mean, IBM



As the next step, regression analysis is performed for Revenue, Stock Price **(X_i, Y_i)** for each period separately. Table 7.7. represents the output of regression analysis.

Table 7.7. Regression analysis for periods n_1 and n_2 separately. Gross Profit, Stock Price (X_i,Y_i), IBM

pre-AI period	
Regression Statistics	
Multiple R	0,370875759
R Square	0,137548828
Adjusted R Square	0,100050951
Standard Error	29,4046717
Observations	25

AI period	
Regression Statistics	
Multiple R	0,121803673
R Square	0,014836135
Adjusted R Square	-0,027997077
Standard Error	11,7887363
Observations	25

In **n_1** (pre-AI) period multiple R of 0,37 and R Square of 0,14 represent a weak 37% correlation between Gross Profit and Stock Price with 14% of the variance in Stock Price being explained by fluctuations of Gross Profit. In **n_2** (AI) period multiple R of 0,12 and R Square of 0,01 represent no correlation between Gross Profit and Stock Price.

3.7.6. Results

For IBM, no correlation has been found between its financial metrics and Stock Price over **n_1+n_2** period. Results of the analysis show that financial results in AI period are significantly worse compared to pre-AI values with the **T_{obs}** being below the 99% CI. Therefore, **H_0** for IBM is rejected with following conclusions regarding correlation, financial and market performance:

FC_2 Financial performance of IBM is significantly worse in AI period compared to forecasted values based on pre-AI period

C_3 Financial data does not explain the fluctuations of Stock Price for IBM – stock prices of the company are not fluctuating according to fundamental financial factors.

Due to the weak to none correlation between Stock Price and all financial metrics, no conclusions considering market performance were drawn for IBM.

4. Supporting Numerical Study

4.1. Verizon Communications

4.1.1. General information

Verizon Communications (in further text - Verizon) is a communication technology company developing communications and technology solutions based in New York, USA.[31] The market capitalization of Verizon is $238 billion.[32] First AI acquisition by Verizon took place in May 2015. Verizon acquired AOL that had acquired a variety of AI companies prior to this.[33] Thus, AI period is marked starting from Q2 2015 to Q2 2020 and pre-AI is marked from Q1 2010 to Q1 2015, implying $\mathbf{n_1}=\mathbf{n_2}=21$.

4.1.2. AI Implementation and Monetization

Verizon doesn't monetize AI directly, it is used mainly to improve customer experience, solve different problems and predict factors that might affect customers in the future.[34]

[31] Verizon, About our Company, retrieved from https://www.verizon.com/about/our-company, accessed 25.10.2020
[32] Yahoo! Finance, VZ, retrieved from https://finance.yahoo.com/quote/VZ?p=VZ&.tsrc=fin-srch, accessed 25.10.2020
[33] Mergr: M&A and Private Equity Database, AOL Acquisitions, retrieved from https://mergr.com/aol-acquisitions, accessed 25.10.2020
[34] Verizon, About our Company, How Verizon is using artificial intelligence and machine learning to help maintain network superiority, 2018, retrieved from https://www.verizon.com/about/our-company/fourth-industrial-revolution/how-verizon-using-artificial-intelligence-and-machine-learning-help-maintain-network, accessed 25.10.2020

4.1.3. Financial Data

Financial metrics in Table 8.1. represent quarterly financial results of Verizon chosen on the same basis as for Alphabet (see **3.1.3. Financial data**, p.13). Research and Development (R&D) Expense data is unavailable for Verizon, thus Gross Profit adjustment for R&D is not performed.

Table 8.1. Financial data of n_1+n_2 period, Verizon

Date	Quarter	Revenue, $Mil.	Gross Profit, $Mil.	EBIT, $Mil	Stock price$ adjusted
30.06.2020	Q2_2020	30.447	18.968	7.361	56,84
31.03.2020	Q1_2020	31.610	19.314	6.579	56,21
31.12.2019	Q4_2019	34.775	19.144	6.639	57,56
30.09.2019	Q3_2019	32.894	19.510	8.180	57,95
30.06.2019	Q2_2019	32.071	19.350	7.850	52,41
31.03.2019	Q1_2019	32.128	19.138	7.709	53,68
31.12.2018	Q4_2018	34.281	18.990	6.370	51,15
30.09.2018	Q3_2018	32.607	19.276	7.675	52,45
30.06.2018	Q2_2018	32.203	18.572	6.617	46,90
31.03.2018	Q1_2018	31.772	18.517	7.349	44,27
31.12.2017	Q4_2017	33.955	18.397	5.461	47,95
30.09.2017	Q3_2017	31.717	18.743	6.988	41,95
30.06.2017	Q2_2017	30.548	18.064	8.014	41,87
31.03.2017	Q1_2017	29.814	17.767	6.962	39,24
31.12.2016	Q4_2016	32.340	16.701	10.213	41,45
30.09.2016	Q3_2016	30.937	18.708	6.540	40,22
30.06.2016	Q2_2016	30.532	18.311	4.554	45,87
31.03.2016	Q1_2016	32.171	19.559	7.942	41,73
31.12.2015	Q4_2015	34.254	19.547	9.744	40,44
30.09.2015	Q3_2015	33.158	19.853	7.535	37,45
30.06.2015	Q2_2015	32.224	19.775	7.821	36,95
31.03.2015	Q1_2015	31.984	19.888	7.960	39,38
31.12.2014	Q4_2014	33.192	18.789	-2.136	35,27
30.09.2014	Q3_2014	31.586	19.334	6.890	38,35
30.06.2014	Q2_2014	31.483	19.396	7.685	38,07
31.03.2014	Q1_2014	30.818	19.629	7.160	34,89
31.12.2013	Q4_2013	31.065	19.103	12.063	35,47
30.09.2013	Q3_2013	30.279	19.319	7.128	36,89
30.06.2013	Q2_2013	29.786	18.753	6.555	35,78
31.03.2013	Q1_2013	29.420	18.488	6.222	38,57
31.12.2012	Q4_2012	30.045	16.976	-3.169	30,84
30.09.2012	Q3_2012	29.007	18.016	5.483	31,23
30.06.2012	Q2_2012	28.552	17.656	5.651	31,23
31.03.2012	Q1_2012	28.242	16.923	5.195	27,57
31.12.2011	Q4_2011	28.436	16.346	-1.112	25,38
30.09.2011	Q3_2011	27.913	16.515	4.647	24,58
30.06.2011	Q2_2011	27.536	16.378	4.892	23,16

31.03.2011	Q1_2011	26.990	15.761	4.453	24,47
31.12.2010	Q4_2010	26.395	15.785	6.411	22,78
30.09.2010	Q3_2010	26.484	15.813	3.383	20,47
30.06.2010	Q2_2010	26.773	14.557	4.100	17,98
31.03.2010	Q1_2010	26.913	16.261	4.441	16,52

4.1.4. Regression analysis

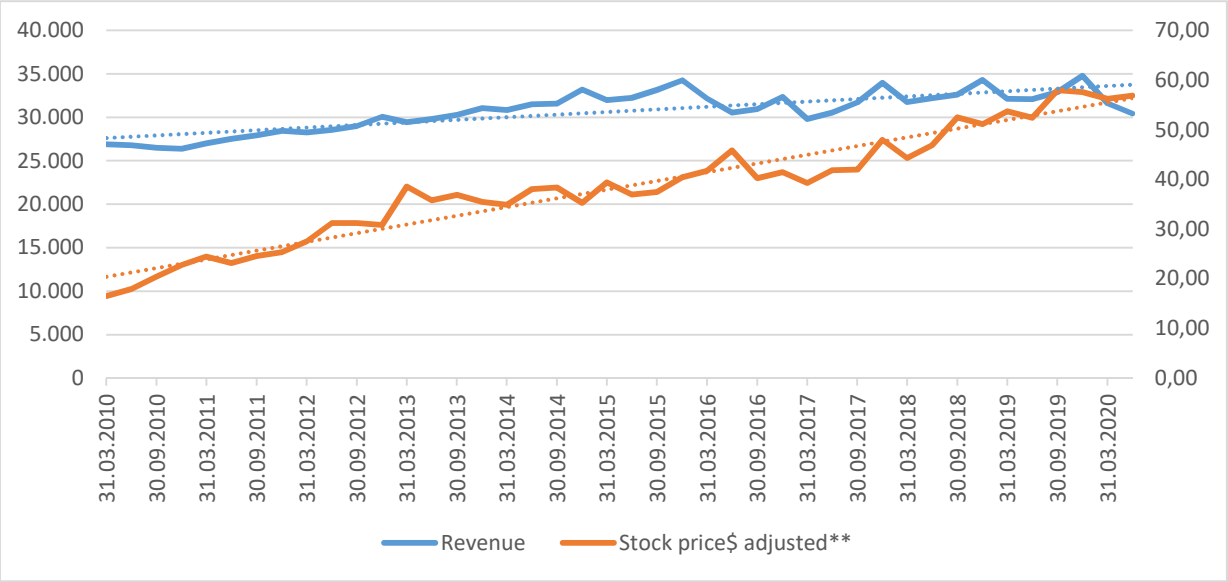
The analysis is performed as in **3.1.4. Regression analysis** for Alphabet (see p.15), other than there is no analysis for Gross Profit adjusted for R&D Expense for Verizon. Table 8.2. represents the output of regression analysis for each of financial metrics.

Table 8.2. Regression analysis for n_1+n_2 period, Verizon (Xi, Yi)

Revenue, Stock Price		Gross Profit, Stock Price		EBIT, Stock Price	
Regression Statistics		*Regression Statistics*		*Regression Statistics*	
Multiple R	0,805461	Multiple R	0,737349	Multiple R	0,393058
R Square	0,648768	R Square	0,543684	R Square	0,1544946
Adjusted R Square	0,639987	Adjusted R Square	0,532276	Adjusted R Square	0,133357
Standard Error	6,673801	Standard Error	7,606922	Standard Error	10,354623
Observations	42	Observations	42	Observations	42

Revenue of Verizon has a very strong correlation with Stock Price with the value of 0,8 for the coefficient of correlation. Gross Profit has a strong correlation with Stock Price with the value of 0,73 and EBIT has the weak correlation with the value of 0,39. Revenue has the strongest 90% correlation and is chosen for further analysis. R Square with the value of 0,65 means that 65% of the variance in Stock Price is explained by Revenue fluctuations. Values of Stock Price and Revenue are plotted on a graph for visual analysis. Figure 8.3. represents the relationship between Revenue and Stock Price graphically.

Figure 8.3 Relationship between Revenue and Stock Price, Verizon



Blue and orange dotted lines represent trend lines for Gross Profit and Stock Price respectively. The graph shows that the development of Stock Price values over time is visually similar to the development of Revenue and constant over time with the trend line of Stock Price having a higher slope.

Now trends for periods $\mathbf{n_1}$, $\mathbf{n_2}$ separately are calculated using the least squares method. Based on the trend values in pre-AI period a forecast for the trend values in AI period is performed. Table 8.4. represents the output of this procedure.

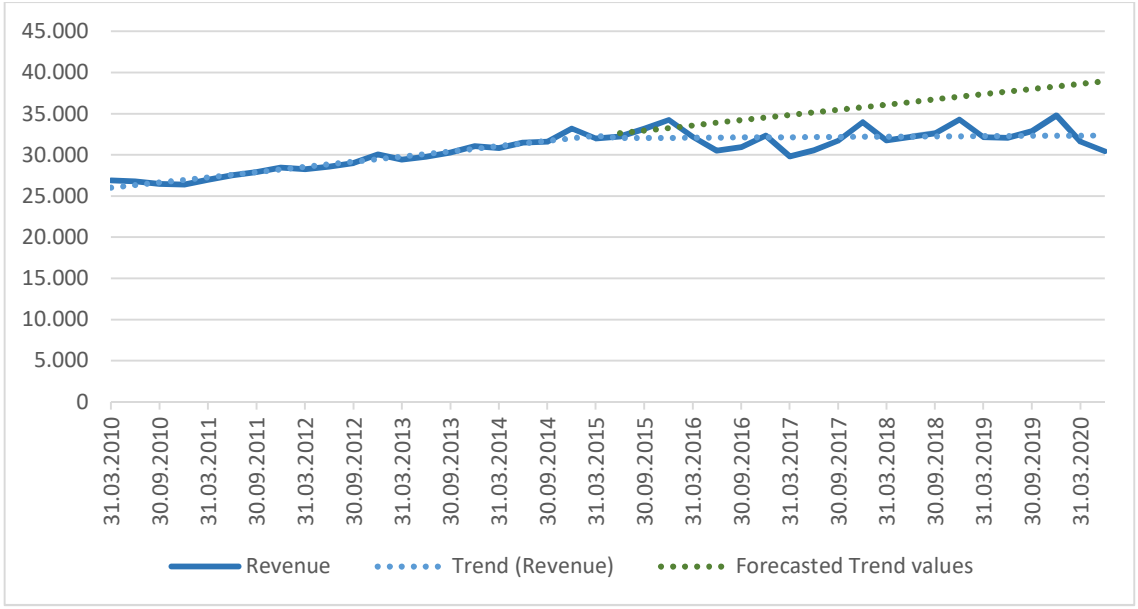
Table 8.4. Revenue trend and forecasted trend values, Verizon

Period	Date	Quarter	Trend (Revenue)	Forecasted Trend values
AI period	30.06.2020	Q2_2020	32.370	38.963
	31.03.2020	Q1_2020	32.354	38.648
	31.12.2019	Q4_2019	32.338	38.334
	30.09.2019	Q3_2019	32.322	38.016
	30.06.2019	Q2_2019	32.307	37.699
	31.03.2019	Q1_2019	32.291	37.384
	31.12.2018	Q4_2018	32.275	37.073
	30.09.2018	Q3_2018	32.259	36.756
	30.06.2018	Q2_2018	32.243	36.438
	31.03.2018	Q1_2018	32.227	36.123
	31.12.2017	Q4_2017	32.211	35.813
	30.09.2017	Q3_2017	32.195	35.495
	30.06.2017	Q2_2017	32.180	35.177

	31.03.2017	Q1_2017	32.164	34.863
	31.12.2016	Q4_2016	32.148	34.552
	30.09.2016	Q3_2016	32.132	34.234
	30.06.2016	Q2_2016	32.116	33.916
	31.03.2016	Q1_2016	32.100	33.602
	31.12.2015	Q4_2015	32.084	33.288
	30.09.2015	Q3_2015	32.068	32.970
	30.06.2015	Q2_2015	32.053	32.652
pre-AI period	31.03.2015	Q1_2015	32.340	
	31.12.2014	Q4_2014	32.025	
	30.09.2014	Q3_2014	31.709	
	30.06.2014	Q2_2014	31.394	
	31.03.2014	Q1_2014	31.078	
	31.12.2013	Q4_2013	30.763	
	30.09.2013	Q3_2013	30.447	
	30.06.2013	Q2_2013	30.132	
	31.03.2013	Q1_2013	29.817	
	31.12.2012	Q4_2012	29.501	
	30.09.2012	Q3_2012	29.186	
	30.06.2012	Q2_2012	28.870	
	31.03.2012	Q1_2012	28.555	
	31.12.2011	Q4_2011	28.239	
	30.09.2011	Q3_2011	27.924	
	30.06.2011	Q2_2011	27.608	
	31.03.2011	Q1_2011	27.293	
	31.12.2010	Q4_2010	26.978	
	30.09.2010	Q3_2010	26.662	
	30.06.2010	Q2_2010	26.347	
	31.03.2010	Q1_2010	26.031	

Trends for Revenue are visually analyzed for both periods in Figure 8.5.

Figure 8.5. Revenue trends in n_1 and n_2, Verizon



The difference of the trend of the observed Revenue in AI period compared to forecasted trend values is notably different, the Revenue trend line has visibly declined downwards. **H_0** testing is not performed for Verizon as the sample size **n_1=n_2**=21 is considered too small to produce statistically meaningful results.

Table 8.6. Regression analysis for periods n_1 and n_2 separately. Revenue, Stock Price (X_i,Y_i), Verizon

pre-AI period		AI period	
Regression Statistics		*Regression Statistics*	
Multiple R	0,88231553	Multiple R	0,2153148
R Square	0,7784807	R Square	0,0463604
Adjusted R Square	0,76682179	Adjusted R Square	-0,003831
Standard Error	3,52467744	Standard Error	7,0670609
Observations	21	Observations	21

In **n_1** (pre-AI) period multiple R of 0,8 and R Square of 0,78 represent a very strong 88% correlation between Revenue and Stock Price with 78% of the variance in Stock Price being explained by fluctuations of Revenue. In **n_2** (AI) period, multiple R has decreased to very weak 21% correlation with R Square value of 0,05.

4.1.5. Results

For Verizon, the strongest correlation has been found between its Revenue and Stock Price. Graphical analysis shows that financial results in AI period are somewhat worse than in pre-AI period, although the sample size **n_1=n_2**=21 is not acceptably big for **H_0** testing. Thus, further conclusions considering financial market performance are not applicable for Verizon, however it is suggested without statistical power that Verizon is likely to have significantly worse financial results in AI period compared to pre-AI period. As the correlation between Stock Price and Revenue is weak in AI period, no conclusions considering market performance can be drawn. Additionally, the coefficient of correlation between Stock Price and Revenue is very strong for **n_1+n_2** period with the value of 0,8., combined with weak correlation in AI period it is concluded:

C_2 Stock Price fluctuations are partly explained by financial results of Verizon, some amount of fluctuations is caused by technical factors and/or market sentiment.

4.2. NVIDIA Corporation

4.2.1. General information

NVIDIA Corporation (in further text - NVIDIA) is an IT company producing computer and mobile hardware based in California, USA.[35] The market capitalization of NVIDIA as of 24.10.2020 is $329.816 billion.[36] The company reported its first AI implementation in Tegra X1, released in 2015 with no exact date specified.[37] Thus, AI period is marked starting from Q1 2015 to Q1 2020 and pre-AI is marked from Q4 2009 to Q4 2014, implying $\mathbf{n_1}=\mathbf{n_2}=21$. NVIDIA has its fiscal year ending on January 31st, for this reason all financial quarters begin and end one month later compared to commonly used financial quarters for the fiscal year ending on December 31st.

4.2.2. AI Implementation and Monetization

AI is directly monetized by direct sales of products that use the technology, such as Tegra X1 and later versions, and other AI based hardware.

4.2.3. Financial Data

Financial metrics in Table 9.1. represent quarterly financial results of NVIDIA chosen on the same basis as for Alphabet (see **3.1.3. Financial data**, p.13).

Table 9.1. Financial data of n_1+n_2 period, NVIDIA

Date	Quarter	Revenue	Gross Profit, $Mil.*	R&D Expense, $Mil*	Gross Profit adj. for R&D	EBIT, $Mil*	Stock price$ adjusted**
30.04.2020	Q1_2020	3.080	2.004	735	1.269	976	354,86
31.01.2020	Q4_2019	3.105	2.015	739	1.276	990	269,79
31.10.2019	Q3_2019	3.014	1.916	712	1.204	927	216,35
31.07.2019	Q2_2019	2.579	1.541	704	837	571	167,04
30.04.2019	Q1_2019	2.220	1.296	674	622	358	134,93
31.01.2019	Q4_2018	2.205	1.207	648	559	294	153,50
31.10.2018	Q3_2018	3.181	1.921	605	1.316	1.058	162,46
31.07.2018	Q2_2018	3.123	1.975	581	1.394	1.157	278,86
30.04.2018	Q1_2018	3.207	2.068	542	1.526	1.295	250,40
31.01.2018	Q4_2017	2.911	1.801	508	1.293	1.073	240,13

[35] Encyclopedia Britannica, NVIDIA Corporation, retrieved from https://www.britannica.com/topic/NVIDIA-Corporation, accessed 24.10.2020

[36] Yahoo! Finance, NVDA, retrieved from https://finance.yahoo.com/quote/NVDA?p=NVDA&.tsrc=fin-srch, accessed 24.10.2020

[37] NVIDIA, About NVIDIA, retrieved from https://www.nvidia.com/en-us/about-nvidia/corporate-timeline/, accessed 24.10.2020

31.10.2017	Q3_2017	2.636	1.569	462	1.107	895	209,83
31.07.2017	Q2_2017	2.230	1.302	416	886	688	167,87
30.04.2017	Q1_2017	1.937	1.150	411	739	554	142,86
31.01.2017	Q4_2016	2.173	1.303	394	909	733	100,31
31.10.2016	Q3_2016	2.004	1.183	373	810	639	91,00
31.07.2016	Q2_2016	1.428	826	350	476	317	60,43
30.04.2016	Q1_2016	1.305	751	346	405	245	45,91
31.01.2016	Q4_2015	1.401	790	343	447	250	30,70
31.10.2015	Q3_2015	1.305	734	329	405	245	30,94
31.07.2015	Q2_2015	1.153	634	320	314	76	21,83
30.04.2015	Q1_2015	1.151	653	339	314	176	21,39
31.01.2015	Q4_2014	1.251	700	349	351	232	21,25
31.10.2014	Q3_2014	1.225	676	340	336	213	20,11
31.07.2014	Q2_2014	1.103	619	337	282	163	18,57
30.04.2014	Q1_2014	1.103	604	334	270	151	18,06
31.01.2014	Q4_2013	1.144	619	337	283	167	17,39
31.10.2013	Q3_2013	1.054	584	340	244	141	14,68
31.07.2013	Q2_2013	977	546	332	214	106	13,81
30.04.2013	Q1_2013	955	519	327	191	83	13,48
31.01.2013	Q4_2012	1.107	586	298	288	184	11,72
31.10.2012	Q3_2012	1.204	637	284	352	252	11,01
31.07.2012	Q2_2012	1.044	541	281	260	140	12,91
30.04.2012	Q1_2012	925	463	284	179	73	11,44
31.01.2012	Q4_2011	953	490	267	223	122	13,94
31.10.2011	Q3_2011	1.066	557	256	300	197	14,38
31.07.2011	Q2_2011	1.017	525	248	278	174	12,24
30.04.2011	Q1_2011	962	485	232	253	155	18,44
31.01.2011	Q4_2010	886	426	216	211	180	20,85
31.10.2010	Q3_2010	844	392	205	188	104	12,52
31.07.2010	Q2_2010	811	134	211	-76	-175	8,58
30.04.2010	Q1_2010	1.002	456	218	238	147	12,09
31.01.2010	Q4_2009	982	439	216	222	134	14,90

4.2.4. Regression analysis

The analysis is performed as in **3.1.4. Regression analysis** for Alphabet (see p.15). Table 9.2. represents the output of regression analysis for each of financial metrics.

Table 9.2. Regression analysis for n_1+n_2 period, NVIDIA (Xi, Yi)

Revenue, Stock Price	
Regression Statistics	
Multiple R	0,9571528
R Square	0,9161414
Adjusted R Square	0,914045
Standard Error	28,16946
Observations	42

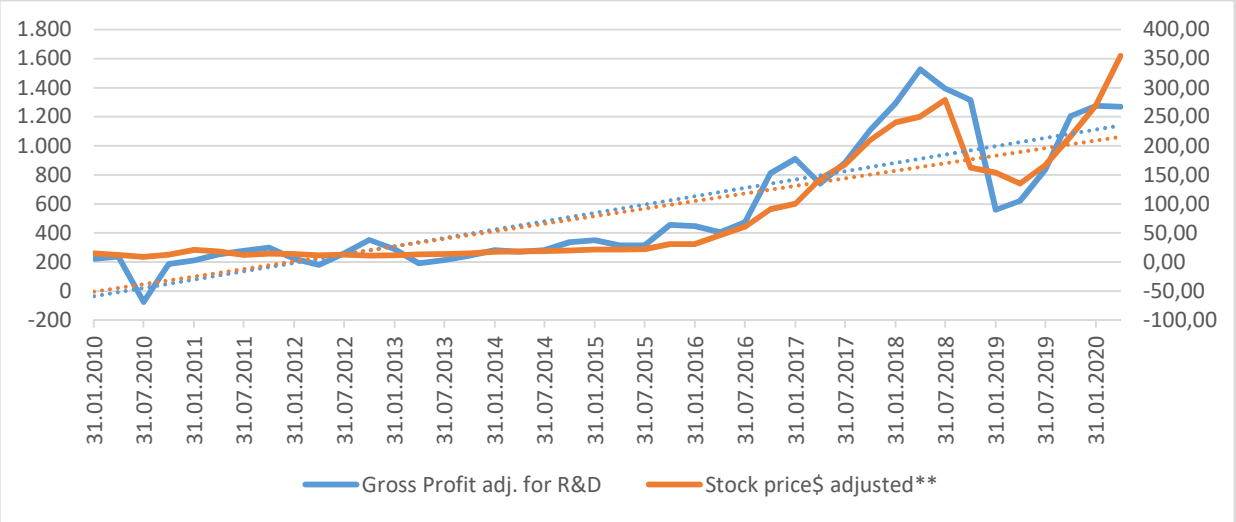
Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,9563119
R Square	0,9145324
Adjusted R Square	0,9123957
Standard Error	28,438419
Observations	42

adj. Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,9938258
R Square	0,9876897
Adjusted R Square	0,9873819
Standard Error	41,417963
Observations	42

EBIT, Stock Price	
Regression Statistics	
Multiple R	0,9184333
R Square	0,8435196
Adjusted R Square	0,8396076
Standard Error	38,479966
Observations	42

All financial metrics of NVIDIA have a very strong correlation with Stock Price, with the coefficient of correlation lying above the 0,8 value. Gross Profit adj. for R&D, Stock Price ($\mathbf{X_i}$, $\mathbf{Y_i}$) has the highest coefficient of correlation with a nearly perfect coefficient of correlation value of 0,99 implying 99% correlation between given metrics. R Square or Coefficient of Determination returns the value of 0,99 for Gross Profit adj., Stock Price ($\mathbf{X_i}$, $\mathbf{Y_i}$). This means that 99% of the variance in Stock Price is explained by Gross Profit adj. fluctuations. Values of Stock Price and Gross Profit adj. are plotted on a graph for visual analysis. Figure 9.3. represents the relationship between Gross Profit adj. and Stock Price graphically.

Figure 9.3. Relationship between Revenue and Stock Price, NVIDIA



Blue and orange dotted lines represent trend lines for Gross Profit and Stock Price respectively. The graph shows that the development of Stock Price values over time is visually similar to the development of Gross Profit adj. with trend lines being nearly parallel.

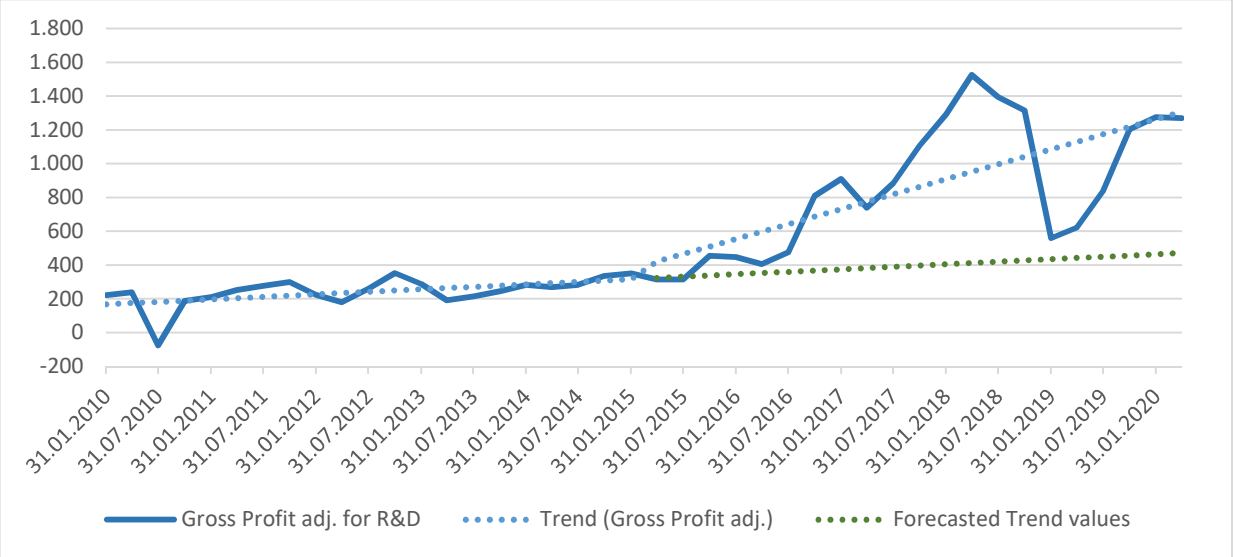
Now trends for periods $\mathbf{n_1}$, $\mathbf{n_2}$ separately are calculated using the least squares method. Based on the trend values in pre-AI period a forecast for the trend values in AI period is performed. Table 9.4. represents the output of this procedure.

Table 9.4. Gross Profit adj. and forecasted trend values, NVIDIA

Period	Date	Quarter	Trend (Gross Profit adj.)	Forecasted Trend values
AI period	30.04.2020	Q1_2020	1.308	472
	31.01.2020	Q4_2019	1.263	465
	31.10.2019	Q3_2019	1.219	458
	31.07.2019	Q2_2019	1.175	450
	30.04.2019	Q1_2019	1.130	443
	31.01.2019	Q4_2018	1.086	435
	31.10.2018	Q3_2018	1.042	428
	31.07.2018	Q2_2018	998	420
	30.04.2018	Q1_2018	953	413
	31.01.2018	Q4_2017	909	406
	31.10.2017	Q3_2017	865	398
	31.07.2017	Q2_2017	820	391
	30.04.2017	Q1_2017	776	383
	31.01.2017	Q4_2016	732	376
	31.10.2016	Q3_2016	687	369
	31.07.2016	Q2_2016	643	361
	30.04.2016	Q1_2016	599	354
	31.01.2016	Q4_2015	555	346
	31.10.2015	Q3_2015	510	339
	31.07.2015	Q2_2015	466	331
	30.04.2015	Q1_2015	422	324
pre-AI period	31.01.2015	Q4_2014	316	
	31.10.2014	Q3_2014	309	
	31.07.2014	Q2_2014	302	
	30.04.2014	Q1_2014	294	
	31.01.2014	Q4_2013	287	
	31.10.2013	Q3_2013	279	
	31.07.2013	Q2_2013	272	
	30.04.2013	Q1_2013	264	
	31.01.2013	Q4_2012	257	
	31.10.2012	Q3_2012	250	
	31.07.2012	Q2_2012	242	
	30.04.2012	Q1_2012	235	
	31.01.2012	Q4_2011	227	
	31.10.2011	Q3_2011	220	
	31.07.2011	Q2_2011	213	
	30.04.2011	Q1_2011	205	
	31.01.2011	Q4_2010	198	
	31.10.2010	Q3_2010	190	
	31.07.2010	Q2_2010	183	
	30.04.2010	Q1_2010	175	
	31.01.2010	Q4_2010	168	

Trends for Gross Profit adj. are visually analyzed for both periods in Figure 9.5. and Table 9.6.

Figure 9.5. Gross Profit adj. trends in n_1 and n_2, NVIDIA



The trend of the observed Gross Profit adj. in AI period compared to forecasted trend values is notably declining upwards. **H_0** testing is not performed for Salesforce as the sample size **n_1=n_2**=21 is considered too small to produce statistically meaningful results.

Table 9.6. Regression analysis for periods n_1 and n_2 separately. Gross Profit adj., Stock Price (X_i,Y_i), NVIDIA

pre-AI period	
Regression Statistics	
Multiple R	0,49704022
R Square	0,24704898
Adjusted R Square	0,20741998
Standard Error	3,15538438
Observations	21

AI period	
Regression Statistics	
Multiple R	0,88862591
R Square	0,789656
Adjusted R Square	0,77858527
Standard Error	45,4201645
Observations	21

In **n_1** (pre-AI) period multiple R of 0,5 and R Square of 0,25 represent a moderate 50% correlation between Gross Profit adj. and Stock Price with 25% of the variance in Stock Price being explained by fluctuations of Gross Profit adj. In **n_2** (AI) period, multiple R has increased to very strong 89% correlation with R Square value of 0,79.

4.2.5. Results

For NVIDIA, the strongest correlation has been found between its Gross Profit adj. for R&D Expense and Stock Price. Graphical analysis shows that financial results in AI period are notably better than in pre-AI period, although the sample size $\mathbf{n_1}=\mathbf{n_2}=21$ is not acceptably big for $\mathbf{H_0}$ testing. It is suggested, that the financial performance of NVIDIA is considerably better in AI period compared to the forecast. This suggestion is made without statistical power for NVIDIA. As Stock Price has a very strong correlation with Gross Profit adj., market performance of NVIDIA is also evaluated as considerably better compared to pre-AI period.

The coefficient of correlation between Stock Price and all financial metrics is very strong with values over 0,8 for $\mathbf{n_1+n_2}$ period. The correlation between Stock Price and Gross Profit adj. is very strong in AI period, therefore it is concluded:

$\mathbf{C_1}$ Stock Prices are in line with financial results and its fluctuations are explained by financial results to a high extent.

4.3. EBAY Inc.

4.3.1. General information

EBAY Inc. (in further text - EBAY) is an online retail platform based in California, USA. The company specializes in online auctions and trading.[38] The market capitalization of EBAY is $37.647 billion.[39] First AI acquisition of EBAY took place on May 5th, 2016, when a company specializing in providing intelligent solutions, Expertmaker, was acquired.[40] Thus, AI period is marked starting from Q2 2016 to Q2 2020 and pre-AI is marked from Q1 2012 to Q1 2016, implying $\mathbf{n_1}=\mathbf{n_2}=17$.

[38] Encyclopedia Britannica, EBAY retrieved from https://www.britannica.com/topic/eBay, accessed 24.10.2020
[39] Yahoo! Finance, EBAY, retrieved from https://finance.yahoo.com/quote/EBAY?p=EBAY&.tsrc=fin-srch, accessed 24.10.2020
[40] EBAY, Stories, retrieved from https://www.ebayinc.com/stories/news/ebay-acquires-expertmaker/, accessed 24.10.2020

4.3.2. AI Implementation and Monetization

AI is used mostly for data structuring in EBAY, thus not being directly monetized. AI is seen as a tool to optimize user experience and increase the amount of customers and deals within the platform.[41]

4.3.3. Financial Data

Financial metrics in Table 10.1. represent quarterly financial results of EBAY chosen on the same basis as for Alphabet (see **3.1.3. Financial data**, p.13).

Table 10.1. Financial data of n_1+n_2 period, EBAY

Date	Quarter	Revenue, $Mil.	Gross Profit, $Mil.	R&D Expense, $Mil	Gross Profit adj. For R&D	EBIT, $Mil	Stock price$ adjusted
30.06.2020	Q2_2020	2.865	2.267	308	1.959	821	55,28
31.03.2020	Q1_2020	2.374	1.848	267	1.581	629	39,69
31.12.2019	Q4_2019	3.315	2.526	360	2.166	638	33,29
30.09.2019	Q3_2019	2.649	2.022	313	1.709	532	34,83
30.06.2019	Q2_2019	2.423	1.870	295	1.575	558	40,55
31.03.2019	Q1_2019	2.413	1.874	272	1.602	593	38,00
31.12.2018	Q4_2018	2.877	2.259	292	1.967	681	32,88
30.09.2018	Q3_2018	2.649	2.041	307	1.734	556	28,36
30.06.2018	Q2_2018	2.640	2.043	352	1.691	406	32,68
31.03.2018	Q1_2018	2.580	2.021	334	1.687	579	37,01
31.12.2017	Q4_2017	2.707	2.117	317	1.800	663	39,65
30.09.2017	Q3_2017	2.498	1.941	316	1.625	574	36,78
30.06.2017	Q2_2017	2.419	1.859	313	1.546	480	34,91
31.03.2017	Q1_2017	2.303	1.789	278	1.511	547	32,64
31.12.2016	Q4_2016	2.714	2.178	292	1.886	638	31,10
30.09.2016	Q3_2016	2.217	1.719	288	1.431	542	27,86
30.06.2016	Q2_2016	2.230	1.737	295	1.442	531	30,45
31.03.2016	Q1_2016	2.137	1.660	239	1.421	614	23,87
31.12.2015	Q4_2015	2.322	1.829	229	1.600	662	22,92
30.09.2015	Q3_2015	2.099	1.666	241	1.425	578	27,26
30.06.2015	Q2_2015	2.110	1.676	232	1.444	428	27,48
31.03.2015	Q1_2015	2.061	1.650	221	1.429	529	23,96
31.12.2014	Q4_2014	2.323	1.881	236	1.645	731	21,80
30.09.2014	Q3_2014	2.150	1.737	246	1.491	596	21,59
30.06.2014	Q2_2014	4.103	2.922	468	2.454	854	21,73
31.03.2014	Q1_2014	4.262	2.911	480	2.431	878	21,31
31.12.2013	Q4_2013	4.530	3.081	450	2.631	1.022	21,88

[41] EBAY, Machine Learning in Engineering, eBay's Platform is Powered by AI and Fueled by Customer Input, retrieved from https://tech.ebayinc.com/engineering/ebays-platform-is-powered-by-ai-and-fueled-by-customer-input/, accessed 28.10.2020

30.09.2013	Q3_2013	3.892	2.668	433	2.235	799	21,68
30.06.2013	Q2_2013	3.877	2.666	451	2.215	750	21,26
31.03.2013	Q1_2013	3.748	2.596	434	2.162	800	21,54
31.12.2012	Q4_2012	3.992	2.769	416	2.353	874	23,02
30.09.2012	Q3_2012	3.404	2.382	389	1.993	667	19,85
30.06.2012	Q2_2012	3.398	2.411	394	2.017	695	18,22
31.03.2012	Q1_2012	3.277	2.294	374	1.920	653	16,87

4.3.4. Regression analysis

The analysis is performed as in **3.1.4. Regression analysis** for Alphabet (see p.15). Table 10.2. represents the output.

Table 10.2. Regression analysis for n_1+n_2 period, EBAY (Xi, Yi)

Revenue, Stock Price	
Regression Statistics	
Multiple R	0,3997268
R Square	0,1597815
Adjusted R Square	0,1335246
Standard Error	7,7877122
Observations	34

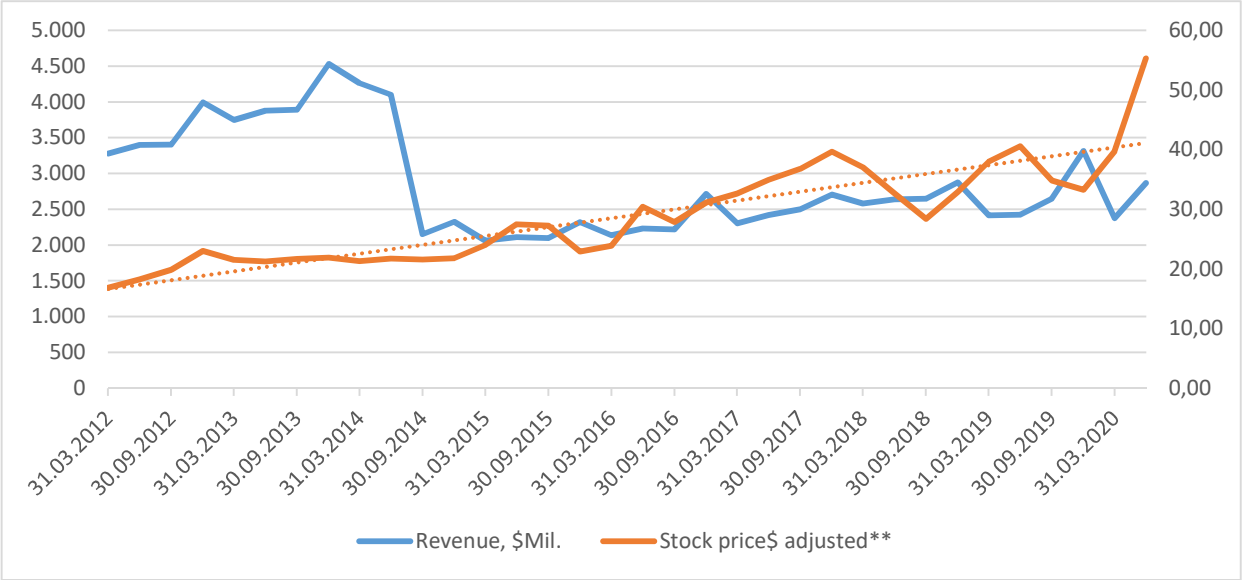
Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,3235718
R Square	0,1046987
Adjusted R Square	0,0767206
Standard Error	8,0389323
Observations	34

adj. Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,3124356
R Square	0,097616
Adjusted R Square	0,0694165
Standard Error	8,0706675
Observations	34

EBIT, Stock Price	
Regression Statistics	
Multiple R	0,2938191
R Square	0,0863297
Adjusted R Square	0,0577775
Standard Error	8,1209817
Observations	34

All financial metrics of EBAY have weak correlation with Stock Price, with the coefficient of correlation lying in 0,19-0,4 range. Revenue, Stock Price ($\mathbf{X_i, Y_i}$) has the highest coefficient of correlation with a borderline to moderate correlation value of 0,399 implying approximately 40% correlation between this values. R Square or Coefficient of Determination returns the value 0,16 for Revenue, Stock Price ($\mathbf{X_i, Y_i}$). This means that 16% of the variance in Stock Price is explained by Revenue fluctuations. Values of Stock Price and Revenue are plotted on a graph for visual analysis. As there is an extreme downswing in revenue values in Q3 2014 and no reliable forecast is possible under this condition, trend analysis for separate periods is not performed. Figure 10.3. represents the relationship between Revenue and Stock Price graphically.

Figure 10.3. Relationship between Revenue and Stock Price, EBAY



The orange dotted line represents the trend line Stock Price. The graph shows that the development of Stock Price values over time is not visually similar to the development of Revenue. The trend of Revenue would have a negative slope due to an extreme downswing in Q3 2014, after this period the slope of the trend would be non-negative. Stock Price trend has a notable upward swing in the last two financial quarters.

Now, trends for periods $\mathbf{n_1}$, $\mathbf{n_2}$ separately are calculated. Based on the trend values in pre-AI period a forecast for the trend values in AI period is performed. Table 10.4. represents the output of this procedure.

Table 10.4. Regression analysis for periods n_1 and n_2 separately. Revenue, Stock Price (X_i,Y_i), EBAY

pre-AI period	
Regression Statistics	
Multiple R	0,492107071
R Square	0,24216937
Adjusted R Square	0,191647328
Standard Error	813,6494494
Observations	17

AI period	
Regression Statistics	
Multiple R	0,204119583
R Square	0,041664804
Adjusted R Square	-0,022224209
Standard Error	278,6671386
Observations	17

In $\mathbf{n_1}$ (pre-AI) period multiple R of 0,49 and R Square of 0,24 represent moderate 49% correlation between Revenue and Stock Price with 24% of the variance in Stock Price being explained by fluctuations of Revenue. In AI period multiple R decreased to 0,2 and R Square to 0,04 representing a weak 20% correlation, borderline to no correlation between Revenue and Stock

Price. $\mathbf{H_0}$ testing is not performed for EBAY as the sample size $\mathbf{n_1}$=$\mathbf{n_2}$=17 is too small to produce statistically meaningful results.

4.3.5. Results

For EBAY, the correlation between Stock Price and all financial metrics was found to be weak, whereas the correlation decreased from moderate to weak for Revenue and Stock Price in AI period compared to pre-AI period., therefore it is concluded:

$\mathbf{C_2}$ Stock Price fluctuations are partly explained by financial results of EBAY, a considerable amount of fluctuations is caused by technical factors and/or market sentiment.

According to Figure 11.3., Revenue developed at the same pace in AI period compared to the second half of pre-AI period (a big downswing occurred in Q3 2014, but it is disregarded in this study as it happened in pre-AI period). $\mathbf{H_0}$ is not tested for EBAY because of an unacceptable sample size in pre-AI and AI periods. It is suggest without statistical power, that financial performance of EBAY in AI period is not significantly different compared with pre-AI period disregarding the downswing.

4.4. Salesforce.com

4.4.1. General information

Salesforce.com (in further text – Salesforce) is an IT company that develops a customer relationship management system (CRM) called Discover Customer 360, all products of the company are within this CRM.[42] The market capitalization of Salesforce as of 24.10.2020 is $218.303 billion.[43] First AI acquisition by Salesforce took place on May 29th, 2015 when a startup called Tempo, that has developed a smart calendar based on AI, was acquired.[44] Thus, AI period is marked starting from Q2 2015 to Q1 2020 and pre-AI is marked from Q2 2010 to Q1 2015, implying $\mathbf{n_1}$=$\mathbf{n_2}$=20. Salesforce has its fiscal year ending on January 31st, for this reason all financial

[42] Salesforce, Products, retrieved from https://www.salesforce.com/products/?d=cta-body-promo-8, accessed 25.10.2020

[43] Yahoo! Finance, CRM, retrieved from https://finance.yahoo.com/quote/CRM?p=CRM&.tsrc=fin-srch, accessed 25.10.2020

[44] Anthony Ha, Tech Crunch, 2015, Salesforce Acquires Smart Calendar Startup Tempo, App Will Shut Down On June 30, retrieved from https://techcrunch.com/2015/05/29/salesforce-acquires-tempo/, accessed 25.10.2020

quarters begin and end one month later compared to companies that have January 31st as the last day of the fiscal year.

4.4.2. AI Implementation and Monetization

Salesforce offers a smart assistant powered by AI, Einstein, within its CRM system. As it is a directly sold product, AI is directly monetized by Salesforce.[45]

4.4.3. Financial Data

Financial metrics in Table 11.1. represent quarterly financial results of Salesforce chosen on the same basis as for Alphabet (see **3.1.3. Financial data**, p.13).

Table 11.1. Financial data of n_1+n_2 period, Salesforce

Date	Quarter	Revenue, $Mil.	Gross Profit, $Mil.	R&D Expense, $Mil	Gross Profit adj. for R&D	EBIT, $Mil	Stock price$ adjusted
30.04.2020	Q1_2020	4.865	3.611	859	2.752	-140	174,79
31.01.2020	Q4_2019	4.851	3.631	831	2.800	-36	170,40
31.10.2019	Q3_2019	4.513	3.379	774	2.605	65	162,89
31.07.2019	Q2_2019	3.997	3.030	607	2.423	58	156,07
30.04.2019	Q1_2019	3.737	2.823	554	2.269	210	151,41
31.01.2019	Q4_2018	3.603	2.657	518	2.139	137	163,65
31.10.2018	Q3_2018	3.392	2.503	481	2.022	92	142,76
31.07.2018	Q2_2018	3.281	2.432	463	1.969	115	152,68
30.04.2018	Q1_2018	3.006	2.239	424	1.815	191	129,33
31.01.2018	Q4_2017	2.865	2.127	396	1.731	211	116,25
31.10.2017	Q3_2017	2.701	1.987	394	1.593	155	107,03
31.07.2017	Q2_2017	2.577	1.907	387	1.520	84	95,49
30.04.2017	Q1_2017	2.397	1.746	376	1.370	4	89,64
31.01.2017	Q4_2016	2.339	1.713	344	1.369	130	81,35
31.10.2016	Q3_2016	2.145	1.559	311	1.248	3	72,00
31.07.2016	Q2_2016	2.037	1.511	292	1.220	33	79,42
30.04.2016	Q1_2016	1.917	1.420	261	1.159	52	83,71
31.01.2016	Q4_2015	1.809	1.366	251	1.115	21	67,75
31.10.2015	Q3_2015	1.712	1.288	239	1.049	43	79,69
31.07.2015	Q2_2015	1.635	1.229	234	995	20	69,36
30.04.2015	Q1_2015	1.511	1.129	222	907	31	72,75
31.01.2015	Q4_2014	1.445	1.089	206	883	-35	69,38
31.10.2014	Q3_2014	1.384	1.050	195	855	-22	59,87
31.07.2014	Q2_2014	1.319	1.011	203	808	-33	59,09
30.04.2014	Q1_2014	1.227	934	188	746	-55	52,63

[45] Salesforce.com, Products, Einstein, retrieved from https://www.salesforce.com/products/einstein/roles/, accessed 24.10.2020

31.01.2014	Q4_2013	1.145	872	173	699	-104	62,37
31.10.2013	Q3_2013	1.076	808	171	637	-98	52,09
31.07.2013	Q2_2013	957	739	148	591	-40	49,13
30.04.2013	Q1_2013	893	684	132	552	-45	42,33
31.01.2013	Q4_2012	835	651	121	530	-21	42,31
31.10.2012	Q3_2012	788	602	114	488	-54	39,42
31.07.2012	Q2_2012	732	569	99	470	-13	36,29
30.04.2012	Q1_2012	695	544	95	449	-22	34,65
31.01.2012	Q4_2011	632	496	81	415	-6	35,79
31.10.2011	Q3_2011	584	456	76	380	-10	29,60
31.07.2011	Q2_2011	546	425	73	352	-16	32,19
30.04.2011	Q1_2011	504	401	65	336	-3	38,06
31.01.2011	Q4_2010	457	365	58	307	0	33,07
31.10.2010	Q3_2011	429	347	47	300	35	34,81
31.07.2010	Q2_2011	394	317	43	274	30	27,47

4.4.4. Regression analysis

The analysis is performed as in **3.1.4. Regression analysis** for Alphabet (see p.15). Table 11.2. represents the output.

Table 11.2. Regression analysis for n_1+n_2 period, Salesforce (Xi, Yi)

Revenue, Stock Price	
Regression Statistics	
Multiple R	0,9828942
R Square	0,9660811
Adjusted R Square	0,9651885
Standard Error	8,6602355
Observations	40

Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,9829557
R Square	0,966202
Adjusted R Square	0,9653125
Standard Error	8,6447873
Observations	40

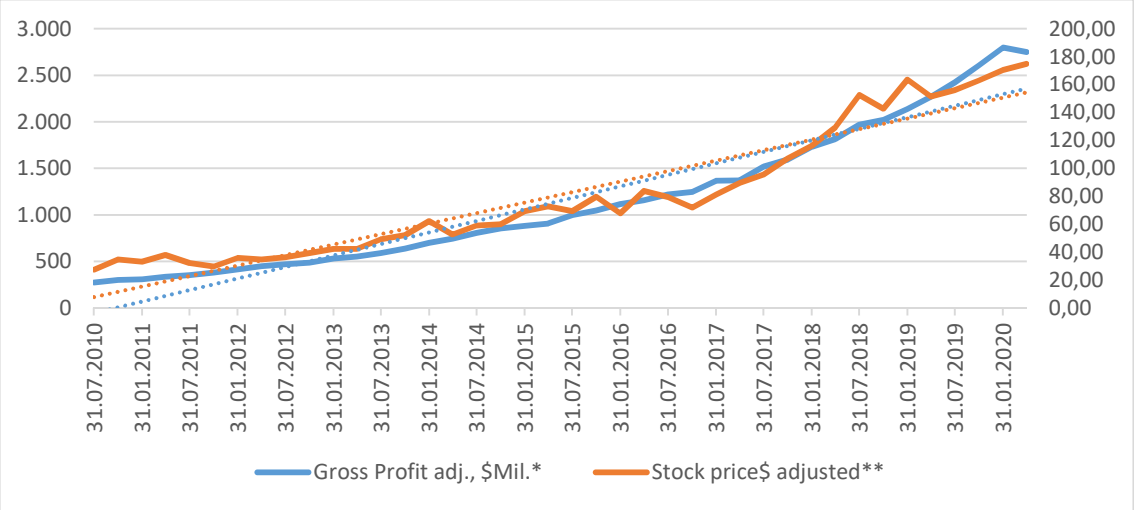
adj. Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,9862438
R Square	0,9726768
Adjusted R Square	0,9719577
Standard Error	7,7727505
Observations	40

EBIT, Stock Price	
Regression Statistics	
Multiple R	0,4612387
R Square	0,2127411
Adjusted R Square	0,1920238
Standard Error	41,722216
Observations	40

All financial metrics except EBIT have a very strong correlation with Stock Price, lying above the 0,8 value of the coefficient of correlation, Multiple R. EBIT has moderate correlation with Stock Price, with the coefficient of correlation lying above the 0,4 value. Gross Profit adj. for R&D has the strongest correlation with Stock Price with a 0.99 value and is selected for further analysis. R Square or Coefficient of Determination returns the value 0.97 for Gross Profit adj., Stock Price

(X_i, Y_i). This means that 99% of the variance in Stock Price is explained by Gross Profit adj. fluctuations. Values of Stock Price and Gross Profit adj. are plotted on a graph for visual analysis. Figure 11.3. represents the relationship between Gross Profit adj. and Stock Price graphically.

Figure 11.3. Relationship between Gross Profit adj. and Stock Price, Salesforce



Blue and orange dotted lines represent trend lines for Gross Profit adj. and Stock Price respectively. The graph shows that the development of Stock Price values over time is almost identical to the development of Gross Profit adj..

Now, trends for periods n_1, n_2 separately are calculated using the least squares method. Based on the trend values in pre-AI period a forecast for the trend values in AI period is performed. Table 11.4. represents the output of this procedure.

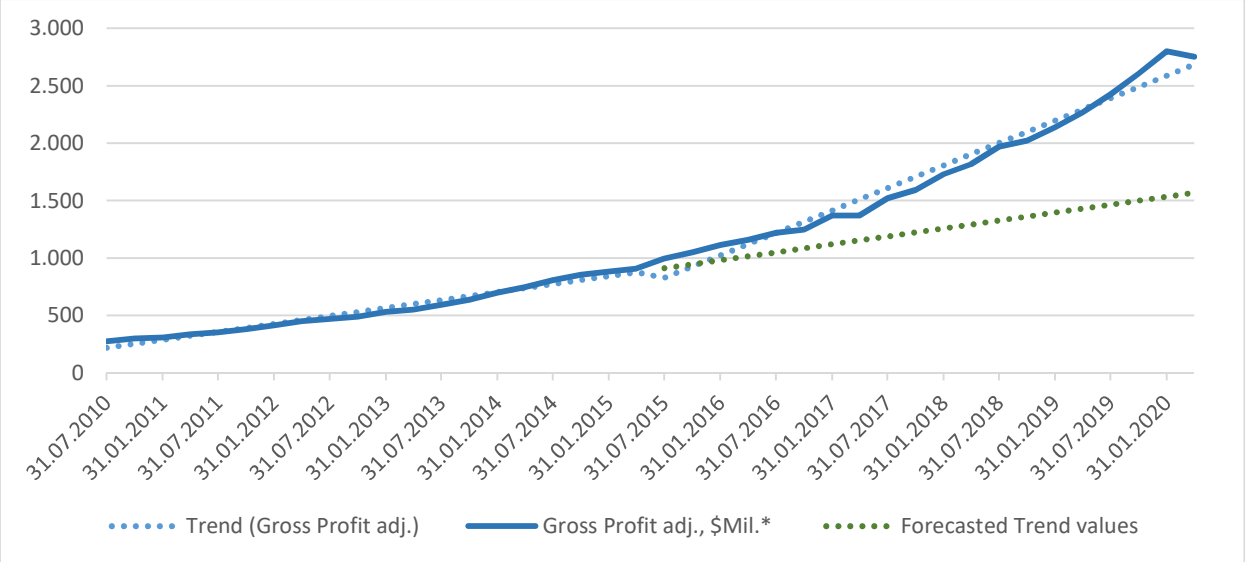
Table 11.4. Gross Profit adj. and forecasted trend values, Salesforce

Period	Date	Quarter	Trend (Gross Profit adj.)	Forecasted Trend values
AI period	30.04.2020	Q1_2020	2.687	1.570
	31.01.2020	Q4_2019	2.589	1.536
	31.10.2019	Q3_2019	2.492	1.501
	31.07.2019	Q2_2019	2.394	1.466
	30.04.2019	Q1_2019	2.296	1.431
	31.01.2019	Q4_2018	2.198	1.398
	31.10.2018	Q3_2018	2.100	1.363
	31.07.2018	Q2_2018	2.003	1.328
	30.04.2018	Q1_2018	1.905	1.293
	31.01.2018	Q4_2017	1.807	1.259

	31.10.2017	Q3_2017	1.709	1.224
	31.07.2017	Q2_2017	1.611	1.189
	30.04.2017	Q1_2017	1.514	1.155
	31.01.2017	Q4_2016	1.416	1.121
	31.10.2016	Q3_2016	1.318	1.086
	31.07.2016	Q2_2016	1.220	1.051
	30.04.2016	Q1_2016	1.122	1.016
	31.01.2016	Q4_2015	1.025	982
	31.10.2015	Q3_2015	927	947
	31.07.2015	Q2_2015	829	912
pre-AI period	30.04.2015	Q1_2015	878	
	31.01.2015	Q4_2014	843	
	31.10.2014	Q3_2014	809	
	31.07.2014	Q2_2014	774	
	30.04.2014	Q1_2014	739	
	31.01.2014	Q4_2013	705	
	31.10.2013	Q3_2013	670	
	31.07.2013	Q2_2013	635	
	30.04.2013	Q1_2013	601	
	31.01.2013	Q4_2012	566	
	31.10.2012	Q3_2012	532	
	31.07.2012	Q2_2012	497	
	30.04.2012	Q1_2012	462	
	31.01.2012	Q4_2011	428	
	31.10.2011	Q3_2011	393	
	31.07.2011	Q2_2011	358	
	30.04.2011	Q1_2011	324	
	31.01.2011	Q4_2010	289	
	31.10.2010	Q3_2011	254	
	31.07.2010	Q2_2011	220	

Trends for Gross Profit adj. are analyzed for both periods in Figure 11.5. and Table 11.6.

Figure 11.5. Gross Profit adj. trends in n_1 and n_2, Salesforce



The trend of the observed Gross Profit adj. in AI period compared to forecasted trend values is notably declining upwards. **H_0** testing is not performed for Salesforce as the sample size **n_1=n_2**=20 is considered too small to produce statistically meaningful results.

Table 11.6. Regression analysis for periods n_1 and n_2 separately. Gross Profit adj., Stock Price (X_i,Y_i), Salesforce

pre-AI period	
Regression Statistics	
Multiple R	0,95587487
R Square	0,913696767
Adjusted R Square	0,908902143
Standard Error	4,112254682
Observations	20

AI period	
Regression Statistics	
Multiple R	0,954596
R Square	0,911253
Adjusted R Square	0,906322
Standard Error	11,851
Observations	20

In **n_1** (pre-AI) period multiple R of 0,96 and R Square of 0,91 represent a very strong 96% correlation between Revenue and Stock Price with 91% of the variance in Stock Price being explained by fluctuations of Gross Profit. In **n_2** (AI) period, multiple R stays at the same 95% level of correlation with R Square value of 0,91.

4.4.5. Results

For Salesforce, the strongest correlation has been found between its Gross Profit adj. for R&D Expense and Stock Price. Graphical analysis shows that financial results in AI period are notably better than in pre-AI period, although the sample size **n_1=n_2**=20 is not acceptably big for **H_0** testing. Thus, further conclusions considering financial market performance are not applicable for Salesforce, however it is suggested without statistical power, that Salesforce is likely to have significantly better results in both fields in AI period compared to pre-AI period.

The coefficient of correlation between Stock Price and all financial metrics except EBIT is very strong with values over 0,8. The correlation between Stock Price and Gross Profit adj. is very strong in both periods, therefore it is concluded:

C_1 Stock Prices are in line with financial results and its fluctuations are explained by financial results to a high extent.

4.5. Oracle Corporation

4.5.1. General information

Oracle Corporation (in further text – Oracle) is an IT company that develops software applications for business needs, based in California, USA.[46] The market capitalization of Oracle as of 24.10.2020 is $173.096 billion.[47] First AI acquisition by Oracle took place on April 14, 2016 when Crosswise, an AI based user data processor, was acquired.[48] Thus, AI period is marked starting from Q2 2016 to Q2 2020 and pre-AI is marked from Q4 2011 to Q4 2015, implying $\mathbf{n_1}=\mathbf{n_2}=17$. Oracle has its fiscal year ending on May 31st, for this reason all financial quarters begin and end four months later compared to other companies.

4.5.2. AI Implementation and Monetization

AI technology is directly monetized by Oracle through direct sales of AI products, such as AI Apps for ERP, Adaptive Intelligent Apps for Sales and Adaptive Intelligence Apps for Capital Management.[49]

4.5.3. Financial Data

Financial metrics in Table 12.1. represent quarterly financial results of Oracle chosen on the same basis as for Alphabet (see 3**.1.3. Financial data**, p.13). Financial data of Oracle is subject to seasonality, for this reason smoothing of the Gross Profit (the selected financial metric) was performed in the column "Gross Profit TFQ (Trailing Four Quarters)".

Table 12.1. Financial data of n_1+n_2 period, Oracle

Date	Quarter	Revenue Mil	Gross Profit Mil.	Gross Profit TFQ	R&D Expense, $Mil	Gross Profit adj. for R&D	EBIT Mil	Stock price adj.
31.08.2020	Q1_2020	9.367	7.487	7.839	1.589	5.898	3.211	59,70
31.05.2020	Q4_2019	10.440	8.471	7.783	1.479	6.992	4.308	55,04
29.02.2020	Q3_2019	9.796	7.832	7.933	1.500	6.332	3.528	47,90
30.11.2019	Q2_2019	9.614	7.566	7.884	1.531	6.035	3.183	52,27

[46] Encyclopedia Britannica, Oracle Corporation, retrieved from https://www.britannica.com/topic/Oracle-Corporation, accessed 24.10.2020
[47] Yahoo! Finance, ORCL, retrieved from https://finance.yahoo.com/quote/ORCL?p=ORCL&.tsrc=fin-srch, accessed 24.10.2020
[48] Oracle, About Oracle, Strategic Acquisitions, retrieved from https://www.oracle.com/corporate/acquisitions/crosswise/, accessed 25.10.2020
[49] Oracle, Applications, retrieved from https://www.oracle.com/applications/ai-apps/, accessed 25.10.2020

31.08.2019	Q1_2019	9.218	7.261	7.883	1.557	5.704	2.877	54,06
31.05.2019	Q4_2018	11.137	9.072	7.878	1.561	7.511	4.257	55,74
28.02.2019	Q3_2018	9.614	7.638	7.819	1.426	6.212	3.399	52,31
30.11.2018	Q2_2018	9.562	7.561	7.830	1.475	6.086	3.101	43,80
31.08.2018	Q1_2018	9.193	7.240	7.847	1.564	5.676	2.778	49,82
31.05.2018	Q4_2017	11.014	8.838	7.831	1.543	7.295	4.161	42,41
28.02.2018	Q3_2017	9.676	7.680	7.864	1.496	6.184	3.315	43,85
30.11.2017	Q2_2017	9.589	7.629	7.772	1.473	6.156	3.039	45,14
31.08.2017	Q1_2017	9.104	7.176	7.674	1.572	5.604	2.749	45,98
31.05.2017	Q4_2016	10.957	8.970	7.585	1.602	7.368	4.276	47,51
28.02.2017	Q3_2016	9.205	7.313	7.507	1.521	5.792	2.959	42,09
30.11.2016	Q2_2016	9.035	7.238	7.472	1.510	5.728	3.037	36,13
31.08.2016	Q1_2016	8.595	6.819	7.447	1.520	5.299	2.641	36,72
31.05.2016	Q4_2015	10.594	8.657	7.392	1.534	7.123	3.968	38,17
29.02.2016	Q3_2015	9.012	7.173	7.391	1.419	5.754	3.027	38,01
30.11.2015	Q2_2015	8.993	7.140	7.455	1.444	5.696	2.955	33,80
31.08.2015	Q1_2015	8.448	6.598	7.594	1.390	5.208	2.654	33,29
31.05.2015	Q4_2014	10.705	8.653	7.674	1.436	7.217	3.983	37,01
28.02.2015	Q3_2014	9.327	7.427	7.857	1.370	6.057	3.383	39,49
30.11.2014	Q2_2014	9.598	7.699	7.884	1.389	6.310	3.542	41,04
31.08.2014	Q1_2014	8.596	6.915	7.826	1.329	5.586	2.963	34,83
31.05.2014	Q4_2013	11.321	9.388	7.760	1.349	8.039	4.909	36,77
28.02.2014	Q3_2013	9.307	7.532	7.626	1.292	6.240	3.567	37,00
30.11.2013	Q2_2013	9.275	7.468	7.554	1.273	6.195	3.410	34,49
31.08.2013	Q1_2013	8.372	6.651	7.512	1.237	5.414	2.873	29,80
31.05.2013	Q4_2012	10.947	8.853	7.450	1.264	7.589	5.000	27,48
28.02.2013	Q3_2012	8.958	7.242	7.430	1.186	6.056	3.334	28,93
30.11.2012	Q2_2012	9.094	7.300	7.403	1.199	6.101	3.471	29,65
31.08.2012	Q1_2012	8.181	6.406	7.287	1.201	5.205	2.879	27,94
31.05.2012	Q4_2011	10.916	8.773	7.282	1.226	7.547	4.595	26,32

4.5.4. Regression analysis

The analysis is performed as in **3.1.4. Regression analysis** for Alphabet (see p.15). Table 12.2. represents the output. Gross Profit adj., Stock Price **(Xi, Yi)** has no correlation, Gross Profit TFQ, Stock Price **(Xi, Yi)** is presented instead.

Table 12.2. Regression analysis for n_1+n_2 period, Oracle (Xi, Yi)

Revenue, Stock Price	
Regression Statistics	
Multiple R	0,2186422
R Square	0,0478044
Adjusted R Square	0,0180483
Standard Error	8,9423848
Observations	34

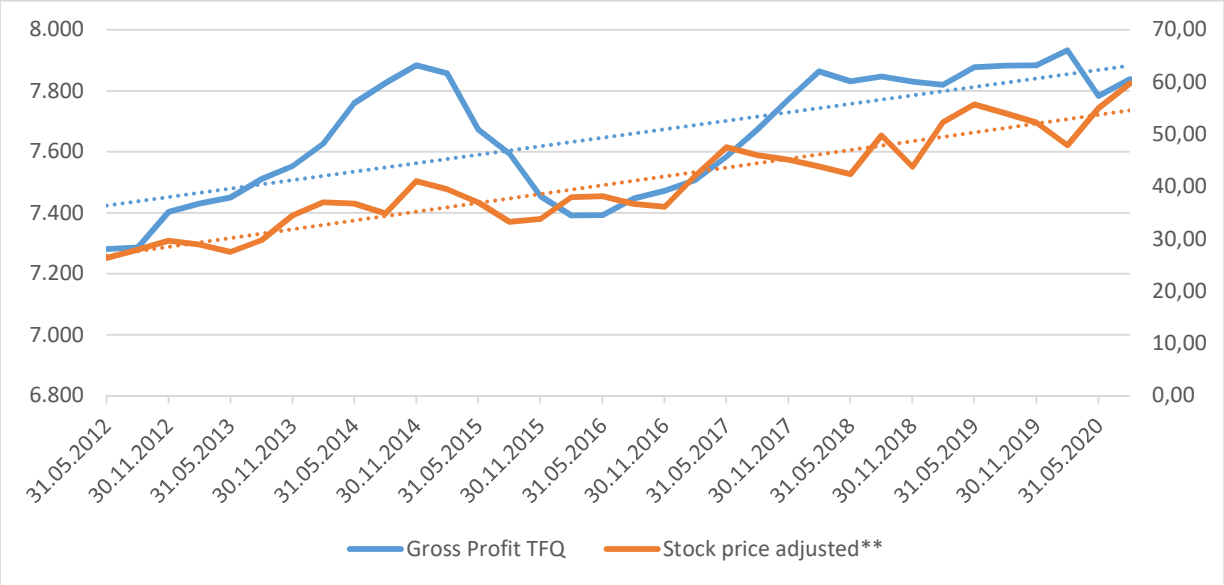
Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,186001
R Square	0,034597
Adjusted R Square	0,004428
Standard Error	9,004191
Observations	34

Gross Profit TFQ, Stock Price	
Regression Statistics	
Multiple R	0,7513132
R Square	0,5644716
Adjusted R Square	0,5508613
Standard Error	6,0478152
Observations	34

EBIT, Stock Price	
Regression Statistics	
Multiple R	0,056146
R Square	0,003152
Adjusted R Square	-0,027999
Standard Error	9,149654
Observations	34

Revenue (value 0,22) has the weak correlation while other financial metrics have no correlation with Stock Price, lying below the 0,2 value of the coefficient of correlation, Multiple R. The difference between correlations of Revenue and Gross Profit to Stock Price is <3,5%, Gross Profit is selected for further analysis for better comparability with other companies. As Oracle is subject to seasonality, an adjustment was performed to disregard seasonality in this regression analysis. Gross Profit TFQ has high correlation with Stock Price with the value of the coefficient of correlation being 0,75 and the value of coefficient of determination, R Square, being 0,56. This means that 75% of the variance in Stock Price is explained by Gross Profit TFQ fluctuations. Values of Stock Price and Gross Profit TFQ are plotted on a graph for visual analysis. Figure 12.3. represents the relationship between Gross Profit TFQ and Stock Price graphically.

Figure 12.3. Relationship between Gross Profit adj. and Stock Price, Oracle



Blue and orange dotted lines represent trend lines for Gross Profit TFQ and Stock Price respectively. The graph shows that the development of Stock Price values over time is visually similar to the development of Gross Profit TFQ with trends being parallel.

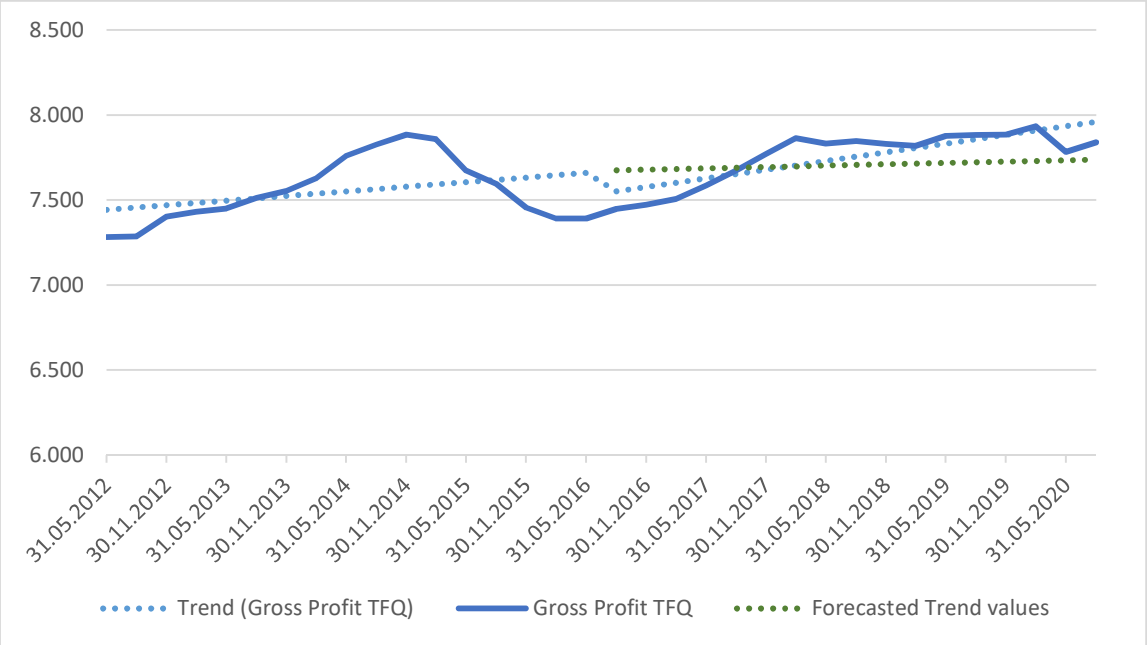
Now, trends for periods n_1, n_2 separately are calculated. Based on the trend values in pre-AI period a forecast for the trend values in AI period is performed. Table 12.4. represents the output of this procedure.

Table 12.4. Gross Profit adj. and forecasted trend values, Oracle

Period	Date	Quarter	Trend (Gross Profit TFQ)	Forecasted Trend values
AI period	31.08.2020	Q1_2020	7.960	7.739
	31.05.2020	Q4_2019	7.935	7.735
	29.02.2020	Q3_2019	7.909	7.731
	30.11.2019	Q2_2019	7.883	7.727
	31.08.2019	Q1_2019	7.858	7.723
	31.05.2019	Q4_2018	7.832	7.719
	28.02.2019	Q3_2018	7.807	7.715
	30.11.2018	Q2_2018	7.781	7.711
	31.08.2018	Q1_2018	7.756	7.707
	31.05.2018	Q4_2017	7.730	7.703
	28.02.2018	Q3_2017	7.705	7.699
	30.11.2017	Q2_2017	7.679	7.695
	31.08.2017	Q1_2017	7.653	7.691
	31.05.2017	Q4_2016	7.628	7.687
	28.02.2017	Q3_2016	7.602	7.683
	30.11.2016	Q2_2016	7.577	7.679
	31.08.2016	Q1_2016	7.551	7.675
pre-AI period	31.05.2016	Q4_2015	7.660	
	29.02.2016	Q3_2015	7.646	
	30.11.2015	Q2_2015	7.633	
	31.08.2015	Q1_2015	7.619	
	31.05.2015	Q4_2014	7.606	
	28.02.2015	Q3_2014	7.592	
	30.11.2014	Q2_2014	7.579	
	31.08.2014	Q1_2014	7.565	
	31.05.2014	Q4_2013	7.551	
	28.02.2014	Q3_2013	7.538	
	30.11.2013	Q2_2013	7.524	
	31.08.2013	Q1_2013	7.511	
	31.05.2013	Q4_2012	7.497	
	28.02.2013	Q3_2012	7.484	
	30.11.2012	Q2_2012	7.470	
	31.08.2012	Q1_2012	7.456	
	31.05.2012	Q4_2011	7.443	

Trends for Gross Profit TFQ are analyzed for both periods in Figure 12.5. and Table 12.6.

Figure 12.5. Gross Profit adj. trends in n_1 and n_2, Oracle



The difference of the trend of the observed Gross Profit TFQ in AI period compared to forecasted trend values doesn't seem to be different, although it has a slightly higher slope. **H_0** testing is not performed for Oracle as the sample size **n_1=n_2**=17 is too small to produce statistically meaningful results.

Table 12.6. Regression analysis for periods n_1 and n_2 separately. Gross Profit TFQ, Stock Price (X_i,Y_i), Oracle

pre-AI period	
Regression Statistics	
Multiple R	0,692288488
R Square	0,47926335
Adjusted R Square	0,444547574
Standard Error	3,435242743
Observations	17

AI period	
Regression Statistics	
Multiple R	0,671243
R Square	0,450567
Adjusted R Square	0,413938
Standard Error	5,074776
Observations	17

In **n_1** (pre-AI) period multiple R of 0,69 and R Square of 0,48 represent high 69% correlation between Gross Profit TFQ and Stock Price with 48% of the variance in Stock Price being explained

by fluctuations of Gross Profit TFQ. In $\mathbf{n_2}$ (AI) period multiple R is on the same level with the value 0,67 and R Square value of 0,45 representing a strong 67% correlation between Gross Profit TFQ and Stock Price.

4.5.5. Results

For Oracle, strong correlation has been found between Stock Price and Gross Profit TFQ, this correlation stayed at the same level in pre-AI and AI periods, therefore it is concluded:

$\mathbf{C_1}$ Financial data is in line with stock prices and fluctuations are explained with the observed financial results to a high extent.

According to Figure 13.3., Gross Profit TFQ developed at the same pace in AI period compared to pre-AI period. $\mathbf{H_0}$ is not tested for Oracle because of an unacceptable sample size in pre-AI and AI periods. The development of Gross Profit TFQ doesn't appear to be different in AI period compared to pre-AI period based on the visual analysis.

4.6. Baidu, Inc.

4.6.1. General information

Baidu Inc. (in further text - Baidu) is an internet search engine company that also offers community-based products[50] with headquarters in Beijin, China. The market capitalization of Baidu as of 24.10.2020 is $46.008 billion.[51] In May 2014 Baidu opened a Silicon Valley AI Lab.[52] Thus, AI period is marked starting from Q2 2012 to Q2 2014 and pre-AI is marked from Q1 2008 to Q1 2014, implying $\mathbf{n_1}$=$\mathbf{n_2}$=25.

4.6.2. AI Implementation and Monetization

AI is not directly monetized by Baidu, it is used in free-to-use features like Baidu WenKu – a document sharing platform for registered users[53], Duer, a virtual assistant using AI[54] and other.

[50] Baidu, Company Overview, retrieved from http://ir.baidu.com/company-overview/, accessed 24.10.2020
[51] Yahoo! Finance, BIDU, retrieved from https://finance.yahoo.com/quote/BIDU?p=BIDU&.tsrc=fin-srch, accessed 24.10.2020
[52] Baidu, Inc., Financial Reports, 2015 Annual Financial report, p.51, retrieved from http://ir.baidu.com/static-files/530c4b57-5d90-4c93-91c6-a91ff65dcaa2, accessed 26.10.2020
[53] Baidu, Inc., Financial Reports, 2016 Annual Financial report, p.48, retrieved from http://ir.baidu.com/static-files/e249a0f8-082a-4f8a-b60d-7417fa2f8e7e, accessed 26.10.2020
[54] Baidu, Inc., Financial Reports, 2015 Annual Financial report, p.45, retrieved from http://ir.baidu.com/static-files/530c4b57-5d90-4c93-91c6-a91ff65dcaa2, accessed 26.10.2020

4.6.3. Financial Data

Full data is only available for Revenue and Stock Price for Baidu. Table 13.1. represents this data.

Table 13.1. Financial data of n_1+n_2 period, Baidu

Date	Quarter	Revenue, $Mil.	Stock price$ adj.	Date	Quarter	Revenue, $Mil.	Stock price$ adj.
30.06.2020	Q2_2020	3.685	119,40	31.03.2014	Q1_2014	1.528	153,85
31.03.2020	Q1_2020	3.184	100,93	31.12.2013	Q4_2013	1.573	156,50
31.12.2019	Q4_2019	4.071	123,56	30.09.2013	Q3_2013	1.453	160,80
30.09.2019	Q3_2019	3.929	101,85	30.06.2013	Q2_2013	1.232	132,31
30.06.2019	Q2_2019	3.835	111,70	31.03.2013	Q1_2013	961	85,85
31.03.2019	Q1_2019	3.594	166,23	31.12.2012	Q4_2012	1.050	108,30
31.12.2018	Q4_2018	3.366	172,63	30.09.2012	Q3_2012	995	106,73
30.09.2018	Q3_2018	4.146	190,06	30.06.2012	Q2_2012	859	120,52
30.06.2018	Q2_2018	4.075	247,18	31.03.2012	Q1_2012	677	132,70
31.03.2018	Q1_2018	3.289	250,90	31.12.2011	Q4_2011	711	127,52
31.12.2017	Q4_2017	4.019	246,92	30.09.2011	Q3_2011	655	140,18
30.09.2017	Q3_2017	3.521	243,94	30.06.2011	Q2_2011	528	157,07
30.06.2017	Q2_2017	3.043	226,35	31.03.2011	Q1_2011	342	148,52
31.03.2017	Q1_2017	2.451	180,23	31.12.2010	Q4_2010	372	108,63
31.12.2016	Q4_2016	2.208	175,07	30.09.2010	Q3_2010	337	110,01
30.09.2016	Q3_2016	2.738	176,86	30.06.2010	Q2_2010	282	81,41
30.06.2016	Q2_2016	2.796	159,60	31.03.2010	Q1_2010	190	68,90
31.03.2016	Q1_2016	2.419	194,30	31.12.2009	Q4_2009	185	41,17
31.12.2015	Q4_2015	2.887	163,27	30.09.2009	Q3_2009	187	37,79
30.09.2015	Q3_2015	2.939	187,47	30.06.2009	Q2_2009	161	34,81
30.06.2015	Q2_2015	2.722	172,66	31.03.2009	Q1_2009	119	23,29
31.03.2015	Q1_2015	2.074	200,28	31.12.2008	Q4_2008	132	12,88
31.12.2014	Q4_2014	2.264	217,92	30.09.2008	Q3_2008	134	20,60
30.09.2014	Q3_2014	2.203	238,77	30.06.2008	Q2_2008	116	34,72
30.06.2014	Q2_2014	1.932	216,05	31.03.2008	Q1_2008	82	35,56

4.6.4. Regression analysis

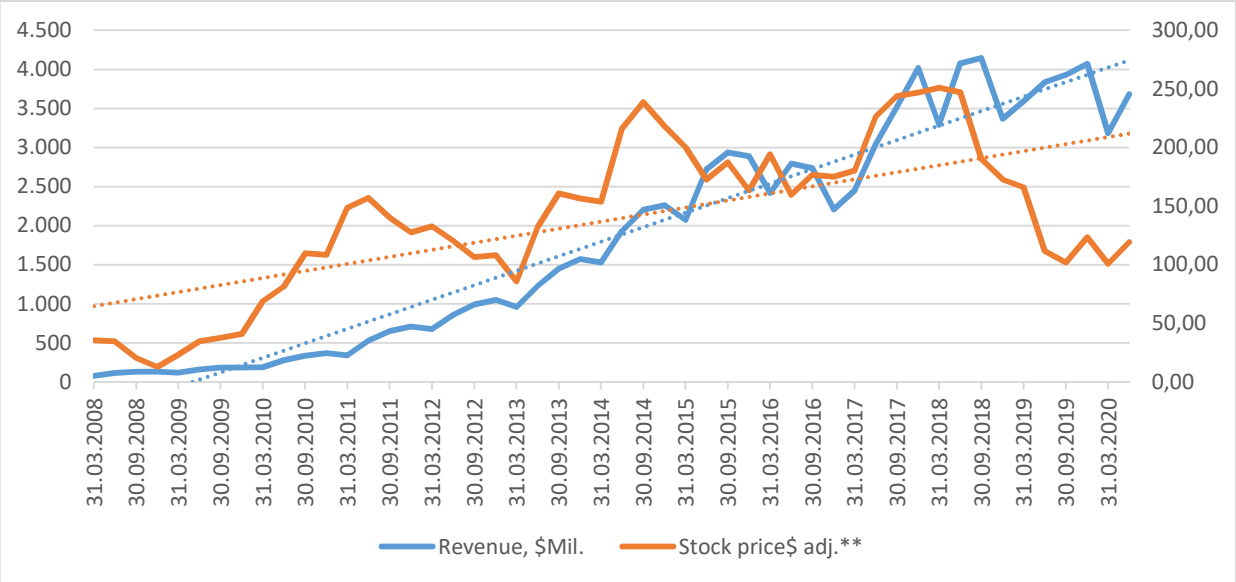
As there is only Revenue data available, the regression analysis is performed in one table 13.2.

Table 13.2. Regression analysis for periods n_1+n_2 and n_1, n_2 separately. Revenue, Stock Price (X_i,Y_i), Baidu

n1+n2 period		**n1** period		**n2** period	
Regression Statistics		*Regression Statistics*		*Regression Statistics*	
Multiple R	0,678116	Multiple R	0,759535	Multiple R	0,235336
R Square	0,459841	R Square	0,576893	R Square	0,055383
Adjusted R Square	0,448588	Adjusted R Square	0,558497	Adjusted R Square	0,014313
Standard Error	49,00215	Standard Error	33,46154	Standard Error	46,14479
Observations	50	Observations	25	Observations	25

Revenue and Stock Price of Baidu have high correlation in **n_1** (pre-AI) and **n_1+n_2** (overall observed) periods with the value of the coefficient of correlation being above 0,6. In **n_2** (AI) period, this correlation has decreased to very weak being below 0.39. The coefficient of determination of 0,46 means that 46% of the variance in Stock Price is explained by Revenue fluctuation over the observed timeframe **(n_1+n_2)**. Figure 13.3. represents the relationship between Revenue and Stock Price graphically.

Figure 13.3. Relationship between Revenue and Stock Price, Baidu



Blue and orange dotted lines represent trend lines for Revenue and Stock Price respectively. The graph shows that the development of Stock Price values over time is not visually similar to the development of Revenue, especially in AI period, with trends having different slopes over the observed timeframe.

4.6.5. Results

For Baidu, only Revenue was analyzed because of lacking data for other metrics. The correlation between Stock Price and Revenue was found to be strong for $\mathbf{n_1}$ (AI) and $\mathbf{n_1+n_2}$ (the whole timeframe) periods. In $\mathbf{n_2}$ (AI) period the correlation is weak, therefore it is concluded:

$\mathbf{C_3}$ Financial data does not explain the fluctuations on the stock market – stock prices of the company are not fluctuating according to fundamental financial factors.

$\mathbf{H_0}$ is not tested for Baidu because of lacking data and high volatility of Stock Price.

4.7. Facebook

4.7.1. General information

Facebook is a company providing social networking services with headquarters in California, USA.[55] The market capitalization of Facebook as of 24.10.2020 is $807.042 billion.[56] First AI acquisition by Facebook took place in June 2012 when it acquired Face.com, a facial recognition technology.[57] Thus, AI period is marked starting from Q3 2012 to Q2 2020 and pre-AI is marked from Q4 2012 to Q2 2012, implying $\mathbf{n_1}$=10, $\mathbf{n_2}$=32.

4.7.2. AI Implementation and Monetization

Facebook doesn't monetize AI directly, it is used in features such as face mask filters and other across the Facebook social network that is free-to-use.

4.7.3. Financial Data

Financial metrics in Table 14.1. represent quarterly financial results of Facebook chosen on the same basis as for Alphabet (see Alphabet, Financial data, p.13).

[55] Encyclopedia Britannica, Facebook, retrieved from https://www.britannica.com/topic/Facebook, accessed 24.10.2020

[56] Yahoo! Finance, FB, retrieved from https://finance.yahoo.com/quote/FB?p=FB&.tsrc=fin-srch, accessed on 25.10.2020

[57] Mergr: M&A and Private Equity Database, retrieved from https://mergr.com/facebook-acquisitions, accessed 26.10.2020

Table 14.1. Financial data of n_1+n_2 period, Facebook

Date	Quarter	Revenue, $Mil.	Gross Profit, $Mil.	R&D Expense, $Mil	Gross Profit adj.	EBIT, $Mil	Stock price$ adjusted
30.06.2020	Q2_2020	18.687	14.858	4.462	10.396	5.963	253,67
31.03.2020	Q1_2020	17.737	14.278	4.015	10.263	5.893	204,71
31.12.2019	Q4_2019	21.082	17.590	3.877	13.713	8.858	201,91
30.09.2019	Q3_2019	17.652	14.497	3.548	10.949	7.185	191,65
30.06.2019	Q2_2019	16.886	13.579	3.315	10.264	4.626	194,23
31.03.2019	Q1_2019	15.077	12.261	2.860	9.401	3.317	193,40
31.12.2018	Q4_2018	16.914	14.118	2.885	11.233	7.820	166,69
30.09.2018	Q3_2018	13.727	11.309	2.657	8.652	5.781	151,79
30.06.2018	Q2_2018	13.231	11.017	2.523	8.494	5.863	172,58
31.03.2018	Q1_2018	11.966	10.039	2.238	7.801	5.449	172,00
31.12.2017	Q4_2017	12.972	11.362	1.949	9.413	7.353	186,89
30.09.2017	Q3_2017	10.328	8.880	2.052	6.828	5.122	180,06
30.06.2017	Q2_2017	9.321	8.084	1.919	6.165	4.401	169,25
31.03.2017	Q1_2017	8.032	6.873	1.834	5.039	3.327	150,25
31.12.2016	Q4_2016	8.809	7.762	1.563	6.199	4.566	130,32
30.09.2016	Q3_2016	7.011	6.024	1.542	4.482	3.117	130,99
30.06.2016	Q2_2016	6.436	5.519	1.471	4.048	2.734	123,94
31.03.2016	Q1_2016	5.382	4.544	1.343	3.201	2.010	117,58
31.12.2015	Q4_2015	5.842	5.017	1.313	3.704	2.560	112,21
30.09.2015	Q3_2015	4.501	3.781	1.271	2.510	1.459	101,97
30.06.2015	Q2_2015	4.042	3.374	1.170	2.204	1.273	94,01
31.03.2015	Q1_2015	3.543	2.889	1.062	1.827	933	78,77
31.12.2014	Q4_2014	3.851	3.198	1.111	2.087	1.132	75,21
30.09.2014	Q3_2014	3.203	2.638	608	2.030	1.397	74,99
30.06.2014	Q2_2014	2.910	2.437	492	1.945	1.390	72,65
31.03.2014	Q1_2014	2.502	2.040	455	1.585	1.075	59,78
31.12.2013	Q4_2013	2.585	2.095	409	1.686	1.133	62,57
30.09.2013	Q3_2013	2.016	1.509	369	1.140	736	50,21
30.06.2013	Q2_2013	1.813	1.348	344	1.004	562	36,80
31.03.2013	Q1_2013	1.458	1.045	293	752	373	27,77
31.12.2012	Q4_2012	1.585	1.187	297	890	523	30,98
30.09.2012	Q3_2012	1.262	940	244	696	377	21,11
30.06.2012	Q2_2012	1.184	817	705	112	-743	21,71
31.03.2012	Q1_2012	1.058	781	153	628	381	n/a
31.12.2011	Q4_2011	1.131	884	124	760	548	n/a
30.09.2011	Q3_2011	954	718	108	610	414	n/a
30.06.2011	Q2_2011	895	685	99	586	407	n/a
31.03.2011	Q1_2011	731	564	57	507	388	n/a
31.12.2010	Q4_2010	731	581	45	536	437	n/a
30.09.2010	Q3_2010	467	336	41	295	216	n/a
30.06.2010	Q2_2010	431	320	32	288	218	n/a
31.12.2009	Q1_2010	34	245	25	220	162	n/a

4.7.4. Regression analysis

The analysis is performed as in **3.1.4. Regression analysis** for Alphabet (see p.15). Table 14.2. represents the output. Periods are adjusted for Facebook as it wasn't listed on stock markets before Q2 2012.

Table 14.2. Regression analysis for n_1-9+n_2 period, Facebook (Xi, Yi)

Revenue, Stock Price	
Regression Statistics	
Multiple R	0,9359887
R Square	0,8760749
Adjusted R Square	0,8720773
Standard Error	22,941177
Observations	33

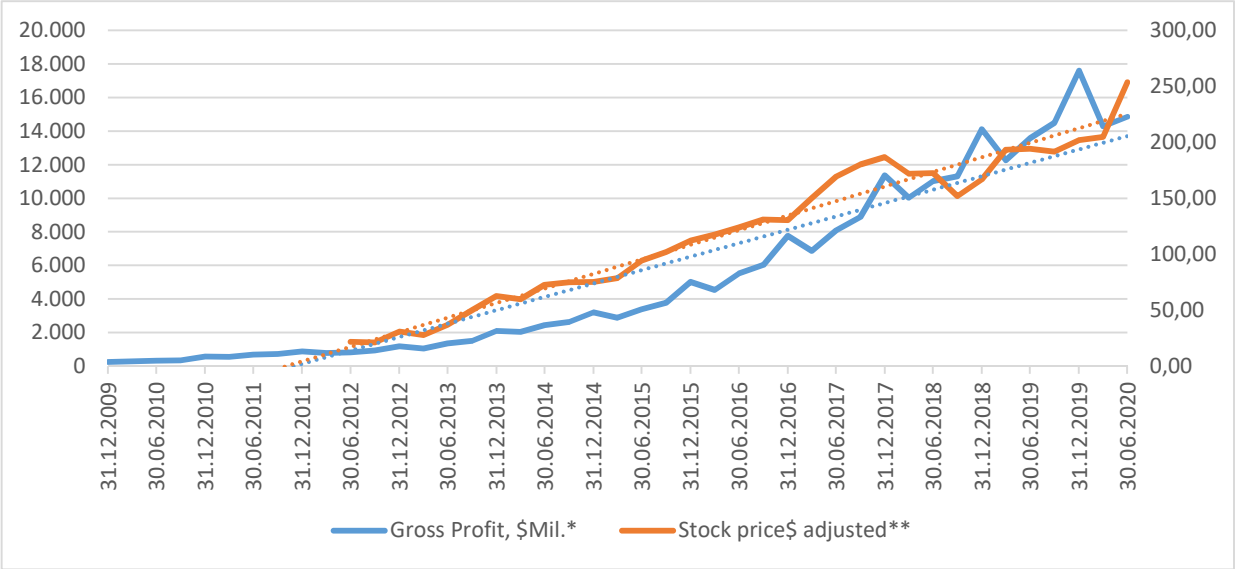
Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,9412249
R Square	0,8859043
Adjusted R Square	0,8822238
Standard Error	22,012569
Observations	33

adj. Gross Profit, Stock Price	
Regression Statistics	
Multiple R	0,9305305
R Square	0,8658869
Adjusted R Square	0,8615607
Standard Error	23,865556
Observations	33

EBIT, Stock Price	
Regression Statistics	
Multiple R	0,8896553
R Square	0,7914866
Adjusted R Square	0,7847603
Standard Error	29,757953
Observations	33

All financial metrics of Facebook have a very strong correlation with Stock Price, lying above the 0,8 value of the coefficient of correlation, Multiple R. Gross Profit has the strongest correlation with Stock Price with a 0.94 value. R Square or Coefficient of Determination returns the value 0.89 for Gross Profit, Stock Price ($\mathbf{X_i, Y_i}$). This means that 89% of the variance in Stock Price is explained by Gross Profit adj. fluctuations. Values of Stock Price and Gross Profit adj. are plotted on a graph for visual analysis. Figure 14.3. represents the relationship between Gross Profit and Stock Price graphically.

Figure 14.3. Relationship between Gross Profit and Stock Price, Facebook



Blue and orange dotted lines represent trend lines for Revenue and Stock Price respectively. The graph shows that the development of Stock Price and Gross Profit has different patterns over time but the trend lines of Stock Price and Gross Profit are parallel.

Regression analysis is not performed and trends are not analyzed for pre-AI and AI periods separately as there is not enough data in pre-AI period. **H_0** is not tested for the same reason.

4.7.5. Results

For Facebook, the correlation between Stock Price and all financial metrics was found to be very strong with trends of Stock Price and Gross Profit being parallel, therefore it is concluded:

C_1 Financial data is in line with stock prices and fluctuations are explained with observed financial results to a high extent.

5. Conclusion

$\mathbf{H_0}$ was rejected with the $\mathbf{T_{obs}}$ value falling in the upper critical region for two companies: Alphabet and Amazon. The financial performance of these companies in AI period is concluded to be significantly better compared to the forecast.

$\mathbf{H_0}$ was rejected with the $\mathbf{T_{obs}}$ value falling in the lower critical region for two companies: IBM and Apple. The financial performance of these companies in AI period is concluded to be significantly worse compared to the forecast.

$\mathbf{H_0}$ could not be rejected with the $\mathbf{T_{obs}}$ falling within the Confidence Interval for three companies: Intel, NICE and Microsoft.

The fluctuations of Stock Prices were found to be explained to a high extent by fluctuations of financial metrics for six companies in the **Main Group**: Alphabet, Intel, NICE, Amazon, Microsoft and Apple. The conclusions considering market performance of these firms match the conclusions considering their financial performance. Stock Prices of one company, IBM, were found to be uncorrelated with the fluctuations of its financial metrics, no conclusions considering market performance were made for IBM.

The results of the supporting study suggest that two of the seven investigated companies have notably better financial performance in AI period with high correlation to Stock Prices: NVIDIA and Salesforce. One company, Verizon, has notably worse results in AI period compared to pre-AI period with a moderate correlation to Stock Price. One company, Oracle, did not show any significant difference in financial performance and has a strong correlation between its financial metrics and Stock Price. Conclusions considering financial performance for Facebook could not be made because of lacking data, but Facebook has shown a strong correlation between its financial metrics and Stock Price. Baidu has shown high volatility in its performance with no correlation of its financial metrics with Stock Price, therefore no conclusions considering its financial performance could be drawn. EBAY has shown moderate correlation and an extreme downswing of its financial performance in pre-AI period, therefore no conclusions considering its financial performance could be drawn.

References

Alphabet, 2015 Alphabet Annual Report, p. 5 retrieved from https://abc.xyz/investor/static/pdf/2015_alphabet_annual_report.pdf?cache=40474a1, accessed 10.10.2020

Anthony Ha, Tech Crunch, 2015, Salesforce Acquires Smart Calendar Startup Tempo, App Will Shut Down On June 30, retrieved from https://techcrunch.com/2015/05/29/salesforce-acquires-tempo/, accessed 25.10.2020

Apple, Apple at Work, retrieved from https://www.apple.com/business/, accessed 24.10.2020

Baidu, Company Overview, retrieved from http://ir.baidu.com/company-overview/, accessed 24.10.2020

Baidu, Inc., Financial Reports, 2015 Annual Financial report, p. 45-51, retrieved from http://ir.baidu.com/static-files/530c4b57-5d90-4c93-91c6-a91ff65dcaa2, accessed 26.10.2020

Baidu, Inc., Financial Reports, 2016 Annual Financial report, p.48, retrieved from http://ir.baidu.com/static-files/e249a0f8-082a-4f8a-b60d-7417fa2f8e7e, accessed 26.10.2020

Catherine Shu, Tech Crunch, 2014, Google Acquires Artificial Intelligence Startup DeepMind For More Than $500M, retrieved from https://techcrunch.com/2014/01/26/google-deepmind/, accessed 24.10.2020

CCNBC, Enterprise, "Google is finding ways to make money from Alphabet's DeepMind A.I. technology", 31.03.2018, retrieved from retrieved from https://www.cnbc.com/2018/03/31/how-google-makes-money-from-alphabets-deepmind-ai-research-group.html, accessed 20.10.2020

Crunchbase, Acquisitions, retrieved from https://www.crunchbase.com/acquisition/intel-acquires-indisys--64ed3847, accessed 24.10.2020

Crunchbase, Netbreeze acquired by Microsoft, retrieved from https://www.crunchbase.com/acquisition/microsoft-acquires-netbreeze--40d0f88d, accessed 23.10.2020

EBAY, Machine Learning in Engineering, eBay's Platform is Powered by AI and Fueled by Customer Input, retrieved from https://tech.ebayinc.com/engineering/ebays-platform-is-powered-by-ai-and-fueled-by-customer-input/, accessed 28.10.2020

EBAY, Stories, retrieved from https://www.ebayinc.com/stories/news/ebay-acquires-expertmaker/, accessed 24.10.2020

Encyclopedia Britannica, Amazon.com, Inc., retrieved from https://www.britannica.com/topic/Amazoncom, accessed 24.10.2020

Encyclopedia Britannica, IBM, retrieved from https://www.britannica.com/topic/International-Business-Machines-Corporation, accessed 24.10.2020

Encyclopedia Britannica, NVIDIA Corporation, retrieved from https://www.britannica.com/topic/NVIDIA-Corporation, accessed 24.10.2020

Encyclopedia Britannica, EBAY retrieved from https://www.britannica.com/topic/eBay, accessed 24.10.2020

Encyclopedia Britannica, Oracle Corporation, retrieved from https://www.britannica.com/topic/Oracle-Corporation, accessed 24.10.2020

Encyclopedia Britannica, Facebook, retrieved from https://www.britannica.com/topic/Facebook, accessed 24.10.2020

Fast Company, Inside Intel's billion-dollar transformation in the age of AI, 2019, retrieved from https://www.fastcompany.com/90425160/inside-intels-billion-dollar-transformation-in-the-age-of-ai, accessed 24.10.2020

IBM, AI Services, retrieved from https://cloud.ibm.com/catalog?category=ai#services, accessed 23.10.2020

Intel, About Intel, retrieved from https://www.intc.com/about-intel, accessed 24.10.2020

Intel, How Intel Uses AI to Identify Sales & Marketing Opportunities, retrieved from https://www.intel.com/content/www/us/en/artificial-intelligence/posts/ai-identifies-sales-marketing-opportunities.html, accessed 24.10.2020

Macrotrends, Financials, retrieved from https://www.macrotrends.net/stocks/charts/>insert company index</>insert company name</income-statement, accessed in August 2020

McCarthy, J., Minsky, M. L., Rochester, N., & Shannon, C. E. (2006, Winter). A proposal for the Dartmouth summer research project on artificial intelligence: August 31, 1955. AI Magazine, 27(4), 12+. https://link.gale.com/apps/doc/A157035547/AONE?u=43wien&sid=AONE&xid=84189b50

Mergr: M&A and Private Equity Database, retrieved from https://mergr.com/facebook-acquisitions, accessed 26.10.2020

Mergr: M&A and Private Equity Database, retrieved from https://mergr.com/aol-acquisitions, accessed 25.10.2020

Microsoft, Microsoft Azure, Azure Cognitive Services, retrieved from https://azure.microsoft.com/ru-ru/services/cognitive-services/, accessed 23.10.2020

NICE, Company Overview, retrieved from https://www.nice.com/about-nice/company-overview/, accessed 23.10.2020

NICE, Press Releases, NICE to Acquire Causata to Enable a Seamless Customer Experience across the Web and Contact Center, retrieved from https://www.nice.com/press-releases/NICE-to-Acquire-Causata-to-Enable-a-Seamless-Customer-Experience-across-the-Web-and-Contact-Center-155/, accessed 23.10.2020

NICE, Press Releases, NICE Revolutionizes IVR Optimization with Advanced Artificial Intelligence, retrieved from https://www.nice.com/engage/press-releases/NICE-Revolutionizes-IVR-Optimization-with-Advanced-Artificial-Intelligence-691/, accessed 23.10.2020

NICE, Press Releases, NICE inContact CXone Expands Artificial Intelligence Apps with Speech-Enabled Virtual Assistants and AI Chatbots from Omilia, retrieved from https://www.nice.com/engage/press-releases/NICE-inContact-CXone-Expands-Artificial-Intelligence-Apps-with-SpeechEnabled-Virtual-Assistants-and-AI-Chatbots-from-Omilia-605/

NVIDIA, About NVIDIA, retrieved from https://www.nvidia.com/en-us/about-nvidia/corporate-timeline/, accessed 24.10.2020

Oracle, Applications, retrieved from https://www.oracle.com/applications/ai-apps/, accessed 25.10.2020

Ross A., Willson V.L. (2017) One-Sample T-Test. In: Basic and Advanced Statistical Tests. SensePublishers, Rotterdam. https://doi.org/10.1007/978-94-6351-086-8_2

Rouaud, Mathieu (2013). Probability, Statistics and Estimation, p.10

Samuel Axon, arstechnica, Here's why Apple believes it's an AI leader—and why it says critics have it all wrong, 2020, retrieved from https://arstechnica.com/gadgets/2020/08/apple-explains-how-it-uses-machine-learning-across-ios-and-soon-macos/#h2, accessed 23.10.2020

Salesforce, Products, retrieved from https://www.salesforce.com/products/?d=cta-body-promo-8, accessed 25.10.2020

Salesforce, Products, Einstein, retrieved from https://www.salesforce.com/products/einstein/roles/, accessed 24.10.2020r

Sarah Perez, Tech Crunch, 2014, Speech Recognition Pioneer Novauris Bought By Apple, Team Now Works On Siri, retrieved from https://techcrunch.com/2014/04/03/speech-recognition-pioneer-novauris-bought-by-apple-team-now-works-on-siri/, accessed 23.10.2020

Stephanie Condon, ZDNet, Amazon shares how it leverages AI throughout the businessretrieved from https://www.zdnet.com/article/amazon-shares-how-it-leverages-ai-throughout-the-business/, accessed 22.10.2020

Verizon, About our Company, retrieved from https://www.verizon.com/about/our-company, accessed 25.10.2020

Verizon, About our Company, How Verizon is using artificial intelligence and machine learning to help maintain network superiority, 2018, retrieved from https://www.verizon.com/about/our-company/fourth-industrial-revolution/how-verizon-using-artificial-intelligence-and-machine-learning-help-maintain-network, accessed 25.10.2020

Yahoo! Finance, CRM, retrieved from https://finance.yahoo.com/quote/CRM?p=CRM&.tsrc=fin-srch, accessed 25.10.2020

Yahoo! Finance, ORCL, retrieved from https://finance.yahoo.com/quote/ORCL?p=ORCL&.tsrc=fin-srch, accessed 24.10.2020

Yahoo! Finance, AAPL, retrieved from https://finance.yahoo.com/quote/AAPL?p=AAPL&.tsrc=fin-srch, accessed 24.10.2020

Yahoo! Finance, INTC, retrieved from https://finance.yahoo.com/quote/INTC?p=INTC&.tsrc=fin-srch, accessed 24.10.2020

Yahoo! Finance, NICE, retrieved from https://finance.yahoo.com/quote/NICE?p=NICE&.tsrc=fin-srch, accessed 23.10.2020

Yahoo! Finance, AMZN, retrieved from https://finance.yahoo.com/quote/AMZN?p=AMZN&.tsrc=fin-srch, accessed on Oct 12, 2020

Yahoo! Finance, MSFT, retrieved from https://finance.yahoo.com/quote/MSFT?p=MSFT&.tsrc=fin-srch, accessed on 20.10.2020

Yahoo! Finance, IBM, retrieved from https://finance.yahoo.com/quote/IBM?p=IBM&.tsrc=fin-srch, accessed 23.10.2020

Yahoo! Finance, VZ, retrieved from https://finance.yahoo.com/quote/VZ?p=VZ&.tsrc=fin-srch, accessed 25.10.2020

Yahoo! Finance, NVDA, retrieved from https://finance.yahoo.com/quote/NVDA?p=NVDA&.tsrc=fin-srch, accessed 24.10.2020

Yahoo! Finance, EBAY, retrieved from https://finance.yahoo.com/quote/EBAY?p=EBAY&.tsrc=fin-srch, accessed 24.10.2020

Yahoo! Finance, FB, retrieved from https://finance.yahoo.com/quote/FB?p=FB&.tsrc=fin-srch, accessed 24.10.2020

Yahoo! Finance, GOOG, retrieved from https://finance.yahoo.com/quote/GOOG?p=GOOG&.tsrc=fin-srch, accessed 24.10.2020

Yahoo! Finance, BIDU, retrieved from https://finance.yahoo.com/quote/BIDU?p=BIDU&.tsrc=fin-srch, accessed 24.10.2020

Abstract (EN):

In recent years, Artificial Intelligence has been disrupting various industries with more and more companies joining the "AI race" as time goes. As of 2020, some of the companies have been implementing AI for over five years and have sufficient data to assess whether this technology is worth investing time and money in its development. This Master's Thesis investigates the financial performance of big tech companies after they started implementing AI technology in their business activities and compares it with the forecast, which is based on the financial performance of the company over the same timeframe before AI implementation using a statistical one sample t-test. Additionally, this test is supported by a linear regression analysis evaluating the correlation between financial results and fluctuations of stock prices of investigated companies. The results suggest that, out of seven investigated companies, two have shown a significantly better financial performance compared to the forecast after AI implementation, two have shown a significantly worse performance and three have not shown a significant difference.

Keywords: Artificial Intelligence/AI/tech giants/financial performance/stock price/

Abstract (DE)

In den letzten Jahren hat die künstliche Intelligenz (KI) verschiedene Branchen gestört. Im Laufe der Zeit haben sich immer mehr Unternehmen dem „AI Race“ angeschlossen. Ab 2020 implementieren einige Unternehmen AI seit mehr als fünf Jahren und verfügen über ausreichende Daten, um zu beurteilen, ob es sich lohnt, Zeit und Geld in ihre Entwicklung zu investieren. Diese Masterarbeit untersucht die finanzielle Leistung großer Technologieunternehmen, nachdem sie mit der Implementierung von KI-Technologie in ihren Geschäftsaktivitäten begonnen haben, und vergleicht sie mit der Prognose, die auf der finanziellen Leistung des Unternehmens im gleichen Zeitraum vor der KI-Implementierung basiert, anhand eines Einstichproben-t-Tests. Zusätzlich wird dieser Test durch eine lineare Regressionsanalyse unterstützt, die die Korrelation zwischen Finanzergebnissen und Schwankungen der Aktienkurse der untersuchten Unternehmen analysiert. Die Ergebnisse legen nahe, dass von sieben untersuchten Unternehmen zwei eine signifikant bessere finanzielle Leistung im Vergleich zur Prognose nach der Implementierung der KI zeigten, zwei eine signifikant schlechtere Leistung zeigten und drei keinen signifikanten Unterschied zeigten.