

**Czech University of Life Sciences Prague**

**Faculty of Economics and Management**

**Department of Economics**



Diploma Thesis

**Analysis of stock indices (PX, DAX, S&P 500)**

Author: Ondřej Novák

Supervisor: Ing. Petr Procházka, MSc. Ph.D.

© 2016 CULS Prague

# CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

## DIPLOMA THESIS ASSIGNMENT

Ondřej Novák

Economics and Management

Thesis title

**Analysis of stock indices (S&P 500, PX, DAX)**

---

### Objectives of thesis

Objectives of thesis: Evaluate current and future development of the stock indices S&P 500, PAX and DX. Particularly compare those indexes with each other and evaluate their market performance. Determine main factors affecting the progress of the indices and application of the findings on trading.

### Methodology

Literature review is conducted using methods of extraction, synthesis, induction and deduction. Goals of the analytical section are achieved using regression analysis and various particular methods of technical analysis of quantitative data (SMA, Bollinger Bands, RSI, MACD)

**The proposed extent of the thesis**

60 – 80 pages

**Keywords**

stock, index, regression analysis, technical analysis, charts, S&P 500, PX, DAX, forecast, market, exchange

---

**Recommended information sources**

- GRAHAM, Benjamin a Jason ZWEIG. The intelligent investor. Rev. ed. New York: HarperBusiness Essentials, c2003, xiv, 623 p. ISBN 00-605-5566-1.
- JÍLEK, Josef. Finance v globální ekonomice II: Měnová a kurzová politika. 1. vyd. Praha: Grada, 2013, 557 s. Finanční trhy a instituce. ISBN 978-80-247-4516-9.
- MALKIEL, Burton Gordon. A random walk down Wall Street: the time-tested strategy for successful investing. Rev. and updated ed. New York: W.W. Norton, c2012, 489 p. ISBN 03-933-4074-0.
- SHILLER, Robert J. Irrational exuberance. 2nd ed. New York: Currency/Doubleday, c2005, xxvii, 304 p. ISBN 978-076-7923-637.
- 

**Expected date of thesis defence**

2015/16 WS – FEM

**The Diploma Thesis Supervisor**

Ing. Petr Procházka, Ph.D., MSc

**Supervising department**

Department of Economics

Electronic approval: 6. 10. 2014

**prof. Ing. Miroslav Svatoš, CSc.**

Head of department

Electronic approval: 6. 10. 2014

**Ing. Martin Pelikán, Ph.D.**

Dean

Prague on 25. 11. 2015

### **Declaration**

I declare that I have worked on my diploma thesis titled "Analysis of world indexes (PX, DAX, S&P 500)" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any third person.

In Prague .....

.....

Ondřej Novák

## **Acknowledgement**

I would like to thank Ing. Petr Procházka, Msc. Ph.D. for his support, supervision, and assistance during the assessment of my diploma thesis. Also, I would like to thank my friend Thibaut Bandarra, for commenting on the results of the thesis. My last thank you is for my girlfriend, Ing. Nikola Holečková, for the incredible patience she had with me, during the period of creating this thesis.

# **Analysis of stock indices (PX, DAX, S&P 500)**

---

## **Analýza burzovních indexů (PX, DAX, S&P 500)**

### **Summary**

This diploma thesis is focused on the analysis of world indices, namely PX, DAX and S&P 500. It is divided into two parts, both complementing each other as a source of information. Theoretical part examines the theory of an index, then examines indices separately, evaluating their performance, constituents, and a brief history. It also talks about the reason for investing in index funds and how a person can invest in such thing. The practical part uses technical analysis as a key factor of evaluating the past and future performance and gives advice, whether the current signal is a buy or sell. Regression analysis, the second part of the practical part, assess whether the indices are affecting each other and if so, how significant is the relationship. The output of this thesis is an outlook how selected indices behaves, their detailed performance and gives recommendation, whether there are any positive or negative signals for trading

**Keywords:** stock, index, regression analysis, technical analysis, charts, S&P 500, PX, DAX, forecast, market, exchange

## **Souhrn**

Tato diplomová práce se soustředí na analýzu světových indexů, zejména PX, DAX a S&P 500. Je rozdělena do dvou částí, které se vzájemně doplňují a poskytují informační kanál skrze celou tuto práci. První část, zabývající se teoretickou částí problematiky, zkoumá teorii na pozadí indexů, následně analyzuje každý index zvlášť, hodnotí jejich výkonnost a krátce popisuje historii. Poskytuje podpůrné informace pro investování do indexových fondů a jak se do jednotlivých fondů, které kopírují zkoumané indexy, investuje. Druhá část, která prakticky analyzuje všechny tři indexy, používá technickou analýzu jako klíčový faktor pro vysvětlení budoucí a minulé výkonnosti a podává současný signál pro nákup či prodej. Regresní analýza, sloužící v této práci jako podpůrná analýza a jako druhá část praktické části, vysvětluje, jak se indexy vzájemně ovlivňují a do jaké míry. Výsledek této práce je přehled jak se jmenované indexy chovají, jaká je jejich výkonnost a podání doporučení, zdali jsou přítomné signály pro nákup či prodej.

**Klíčová slova:** akcie, index, regresní analýza, technická analýza, grafy, S & P 500, PX, DAX, předpověď, trh, burza

## Table Of Contents

<b>1</b>	<b>INTRODUCTION .....</b>	<b>8</b>
<b>2</b>	<b>OBJECTIVES AND METHODOLOGY .....</b>	<b>9</b>
2.1	Objectives .....	9
2.2	Methodology.....	9
<b>3</b>	<b>LITERATURE REVIEW .....</b>	<b>10</b>
3.1	Definition of Index .....	10
3.2	Index Investing .....	10
3.2.1	Reason for index investing .....	11
3.2.2	Index Investing and the Efficient Market Hypothesis .....	12
3.2.3	Types of indexes .....	13
3.3	Selected Indexes .....	14
3.4	PX Index .....	15
3.4.1	Current performance of PX Index .....	15
3.4.2	How PX Index is Calculated .....	16
3.4.3	Constituents of the PX Index.....	17
3.4.4	Criteria for entering the index .....	17
3.4.5	Prague Stock Exchange (PSE).....	18
3.4.6	History of Prague Stock Exchange .....	19
3.5	DAX.....	19
3.5.1	Current performance of DAX Index.....	20
3.5.2	Constituents of the DAX Index .....	21
3.5.3	Criteria for entering the Index .....	21
3.5.4	Frankfurt Stock Exchange .....	22
3.5.5	History of Frankfurt Stock Exchange .....	22
3.6	Standard and Poor's 500 Index .....	23



3.6.1	Current Performance of S&P 500.....	24
3.6.2	How S&P 500 is calculated.....	24
3.6.3	Constituents of the S&P 500 Index.....	24
3.6.4	Criteria for entering the Index.....	25
3.6.5	History of US Stock Exchanges.....	26
3.7	How to Invest in Selected Indexes.....	27
3.7.1	PX Investing.....	28
3.7.2	DAX Investing.....	28
3.7.3	S&P 500 Investing.....	29
3.8	Regression Analysis.....	30
3.8.1	Spurious Regression.....	31
3.8.2	Durbin-Watson Value.....	32
3.9	Technical Analysis - Introduction.....	33
3.9.1	Selected Technical Analysis tools.....	34
3.9.2	Moving Averages.....	34
3.9.3	Bollinger Bands.....	36
3.9.4	MACD – Moving Average Convergence Divergence.....	37
3.9.5	Relative Strength Index.....	38
<b>4</b>	<b>ANALYSIS.....</b>	<b>40</b>
4.1	Technical Analysis of PX.....	40
4.1.1	Moving averages.....	40
4.1.2	Bollinger Bands.....	42
4.1.3	MACD.....	44
4.1.4	Relative Strength Index.....	45
4.2	Regression Analysis of the PX.....	46
4.2.1	Gretl Results of the Regression Analysis.....	47

4.2.2	Economic verification of the model .....	47
4.3	Technical Analysis of DAX .....	48
4.3.1	Moving Averages .....	48
4.3.2	Bollinger Bands .....	50
4.3.3	MACD .....	52
4.3.4	Relative Strength Index .....	53
4.4	Regression Analysis of DAX .....	54
4.4.1	Gretl Results of the Regression Analysis .....	54
4.4.2	Economic Verification of the Model .....	55
4.5	Technical Analysis of S&P 500.....	55
4.5.1	Moving Averages .....	56
4.5.2	Bollinger Bands .....	58
4.5.3	MACD .....	60
4.5.4	Relative Strength Index .....	61
4.6	Regression Analysis of S&P 500.....	62
4.6.1	Gretl Results of the Regression Analysis .....	62
4.6.2	Economic Verification of the model. ....	63
4.6.3	Relationship with US Treasury Bills .....	64
4.6.4	Gretl Results for Regression Analysis.....	65
4.6.5	Economic Verification of the model .....	66
<b>5</b>	<b>RESULTS AND DISCUSSIONS.....</b>	<b>67</b>
5.1	Result of PX analysis.....	67
5.2	Results of DAX analysis.....	68
5.3	Results of S&P 500 analysis.....	69
5.4	Low Durbin-Watson value .....	70
<b>6</b>	<b>CONCLUSIONS AND RECOMMENDATIONS .....</b>	<b>71</b>

<b>7</b>	<b>BIBLIOGRAPHY.....</b>	<b>72</b>
<b>8</b>	<b>APPENDIX.....</b>	<b>77</b>

**List of Figures:**

Figure 1 PX Index Performance - MAX.....	16
Figure 2 PSE Market Scheme.....	19
Figure 3 Performance of DAX Index.....	21
Figure 4 Current Performance of S&P 500 MAX.....	24
Figure 5 Nasdaq Composite.....	27
Figure 6 Performance of the Horizon Access Fund CSOB.....	28
Figure 7 Recon Capital DAX Germany ETF.....	29
Figure 8 SPDR S&P 500 ETF.....	29
Figure 9 Example of Regression Plot.....	30
Figure 10 Example of Technical Analysis - Support and Resistance.....	34
Figure 11 Example of Simple Moving average.....	35
Figure 12 Example of Bollinger Bands.....	36
Figure 13 Example of MACD.....	37
Figure 14 Relative Strength Index Example.....	39
Figure 15 MA 15, 30 30-min Interval.....	41
Figure 16 Bollinger Bands, 30-min Interval.....	43
Figure 17 MACD 30-min Interval.....	44
Figure 18 Relative Strength Index 30-day.....	46
Figure 19 Moving Averages 30,15 interval.....	49
Figure 20 Bollinger Bands 30 min interval.....	50
Figure 21 Volkswagen AG, daily during emission scandal.....	51
Figure 22 MACD, 30-min interval.....	52
Figure 23 Relative Strength Index 30-day.....	53
Figure 24 15,30 MA 30 min interval.....	57
Figure 25 Moving Averages 30,15 interval.....	58
Figure 26 Bollinger Bands SP500.....	59
Figure 27 Relative Strength Index 30-minute.....	61

Figure 28 Results for PX .....	67
Figure 29 Results of DAX .....	68
Figure 30 Results of S&P 500 .....	69

**List of tables:**

Table 1 Values of PX Index.....	15
Table 2 Constituents of the PX Index .....	17
Table 3 DAX Fact Sheet.....	20
Table 4 Highest Constituents of S&P 500 with relevant Weights.....	25
Table 5 Trend In Moving Averages.....	34

**List of appendices:**

Appendix 1 Constituents of DAX Index.....	77
Appendix 2 Durbin-Watson Statistic: 5 Per Cent Significance Points of dL and dU .....	78
Appendix 3 Input for t-bills regression.....	80

# 1 INTRODUCTION

Comments about the stock market are almost everywhere we look. Almost every media ranging from TV to radio talks about the “performance of the market”. Question is, who or what is this market they are talking about? Actually, when is someone talking about the market, he or she refers to an index.

Indexes have vital roles in measuring economic performance and some of them are even considered as a benchmark of an economy. It is important to understand what index is, how it behaves and what are the implication of rise and fall of the value in our everyday lives. There are numerous indexes around the world, with a different number of constituents and different criteria for entering. Indexes are usually shown as long term investments, but on very rare occasion, there are analyzed from a short-term perspective.

This is the place, where this thesis comes in hand. Analyzing index with values in past month can show not only secrets and opportunities, which would not be shown in a broader analysis. The reason why the author of this thesis decided to enter the world of index investing is to deepen his knowledge in trading, using technical analysis as the main tool of assessment the future development of securities.

Aim of this is to understand the future development and behavior of indexes, ranging from the smallest one in this thesis, PX, traded on Prague Stock Exchange, large European index DAX, traded on Frankfurt Stock Exchange, all the way to the index, which serves as a benchmark of the largest world economy – Standard and Poor's 500.

## **2 OBJECTIVES AND METHODOLOGY**

### **2.1 Objectives**

The main objective of this diploma thesis is to thoroughly evaluate selected indexes – DAX, PX, S&P 500 as a tradable instrument and closely analyze the development of said indexes. There is a long time tradition in diversifying a portfolio with disposing certain part of the resources into the index fund as a long-term investment. However, this thesis looks at the short-term development of these instruments and their possible relationship and effects between them. This is the reason, why this diploma thesis closely examines, whether the current state of the markets is either on rise or fall. All these objectives are achieved using methods which are described in following sub-chapter.

### **2.2 Methodology**

This part is an introduction to main methods, which were used through this thesis in order to understand the ongoing development of selected indexes. A literature review was conducted using methods of extraction, synthesis, induction and deduction. In other words, author aimed to understand the basic phenomena and facts regarding selected indexes prior examining its current state and predict the future development. Another vital part was six months' departure as an Erasmus student and attending one of the world most prestigious university in Europe – the University of Gent, where author attended lectures of financial markets and investment analysis, which helped immensely in understanding the background in the world of trading from analyst perspective and as a top institutional trader.

Technical analysis served as a main part of the analytical part, and the author considers it as the most important. Using charts and application of various technical tools selected indexes showed the current recent state and showed the impact of certain events on the performance of the instrument. Regression analysis uncovered possible relationships between selected indexes and talked about the reason for possible autocorrelation using Durbin-Watson value.

## 3 LITERATURE REVIEW

### 3.1 Definition of Index

According to Investopedia and index “*is a statistical measure of change in an economy or a securities market. In the case of financial markets, an index is an imaginary portfolio of securities representing a particular market or a portion of it. Each index has its own calculation methodology and is usually expressed in terms of a change from a base value. Thus, the percentage change is more important than the actual numeric value.*”<sup>1</sup>

Therefore, it can be said that it is a statistical measurement of the ongoing difference or change in selections of stocks, which are included in the portfolio. This portfolio then represents a portion of the overall market performance. Historically speaking, the first index ever created was in 1896 by Charles Dow, the Dow Jones Industrial Average (DJIA), which consisted of 12 largest public companies in the US. Today the index doubled in size, having now 30 companies listed.<sup>2</sup>

### 3.2 Index Investing

It is known that indexes have a significant impact on prices of stocks. The situation in addition to S&P 500 speaks for itself. Having a resonate name in the market world, the only addition to this index has a direct effect in the rise of 7,5% in value on average between the

---

<sup>1</sup> INVESTOPEDIA. *Investopedia: Index* [online]. [cit. 2015-10-11]. Retrieved from: <http://www.investopedia.com/terms/i/index.asp>

<sup>2</sup> DOW JONES INDUSTRIAL AVERAGE. *Dow Jones Industrial Average: Fact Sheet* [online]. 2015-11-17,: 1-4 [cit. 2015-11-17]. Retrieved from: [http://www.djindexes.com/mdsidx/downloads/fact\\_info/Dow\\_Jones\\_Industrial\\_Average\\_Fact\\_Sheet.pdf](http://www.djindexes.com/mdsidx/downloads/fact_info/Dow_Jones_Industrial_Average_Fact_Sheet.pdf)

date and announcement.<sup>34</sup> There are many explanations of this phenomena, one being that “*index composition changes are information-free and suggest the price response reflects downward-sloping demand curves for stocks. Investors require beneficial prices to trade with passive index funds due to the lack of close investment substitutes*”<sup>5</sup>

In general, the aim of an index fund is to deliver the same return as the index itself. In theory, managing index fund should be pretty straightforward: invest in all securities included in the index with relevant proportions, with completely same proportion as the index which is underlying. This is called full replication strategy. There are two other strategies<sup>6</sup>:

- Stratified Sampling – can be characterized as the risk factor portfolio, first select the participant of the index, match market capital with a relevant sector, pick certain securities, which are representative. Then you purchase these securities based on the fact that they represent same factor exposure.
- Optimization Strategy – similar to stratified sampling, only taking into consideration covariance between relevant assets

### 3.2.1 Reason for index investing

The main reason for index investing is lower risk and with that a good night sleep, knowing he or she has its resources in the hand of the free market. It is crucial to understand that in the long term an individual investor is not more efficient than the market, which is represented by the index. For instance in years 1991 – 1996<sup>7</sup> the return on S&P 500 index

---

<sup>3</sup> GREEN, T. Clifton a Russel JAME. *Strategic trading by index funds and liquidity provision around S&P 500 index additions* *Strategic trading by index funds and liquidity provision around S&P 500 index additions*. Journal of Financial Markets, 8<sup>th</sup> March 2011

<sup>4</sup> HARRIS, L., GUREL, E., 1986. Price and volume effects associated with changes in the S&P 500 list: new evidence for the existence of price pressures. *Journal of Finance* 41, 815–829.

<sup>5</sup> SHLEIFER, A., 1986. Do demand curves for stocks slope down? *Journal of Finance* 41, 579–590

<sup>6</sup> FRINO, Alex a David R. GALLAGHER. *Tracking S&P 500 Index Funds* [online]. *Journal of Finance*, 2001, 2015-11-17 [cit. 2015-11-17]. Retrieved from: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.199.4563&rep=rep1&type=pdf>

<sup>7</sup>During this period US economy had a technological boom and significant bull market



fund return was 17.8%, on the other hand, the return on investment of an average individual investor underperformed the market with net return 16.4%.<sup>8</sup>

Now let us imagine the cost of investing to individual stocks, which are included, let's say in Wilshire Total Market Index. There are over 6,000 companies included and the fees for purchasing individually every single stock can go up several thousand dollars. Index funds reduce these costs to a minimum since they are not actively managed.

### **3.2.2 Index Investing and the Efficient Market Hypothesis**

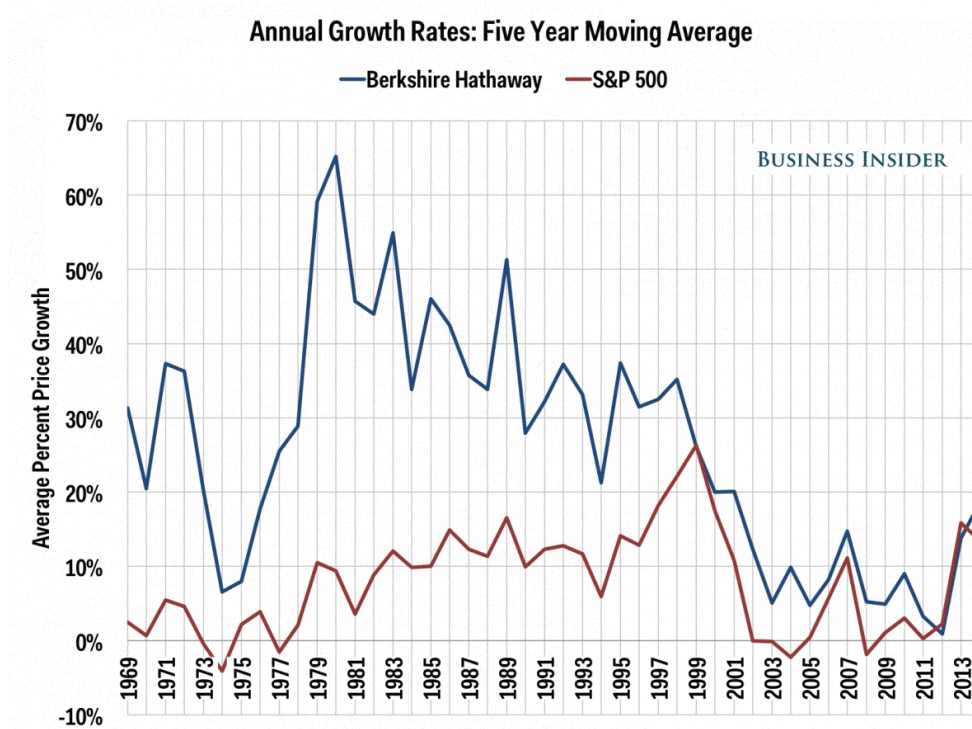
How the Efficient Market Hypothesis famously described by Burton G. Malkiel describes this hypothesis as a “Random Walk” and by the definition it says that “*the logic of the random walk idea is that if the flow of information is unimpeded and information is immediately reflected in stock prices, then tomorrow’s price change will reflect only tomorrow’s news and will be independent of the price changes today. But news is by definition unpredictable and, thus, resulting price changes must be unpredictable and random. As a result, prices fully reflect all known information, and even uninformed investors buying a diversified portfolio at the tableau of prices given by the market will obtain a rate of return as generous as that achieved by the experts.*”<sup>9</sup> In another way it says, that there is no way to predict the future development of prices in stocks/indexes because all the information are already included in the value of a security and there is no way to outsmart the market. Therefore, it is only logical to invest in mutual index funds, since what they do is that they copy the index with similar ROI. It also disregards the reason for doing technical analysis. Not only technical analysis, though, but any kind of analysis. Which of course is very controversial opinion and there are many investors, who are beating the market on a yearly basis. One of the most famous investor, who did manage to outsmart the market almost every year is Warren Buffet.

---

<sup>8</sup>DAMODARAN, Aswath. The Case for Passive Investing. Available also at: <http://people.stern.nyu.edu/adamodar/pdfiles/invphiloh/indexN.pdf>

<sup>9</sup> BURTON G. MALKIEL. *A random walk down Wall Street: the time-tested strategy for successful investing*. Rev. and updated ed. New York, NY [u.a.]: Norton, 2007. ISBN 0393330338.

**Figure 1 Annual Growth Rates BH vs SP500**



*Source: Business Insider*

### 3.2.3 Types of indexes

- **Price-Weighted Index**

This type of index is an index, where each stock has an influence in the index, which is relative to the price of the share. The value of the index is then computed with adding all the prices of all individual stocks and then divided by the number of stocks. This has an effect in that stock with a higher value has more weight, thus affects the value of the index more than stock with a lower price.<sup>10</sup>

A typical example of such index can be Dow Jones Industrial Average Index.

- **Market-Value Index**

---

<sup>10</sup> Different Types of Stock Market Indexes. *ABC of Investing* [online]. [cit. 2015-11-16]. Retrieved from: <http://www.abcsinvesting.net/different-types-of-stock-market-indexes/>

The market value index is a typical index, where the weight of the stock is computed from the market value of the company in the index. Therefore, the larger the company, the larger weight it has in the index. This is the most typical and most common type of calculating an index.

A typical example of such index can be Standards and Poor 500 Index, which is part of the evaluation in this thesis.

### **3.3 Selected Indexes**

This chapter is dealing with chosen world stock indexes, which in this thesis are the indexes of Prague Stock Exchange (PX), Deutscher Aktienindex (DAX) and S&P 500 (SPX).

There are numerous indexes around the world, but there is a significant reason, why these three selected indexes are in this thesis. The author of this project is from the Czech Republic, therefore it was a personal interest to technically evaluate PX index, which is an index of Czech stock exchange. The second index DAX was selected because it is an index of one of the largest European stock exchanges in Frankfurt. Lastly Standards and Poor 500 Index is an index of top 500 companies and serves as a benchmark of US economy.

### 3.4 PX Index

According to Bloomberg.com, a well-respected web portal for everything finance related, PX Index can be defined as a: *“The PX index is the official index of the Prague Stock Exchange. The index was calculated for the first time on March 20, 2006, when it replaced the PX50 and PX-D indices. The index took over the historical values of the PX50 index. The starting date was April 1994, with a base of 1000 points. As of 24 Sep 2012, composition fully reflects the Free Float of members due to methodology changes.”*<sup>11</sup>

#### 3.4.1 Current performance of PX Index

Table 1 Values of PX Index

	Value
<b>Index Title</b>	PX
<b>Weighing</b>	Market capitalization
<b>Starting Date</b>	5/4/ 1994
<b>Base</b>	1,000.0 points
<b>Time</b>	9:00 - 16:28
<b>Frequency of Calculation</b>	real time
<b>Periodical updating</b>	The first exchange day following the third Friday of March, June, September and December

Source: own processing, pse.cz

---

<sup>11</sup> Bloomberg Business: PX. *Prague Stock Exchange Index* [online]. [cit. 2015-10-03]. Retrieved from: <http://www.bloomberg.com/quote/PX:IND>

**Figure 2 PX Index Performance - MAX**



Source: patria.cz

### 3.4.2 How PX Index is Calculated

This formula serves as a tool on how to calculate PX Index:

$$PX_{(t)} = Base\ Value * \frac{\sum_{i=1}^{N(t)} q_i * p_i(t) * FF_i * RF_i}{Start\ cap} * AF(t)$$

Where:

- Base Value = launch value of the index 1 000
- AF(t) = Adjustment Factor
- $q_i$  = denotes the number of securities of the i-th index issue used for the calculation of the index at time t;
- $p_i(t)$  = denotes the price quotation of the i-th index issue at time t;
- $FF_i$  = denotes the free float factor
- $RF_i$  = denotes the representation factor
- $N(t)$  = denotes the number of index issues at time t.

- Start cap. = market capitalization of the index on the launch date = 379 786 853 620 (April 5.1994)<sup>12</sup>

### 3.4.3 Constituents of the PX Index

**Table 2 Constituents of the PX Index**

Instrument	ISIN	Number of securities in the index	Share of Market Capitalization[%]
KOMERČNÍ BANKA	CZ0008019106	38,009,852	20.76
ERSTE GROUP BANK	AT0000652011	429,800,000	20.26
ČEZ	CZ0005112300	537,989,759	18.79
VIG	AT0000908504	128,000,000	15.09
O2 C.R.	CZ0009093209	310,220,057	7.13
PEGAS NONWOVENS	LU0275164910	9,229,400	4.37
STOCK	GB00BF5SDZ96	200,000,000	3.65
PHILIP MORRIS ČR	CS0008418869	1,913,698	3.6
UNIPETROL	CZ0009091500	181,334,764	3.01
CETV	BMG200452024	135,802,274	1.86
FORTUNA	NL0009604859	52,000,000	0.77
PLG	CZ0005124420	11,687,501	0.39
NWR	GB00B42CTW68	6,661,427,452	0.32

*Source: own processing in excel, pse.cz*

### 3.4.4 Criteria for entering the index

Inclusion criteria of the eligible equity issue may be included in the PX index if the meet certain requirements: Market capitalization and trading volume to a specific date are higher than 0.5 billion CZK. This value is fixed by the Index Committee. The last exchange

<sup>12</sup> PX: Prague Stock Exchange. Exchange Indexes [online]. [cit. 2015-10-03]. Retrieved from: <https://www.pse.cz/dokument.aspx?k=Burzovni-Indexy>

days, which are excluded for calculation for market capitalization are in months of February, May, August, and November.

The average daily trading of the equity without Over-The-Counter trade indecisive period is more than 2 million CZK. For calculating the average volume, days which are included in the decisive period from the time the equity was registered for trading in the PSE are taken into consideration.<sup>13</sup>

### **3.4.5 Prague Stock Exchange (PSE)**

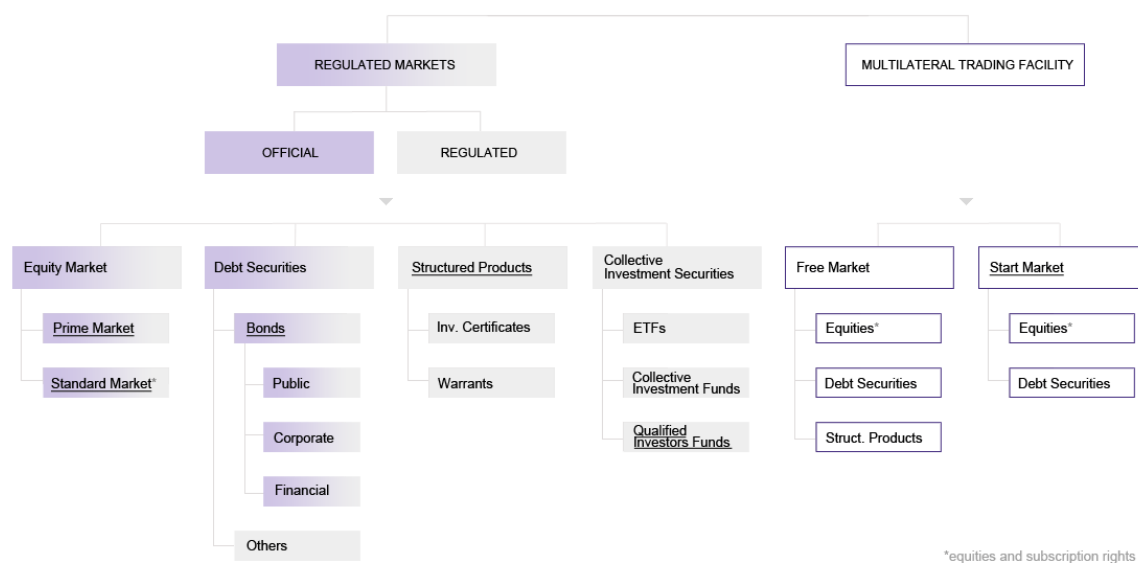
PSE is part of the CEE Stock Exchange Group (CEESEG), whose members are also another three Central European stock exchanges: the stock exchange Vienna (Wiener Börse), the stock exchange in Budapest (Budapest Értéktőzsde) and the Stock Exchange of securities Ljubljana (Ljubljanska Borza). Trading on the PSE is only open to licensed dealers who are also members of the Exchange.<sup>14</sup>

---

<sup>13</sup> The Rules for the PX Index and PX-TR Index of the Prague Stock Exchange. *CEE Stock Exchange Group* [online]. May 2015 [cit. 2015-11-21]. Retrieved from: [http://ftp.pse.cz/Info.bas/Cz/PX\\_pravidla\\_pro\\_vypocet.pdf](http://ftp.pse.cz/Info.bas/Cz/PX_pravidla_pro_vypocet.pdf)

<sup>14</sup> Fio Banka: Burza Cenných Papírů Praha. *Prague Stock Exchange Index* [online]. [cit. 2015-10-03]. Retrieved from: <http://www.fio.sk/akcie-investicie/obchodovanie-akcie/akcie-cr/obchodovanie-prazska-burza>

**Figure 3 PSE Market Scheme**



Source: pse.cz

### 3.4.6 History of Prague Stock Exchange

Prague Stock Exchange (*BCPP – Burza Cenných Papirů Praha*) is the oldest stock exchange in the Czech Republic founded in 1871, although the first attempts were during the reign of Empress Maria Theresa. The exchange itself gained a lot of popularity in sugar trade and later became a key market for the whole Austro-Hungarian Empire.<sup>15</sup>

However, this flawless continuation had a short life. Both world wars and communism reign stopped all trades at PSE for almost 60 years. The first trade after reopening was on 6<sup>th</sup> of April 1993<sup>i</sup> and thus began the start of the modern history of Prague Stock Exchange.

## 3.5 DAX

Since the PX Index definition is from Bloomberg source, let's establish a trend with a definition from the same source; "The German Stock Index is a total return index of 30 selected German blue chip stocks traded on the Frankfurt Stock Exchange. The equities use

<sup>15</sup> PX: Prague Stock Exchange. *PSE* [online]. [cit. 2015-10-03]. Retrieved from: <https://www.pse.cz/dokument.aspx?k=Historie-Burzy>



free float shares in the index calculation. The DAX has a base value of 1,000 as of December 31, 1987. As of June 18, 1999, only XETRA equity prices are used to calculate all DAX indices.”<sup>16</sup>

### 3.5.1 Current performance of DAX Index

In order to evaluate DAX Index, it is an ideal to establish a trend with a description of the index. Firstly with the Fact Sheet (Table 3) and the overall performance via patria.com with a chart (Figure 4).

**Table 3 DAX Fact Sheet**

	<b>Value</b>
<b>Index Title</b>	DAX
<b>Weighting scheme</b>	Market capitalization
<b>Corporate action and dividends</b>	According to the Guide to the Equity Indices of Deutsche Borse
<b>Base</b>	1,000 as of Dec. 30,1987
<b>Time</b>	09:00 - 17:45 CET (real-time, 1 sec.)
<b>Frequency of Calculation</b>	Real-time
<b>History</b>	Available since Dec. 30, 1987

*Source: own processing, <http://www.dax-indices.com/>*

---

<sup>16</sup> Bloomberg Business: PX. *German Stock Index* [online]. [cit. 2015-10-03]. Retrieved from: <http://www.bloomberg.com/quote/DAX:IND>

**Figure 4 Performance of DAX Index**



*Source: patria.com*

### **3.5.2 Constituents of the DAX Index**

There are currently 30 constituents of the DAX index, which can be found in APPENDIX of this thesis. It includes “blue chips” stocks from companies such as Allianz, Adidas AG, Daimler and much more.

### **3.5.3 Criteria for entering the Index**

In order for a company to be eligible to enter DAX index, it needs to fulfill certain criteria:

First and foremost, the number one criteria, which needs to be fulfilled and that is to be listed in the Prime Standard, which is a segment of stocks of the Frankfurt Stock Exchange and stocks which holds the maximum transparency. It has to be continuously traded on Xetra and needs to have widely held stock, set at least on 10%.

Another important factor for a company, if it wants to be a part of DAX index, it needs to have its head office or the largest part of its sales volume located strictly in Germany.

If the company fulfills the requirements listed above, then they are sorted based on another two characteristics:

- The order book turnover on the Xetra trading platform and on the floor trading in Frankfurt.
- The market capitalization based on a free float or widely held stock.

These two characteristics are crucial for selection to DAX index.<sup>17</sup>

### **3.5.4 Frankfurt Stock Exchange**

Today Frankfurter Wertpapierbörse (FWB®, the Frankfurt Stock Exchange) is considered among world's biggest trading centers. It is largest of the seven stock exchanges located in Germany – having 85% turnover. The Frankfurt Stock Exchange uses up-to-date electronically trading and highest quality information systems. Therefore, it is capable of the fulfillment of growing needs for establishing an international trade. With the integration of fully functional trading system Xetra, the FSE managed to increase its competitiveness and thus created an attractive environment for foreign investors and participants in the market.<sup>18</sup>

### **3.5.5 History of Frankfurt Stock Exchange**

The Frankfurt Stock Exchange has a long history. It was founded in 1585 and its roots date back to the 9th century. Eventually, these markets have developed significant Europe-wide commodity and money markets. In the sixteenth century, Frankfurt was one of the most important cities in banking transactions, and in 1820 in Frankfurt started trading shares for the first time in its history, which were the shares of the Austrian National Bank. The modern appearance of the capital market - i.e. financial transactions, banking and trading on the stock

---

<sup>17</sup> Guide to the Equity Indices of Deutsche Börse AG. *RWE* [online]. December 2014 [cit. 2015-11-21]. Retrieved from: <https://www.rwe.com/web/cms/mediablob/en/195148/data/113836/7/rwe/investor-relations/shares/shareholder-structure/Guide-to-the-Equity-Indices-of-Deutsche-Boerse.pdf>

<sup>18</sup> Deutsche Börse AG. The Frankfurt Stock Exchange[online]. Deutsche Börse, 2014. [cit. 6. 4. 2015]. Retrieved from: [https://deutsche-boerse.com/dbg/di-satch/en/kir/dbg\\_nav/about\\_us/20\\_FWB\\_Frankfurt\\_Stock\\_Exchange](https://deutsche-boerse.com/dbg/di-satch/en/kir/dbg_nav/about_us/20_FWB_Frankfurt_Stock_Exchange)

exchange in Frankfurt appeared in the 13th century. Its strong position lost after the announcement of the German Empire in 1871 when trading moved to the stock market in Berlin and Frankfurt, traded mainly in bonds. The initial position of the bourse gained after the Second World War.<sup>19</sup>

### **3.6 Standard and Poor's 500 Index**

Perhaps one of the most famous and most talked about index of the selected three. It is also known as a proxy for measurement of the American economy.

The interesting thing about this index is a fact, that since it is considered as a benchmark of US economy, it also serves as an interesting benchmark for almost every equity manager. The Standards & Poor Index performance is actually pegged against the performance of equity managers.<sup>20</sup>

---

<sup>19</sup> *Boerse Frankfurt: Basic Overview* [online]. [cit. 2015-10-04]. Retrieved from: <http://www.boerse-frankfurt.de/en/basics+overview#>

<sup>20</sup> *Index Investing: The Standard & Poor's 500 Index*. *Investopedia* [online]. [cit. 2015-11-16]. Retrieved from: <http://www.investopedia.com/university/indexes/index3.asp>

### 3.6.1 Current Performance of S&P 500

Figure 5 Current Performance of S&P 500 MAX



Source: patria.cz

### 3.6.2 How S&P 500 is calculated

Every day, the index value is the proportion of the market total capitalization, which is made by constituents of S&P 500 and their relative divisors. Continuousness of values in the index is taken care of by the divisors for all the changes that emerges from constituents share capital, after the base date. Those changes include share buybacks, addition/deletions in the index, various insurances etc.<sup>21</sup>

### 3.6.3 Constituents of the S&P 500 Index

Obviously, there is no need to input all the constituents of the index simply because the number of them is, as the index suggests, 500. In Table 4 there are top 10 constituents by its weight to the index. As we currently see, in 2015, the largest company by weight is

<sup>21</sup> S&P 500: Equity Indices. *Spindices* [online]. [cit. 2015-11-21]. Retrieved from: <http://www.spindices.com/documents/factsheets/fs-sp-500-ltr.pdf>

Apple Inc – the technological giant. Interestingly enough, top two companies are industry giants in Technologic industry.

**Table 4 Highest Constituents of S&P 500 with relevant Weights**

<b>Company</b>	<b>Weight</b>
Apple Inc.	3.517586
Microsoft Corporation	2.137703
Exxon Mobil Corporation	1.880501
General Electric Company	1.594767
Johnson & Johnson	1.482363
Berkshire Hathaway Inc. Class B	1.413023
Wells Fargo & Company	1.383798
JPMorgan Chase & Co.	1.295936
Facebook Inc. Class A	1.177358
AT&T Inc.	1.157675

*Source: stockchart.com*

#### **3.6.4 Criteria for entering the Index**

In order for a company to enter the world famous index Standards and Poor 500, it should fulfill these requirements. The market capital of the company should be \$4.6 billion or more. Another important requirement for a company, which wants to be part of the index is, that it needs to be liquid with at least 100% annual turnover of float shares. Same as with the DAX index, where the company must hold its headquarters in Germany, with Standard and Poor 500 index it needs to be an U.S. Company. The number of stocks issued to general public investors, public float, has to be more than 50%. It has to be financially viable, in other words, it need to fulfill positive earnings under GAAP for four consecutive quarters.

### 3.6.5 History of US Stock Exchanges

#### NYSE – New York Stock Exchange

With market capital over 16.6 trillion dollars, New York Stock Exchange is by far the largest stock exchange in the world.<sup>22</sup> It became best known as a “BIG BOARD” due to the fact, that it still uses open outcry system.<sup>23</sup> New York Stock Exchange has incredibly long history, which is definitely noticeable, but not needed in this thesis. However, a few lines are needed. Its history starts all the way in 1792 and because of this long fame and history, NYSE is the home for a majority world’s most powerful and largest companies in the world. In order for a company, even for a foreign one, to be listed in the New York Stock Exchange, it is needed certain Securities and Exchange Commission rules, also known as listing standards.<sup>24</sup>

#### NASDAQ

It is no coincidence that NASDAQ came second to the list of US Stock Exchanges list. It is because it is a second largest stock exchange in the world, just a bit far down the road from New York Stock Exchange.<sup>25</sup> Even though that NASDAQ is an abbreviation for National Association of Securities Dealers Automatic Quotations. NASDAQ is a global fully electronic marketplace for buying and selling particular securities, but also works as a benchmark for U.S. technology stocks. It started its operation on 8<sup>th</sup> February 1971 and has its own index – Nasdaq Composite, which includes over 3,000 stocks and has all the technological and biotech beasts such as Microsoft, Intel, Amazon or Apple.<sup>ii</sup>

---

<sup>22</sup> *World Exchanges: Monthly Reports* [online]. [cit. 2015-10-25]. Retrieved from: <http://www.world-exchanges.org/statistics/monthly-reports>

<sup>23</sup> Method for communication with the stock using verbal bids and hand signals

<sup>24</sup> *Investopedia: NYSE* [online]. [cit. 2015-10-25]. Retrieved from: <http://www.investopedia.com/terms/n/nyse.asp>

<sup>25</sup> *World Exchanges: Monthly Reports* [online]. [cit. 2015-10-25]. Retrieved from: <http://www.world-exchanges.org/statistics/monthly-reports>

Nasdaq was established by NASD – National Association of Securities Dealers for a specific reason, and that was trade securities on wholly computerized, fast and reliable system. In 2007, Nasdaq finally became independent from NASD and became Nasdaq OMX, after merging with OMX – Scandinavian exchange group.

**Figure 6 Nasdaq Composite**



*Source: patria.cz*

Even though Nasdaq Composite is not the subject of the assessment of this thesis, it is very interesting to see the spike during Dot Com Bubble in the late nineties and early millennium. The index of the Nasdaq fell almost 80%. Interestingly enough the value of the index is almost two times as high as the in early 2000.

### **3.7 How to Invest in Selected Indexes**

Even though a person can't directly invest in the indexes, because index just tracks the overall performance of the market. However, there is a possibility to invest indirectly to the index by funds, which tracks the index itself.



### 3.7.1 PX Investing

#### Horizon Access Fund CSOB Český Akciový

This fund is provided by Československá obchodní banka, a. s. aimed to provide tracking as close as possible to the actual performance of PX Index. One of the advantages of this fund is that the dividends gains are reinvested again, therefore it is expected that the fund will eventually outperform the index itself.<sup>26</sup>

Figure 7 Performance of the Horizon Access Fund CSOB



Source: csob.cz

### 3.7.2 DAX Investing

#### Recon Capital DAX Germany ETF

This fund is so far the only fund that tracks the DAX index and it is since 8<sup>th</sup> June 2015. It seeks to provide investment results that closely corresponds with the performance of the DAX index.

---

<sup>26</sup> ČSOB: ČSOB Český Akciový (PX) [online]. 2015 [cit. 2015-11-22]. Retrieved from:

<https://www.csob.cz/portal/lide/produkty/investicni-produkty/podilove-fondy/akciovne-fondy/detail-fondu-/isin/BE6224091866/1>

**Figure 8 Recon Capital DAX Germany ETF**



*Source: Nasdaq.com*

### **3.7.3 S&P 500 Investing**

#### **SPDR S&P 500 ETF**

Although there are quite a few funds which track the performance of the Standards and Poor's 500 such as Vanguard's VOO, but the most commonly used ETFs is SPDR fund. It is managed by the State Street Global Advisor. Again, the idea of this fund is to track S&P 500 as close as possible. It is traded at AMEX (American Stock Exchange) and it is most actively traded stock market, with trading over 100 million shares per day and sometimes even 400 million.

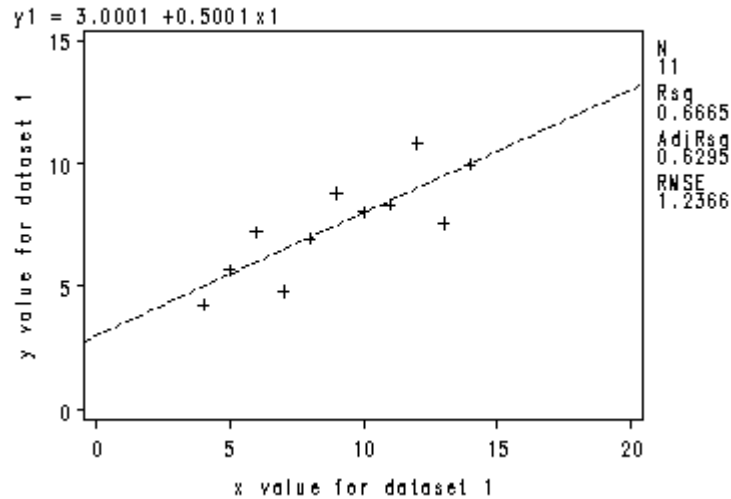
**Figure 9 SPDR S&P 500 ETF**



*Source: Nasdaq.com*

### 3.8 Regression Analysis

Figure 10 Example of Regression Plot



Source: <http://statistics.ats.ucla.edu/>

One of the crucial parts of practical part of the thesis is regression analysis. According to Alan O. Skyes, it is a statistical tool that investigates relationships of different variables. In order to explore these issues, the author assesses data of the said variables and uses regression in order to quantify the effect of the variable on the variable, which the author examines.<sup>27</sup>

There are two types of regressions, which are used daily as a basic one and they are linear and multiple regressions. The difference between those can be explained that with linear regression there is only one independent variable, whereas in multiple regressions there are more than one.<sup>28</sup>

Linear Regression:

$$y = \alpha + \beta X + u$$

---

<sup>27</sup> O. SYKES, Alan. *An Introduction to Regression Analysis: The Inaugural Coase Lecture*. Chicago, 1980. [cit. 2015-10-17].

<sup>28</sup> *Investopedia: Regression Analysis – Regression* [online]. 2015 [cit. 2015-10-17]. Retrieved from: <http://www.investopedia.com/terms/r/regression.asp>

Multiple Regression:

$$y = \alpha + \beta_1x_1 + \beta_2x_2 + \dots + \beta_tx_t + u$$

Where:

y – is the independent variable – the variable which we want to predict

x – are the dependent variables – the variables which are used to predict the independent variable

$\alpha$  – is the intercept

$\beta$  – is the slope

u – is the stochastic variable

### 3.8.1 Spurious Regression

In time series, there can often be a case when, even though that the  $R_2$  is extremely high, which suggests a great relationship, but in reality, there is a hidden so called “third” factor which affects both independent and dependent variables. Often in the literature of the econometric literature time series appear to have a very high degree of fit, however really low Durbin-Watson value.<sup>29,30</sup>

There are three major consequences of autocorrelation:<sup>31</sup>

- I. Estimates of the regression coefficient are inefficient
- II. Forecast based on regression equation are sub-optimal
- III. The usual significance tests on the coefficients are invalid.

---

<sup>29</sup> GRANGER, C.W.G a P. NEWBOLD. *SPURIOUS REGRESSIONS IN ECONOMETRICS*. England: Journal of Econometrics, 1973. Available also at: [http://wolf-web.unr.edu/~zal/STAT758/Granger\\_Newbold\\_1974.pdf](http://wolf-web.unr.edu/~zal/STAT758/Granger_Newbold_1974.pdf). University of Nottingham. [cit. 2015-10-17].

<sup>30</sup> FUKUSHIGE, M. 1994. *Using the Durbin-Watson Ratio to Detect Spurious Regressions: Can we make a rule of thumb?* Japan. University of Koe. [cit. 2015-10-17].

<sup>31</sup> GRANGER, C.W.G a P. NEWBOLD. *SPURIOUS REGRESSIONS IN ECONOMETRICS*. England: Journal of Econometrics, 1973. Available also at: [http://wolf-web.unr.edu/~zal/STAT758/Granger\\_Newbold\\_1974.pdf](http://wolf-web.unr.edu/~zal/STAT758/Granger_Newbold_1974.pdf). University of Nottingham. [cit. 2015-10-17].

### 3.8.2 Durbin-Watson Value

The Durbin-Watson, in this case, has to be tested because it often happens that in regression analysis in economic time series. For example, in this thesis, there is a probability of autocorrelation, because sometimes the past value of a stock can be dependent on the previous observation since the today's price is usually affecting tomorrow's price.<sup>32</sup>

Since it is expected to find positive autocorrelation in the model, the hypothesis is usually stated as following:

$$H_0 : \rho = 0$$

$$H_n : \rho > 0$$

#### Calculating Durbin-Watson

The formula for testing Durbin-Watson is:

$$d = \frac{\sum_{i=2}^n (e_i - e_{i-1})^2}{\sum_{i=1}^n e_i^2}$$

Where the input is:

$e_i = y_i - \hat{y}_i$  and  $y_i$  and  $\hat{y}_i$  are, respectively, the observed and predicted values of the response variable for individual  $i$ .  $d$  becomes smaller as the serial correlations increase.

Upper and lower critical values,  $d_U$  and  $d_L$  have been tabulated for different values of  $k$  (the number of explanatory variables) and  $n$ . The Durbin-Watson table is available in the appendix.

If  $d < d_L$  reject  $H_0 : \rho = 0$

If  $d > d_U$  do not reject  $H_0 : \rho = 0$

---

<sup>32</sup> ZOUHAR, Jan. *ZÁKLADY EKONOMETRIE: Autocorelace* [online]. [cit. 2015-11-16]. Retrieved from: <http://nb.vse.cz/~zouharj/>

If  $dL < d < dU$  test is inconclusive.

However, in this thesis Durbin-Watson value is calculated using Gretl Software, the rule of thumbs is that if the value of Durbin-Watson is very small; heading towards 0.0x there is a positive autocorrelation among residuals.<sup>33</sup>

### **3.9 Technical Analysis - Introduction**

“Technical strategies are usually amusing, often comforting, but of no real value” – Malkiel, 1996

The Technical Analysis is one of the most important tools for the trade, yet it is often disgraced as “*a method of evaluating securities by analyzing statistics generated by market activity, such as past prices and volume. Technical analysts do not attempt to measure a security’s intrinsic value, but instead use charts and other tools to identify patterns that can suggest future activity.*”<sup>34</sup>

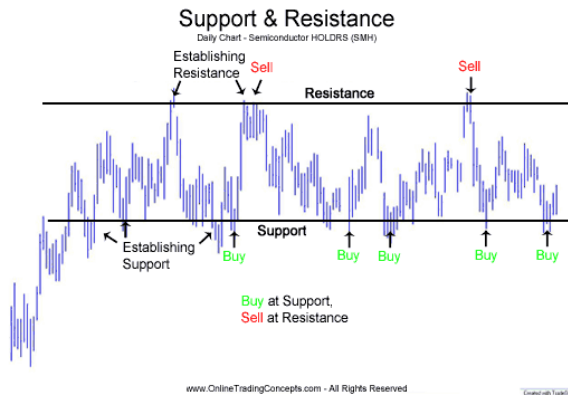
Technical analysis – using past prices to forecast future development of prices is a highly controversial issue. On one hand, many investors agree with Malkiel’s statement, but many intraday traders are steadily accepting technical analysis as a mean of useful information about the market, index or security. The main problem for naysayers of technical analysis is the fact, that it completely neglects the fundamentals and only focuses on prices.

---

<sup>33</sup> MONTGOMERY, Douglas C, Elizabeth A PECK and G VINING. *Introduction to linear regression analysis*. 5th ed. Hoboken, NJ: Wiley, 2012, xvi, 645 p. ISBN 9780470542811.

<sup>34</sup> ELDER, Alexander. *Trading for a living*. New York: John Wiley & Sons Ltd, 1993. 194 pages. ISBN 0-471-59225-0.

**Figure 11 Example of Technical Analysis - Support and Resistance**



Source: <http://www.onlinetradingconcepts.com/>

There are dozens of possible tools to use ranging from Moving Averages, MACD, Relative Strength Index, Histograms, R<sub>2</sub>, numerous oscillators, and others.

### 3.9.1 Selected Technical Analysis tools

This chapter shows selected technical tools, which will be used in this thesis – various short-term and long-term MA, Bollinger Bands, MACD, Rsi. These tools are going to help with the prediction of how the future value of indexes will move – whether if it will be in upward or downwards term.

### 3.9.2 Moving Averages

Moving averages can be defined as an indicator, which shows the average value of any security over given period of time. Trend time of a moving average can have various lengths (Table 5). It is one of the most used and also one of the most versatile indicators in Technical Analysis.

**Table 5 Trend In Moving Averages**

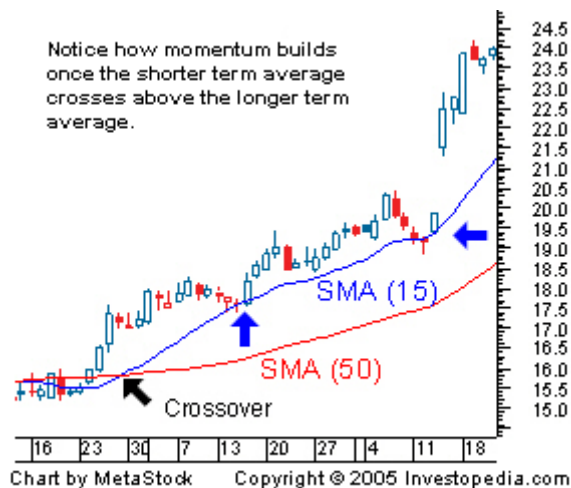
Trend	Moving Average
Very Short Term	5-13 days
Short Term	14-25 days
Minor Intermediate	26-49 days

Intermediate	50-100 days
Long Term	100-200 days

Source: Technical Analysis from A to Z

In the table above, there can be seen various lengths of moving averages, which are used most commonly. This is a simplified example how the moving average is calculated. In the example below (Figure 12) SMA (15) which stands for 15-day simple moving average simply the value of the certain security for last 15 days are added up together, then divided by 15. The *moving* part is because there are always only the latest fifteen days are taken into account. Therefore, the data moves each day forward with the new value of today's trading.

**Figure 12 Example of Simple Moving average**



Very good explanation of a moving averages provide author of a famous “*Technical Analysis of the Financial Markets*” John J. Murphy, who says: “The moving average is essentially a trend following device, its purpose is to identify or signal that a new trend has begun or that an old trend has ended or reversed. Its purpose is to track the progress of the trend. It might be viewed as a curving trend line. It does not, however, predict market action in the same sense that Standard chart analysis attempts to do. The moving average is a follower, not a leader. It never anticipates; it only reacts. The moving average follows a market and tells us that a trend has begun, but only after the fact. The moving average is a smoothing device. By averaging the price data, a smoother line is produced, making it much easier to view the underlying trend. By its very nature, however, the moving average line also lags the market action. A shorter moving average, such as a 20-day average, would hug

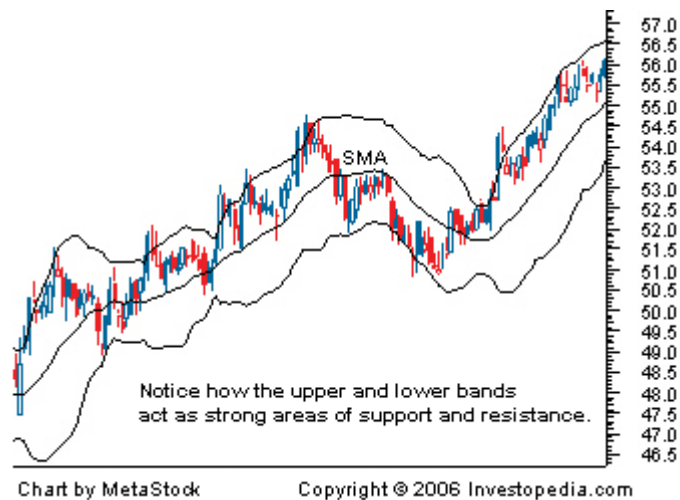


*the price action more closely than a 200-day average. The time lag is reduced with the shorter averages, but can never be completely eliminated. Shorter term averages are more sensitive to the price action, whereas longer range averages are less sensitive. In certain types of markets, it is more advantageous to use a shorter average and, at other times, a longer and less sensitive average proves more- useful.*”<sup>35</sup>

### 3.9.3 Bollinger Bands

Developed by famous John Bollinger, the Bollinger bands are an indicator in technical analysis, which shows whether the security is overbought or oversold. For this purpose, there are three bands which are wrapped around the price chart of the security.

**Figure 13 Example of Bollinger Bands**



Source: Investopedia.com

The middle line is usually 20-day moving average and the upper and lower band are defined as a standard deviation from the moving average.<sup>36</sup> As the volatility increases the wider the upper and lower bands tend to be more from each other. This would indicate for an investor, that current period of time is very unstable and perhaps he/she should wait until

---

<sup>35</sup> MURPHY, John J a John J MURPHY. *Technical analysis of the financial markets: a comprehensive guide to trading methods and applications*. New York: New York Institute of Finance, c1999, xxxi, 542 p. ISBN 0735200661.

<sup>36</sup> BOLLINGER, John. *Bollinger on Bollinger bands*. New York: McGraw-Hill, c2002, xxiv, 227 p. ISBN 00-713-7368-3.

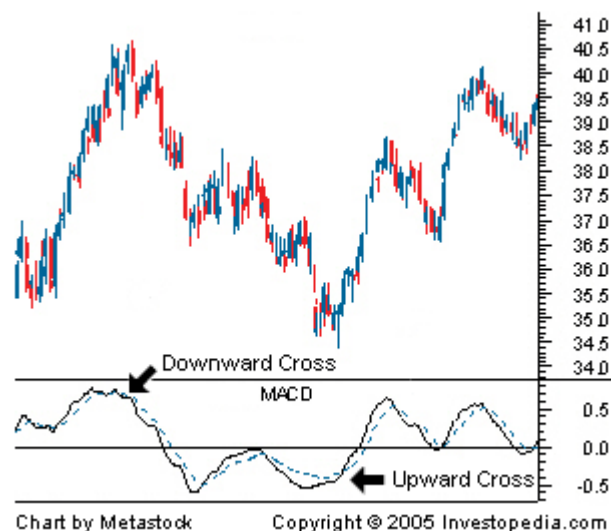
the times are calmer. On the other hand, volatility is something to be desired when it comes to intraday trading. This only shows how Bollinger bands are useful too.

### 3.9.4 MACD – Moving Average Convergence Divergence

The MACD is computed by subtracting a 26-day moving average of a price of chosen security from 12-day moving average of its price. The product of such calculation is an indicator, which oscillates around zero; either above or under.<sup>37</sup>

Now the situation can emerge when MACD is above zero, which means that 12-day moving average is above the 26-day moving average. This suggests that the three is and bullish tendencies in the market and it can be expected, that the price of the security will have upwards trend

Figure 14 Example of MACD



Source: *Investopedia.com*

---

<sup>37</sup> MURPHY, John J a John J MURPHY. *Technical analysis of the financial markets: a comprehensive guide to trading methods and applications*. New York: New York Institute of Finance, c1999, xxxi, 542 p. ISBN 0735200661. [cit. 2015-11-22].

There are three most common ways how to interpret MACD: Crossovers, Divergence and Dramatic Rise<sup>38</sup>.

**Crossovers** – Typical usage of MACD, the one, which will be used through this diploma thesis, is when the MACD line fall below the signal line. That indicates a bearish signal for the investor, that suggests, that it may be time for purchasing a security.

**Divergence** – This situation occurs when the price of the security diverges from the MACD. That indicates end of a trend

**Dramatic rise** – As the name suggests it occurs when the shorter (12-day) moving average moves from

### 3.9.5 Relative Strength Index

Relative strength index, also known as Rsi is a technical momentum indicator, that calculate recent losses against recent gains in order to attempt to decide whether the security is overbought or oversold. This helps the investor determine what is future steps might be. The formula for Rsi is as follows<sup>39</sup>:

$$RSI = 100 - 100 / (1 + RS *)$$

\*Where RS is

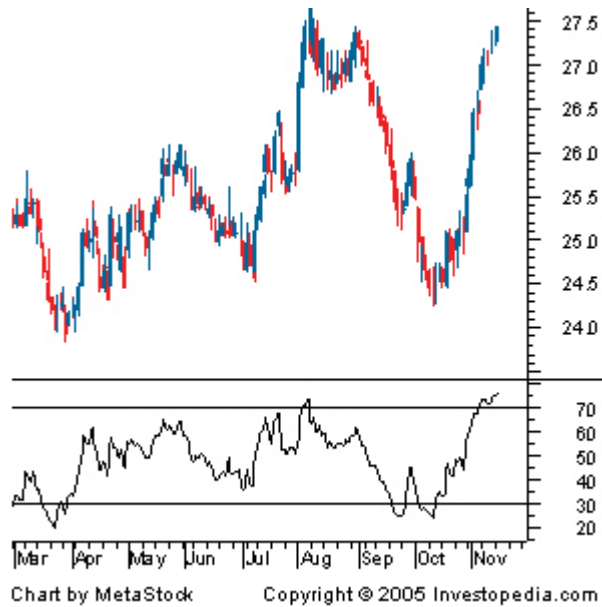
Average of x days' up closes / Average of x days' down closes.

---

<sup>38</sup>*Investopedia: MACD* [online]. [cit. 2015-10-11]. Retrieved from: <http://www.investopedia.com/terms/m/macd.asp>

<sup>39</sup> *Investopedia: Relative Strength Index - RSI* [online]. 2015 [cit. 2015-10-17]. Retrieved from: <http://www.investopedia.com/terms/r/rsi.asp>

**Figure 15 Relative Strength Index Example**



*Source: Investopedia.com*

In the example below there can be seen how the Relative Strength Index works. The line indicates the overbought territory – anything over 70 and oversold anything below 30. At the end of the trend we can see the security in the example is lying in the overbought territory, therefore we can expect that the price of the security is overbought and there is a possibility to gain by shorting said security.

## **4 ANALYSIS**

This part of the diploma thesis deals with core analysis of the issue. There are two parts, with the key part being the technical analysis, which evaluates the past and future performance of the indexes. The software used is Advinion Chart, which is available for use on investing.com. This software is free to use on the web-page; therefore, it provides powerful tool for technical analysis. Second supporting analysis is regression analysis. The software used for regression testing is Gretl software, an open source application, which provides every necessary tool for in-depth analysis.

### **4.1 Technical Analysis of PX**

The first index of the practical part of this thesis will be PX index. Since the author is from the Czech Republic it seems only logical to analyze the index first. For this analysis, author of the thesis will use methodological tools from investing.com, which provides comprehend tool to fully analyze the trend and it is completely free. Let us start with the first analysis and that is moving averages.

#### **4.1.1 Moving averages**

This series of moving averages will be started with SMA 15 and SMA 30, in other words, a simple moving average of 15 days and a simple moving average of 30 days. The moment when the shorter moving average crosses longer moving averages is highlighted with green color, the point when the longer moving average crosses the shorter moving average is highlighted with orange color.

Figure 16 MA 15, 30 30-min Interval



Source: Investing.com, own assessing

This graph was created by using 30-minutes intervals in the period from 2<sup>nd</sup> October until 18<sup>th</sup> October. Interestingly enough there was some significant news, that made the index behave in an extraordinary fashion and that is the time around 21<sup>st</sup> September and 25<sup>th</sup> September 2015 where there was a huge sellout in foreign markets, which hits the Prague Stock Exchange as well. It was partial because of the Eurozone prediction of the economy downturn and as well as a disastrous result from Chinas manufacturing activity slumped to a staggering six and a half year low that September.<sup>40</sup> Interestingly enough the crossing of moving

---

<sup>40</sup> Yahoo Finance: Stock Market News for September 24, 2015. <https://finance.yahoo.com/news/stock-market-news-september-24-141002387.html> [online]. [cit. 2015-10-18]. Retrieved from: <https://finance.yahoo.com/news/stock-market-news-september-24-141002387.html>

averages happened at 18<sup>th</sup> September 2015 at 14:30 full day after the peak of the index, which was the full day after the beginning of the fall (red circle). If the investor could sense upcoming turmoil in stock prices and accounted to this moving average analysis, it could save him tendinous lose if he did not step out from this market. Now that being said, this is a study of an index, not a security, but this study could create an idea of a feeling in the markets, which is crucial for an investor. The upcoming week was incredibly difficult not only in Czech markets but in foreign markets as well.

#### **4.1.2 Bollinger Bands**

Based on what we saw in the previous study, it is definitely interesting to see, how the index behaves, when the Bollinger band is implemented. Again we are going to use 30-minutes interval for last month. On the next page, it can be seen how Bollinger bands explains events which occurred in this period. Important is to look at, how far is the upper and lower band, which indicates, how the securities in the index are volatile.

Figure 17 Bollinger Bands, 30-min Interval



Source: investing.com

The first red circle shows that the stock got just into overbought territory for a couple of hours, together with an incredible gap between upper and lower band, which indicates upcoming volatility and unstable behavior of the securities in the index. In the second circle, we see that the securities in the index were dragged into oversold territory, which indicate that the trend of the index bound to go up. It did. Interestingly enough, in this study, the Bollinger bands served incredibly good for an investor, because with this he/she was able to protect itself from the downturn.



### 4.1.3 MACD

As it was mentioned, when there are bullish or bearish tendencies on the market – either the 12-day moving average is above the 26-day moving average or vice versa. In the table below, author pinpoints 4 crucial parts, when the histogram is showing us the tendencies of the market.

Figure 18 MACD 30-min Interval



Source: Investing.com, own assessment

The first green line, where the shorter moving average crosses the longer moving average, it was an input and beginning of the upwards movement which stayed for about two days. After that the trend was very volatile, the moving averages were moving back and forth until the crucial day. Moving average convergence divergence, could pinpoint exact day when the bearish trend appeared. That could save some intraday investor a lot of money

since they could use MACD as a supporting evidence that indicates, that the bullish trend is coming to an end and now the securities in the index are heading towards bearish trend is approaching. On 24<sup>th</sup> October, the trend entered again the territory of a bear and the ongoing trend was really uncertain and with this study there was not much an investor can do about it. But the last red line, which appeared on 12<sup>th</sup> October indicates the downfall again. Currently, there can't be said very much, although one can argue that the trend begins to go upwards, therefore investor can expect the index hitting the bear trend.

#### **4.1.4 Relative Strength Index**

As was mentioned in the theoretical part of this thesis, the Rsi indicates whether the index or security is overbought or oversold. That can be seen when the index oscillates above 70 or 30 in the histogram. Surprisingly in the whole period of measurement, it seldom happens that the PX Index went into the overbought territory; only in the 8<sup>th</sup> of October 2015, almost immediately after that it went down a bunch. As the downturn which occurred on 18<sup>th</sup> of October, the security was almost exclusively in the oversold territory and stayed there until the 12<sup>th</sup> October 2015, when there was a spike of optimism in the market.

Figure 19 Relative Strength Index 30-day



Source: Investing.com, own processing

## 4.2 Regression Analysis of the PX

Since we are talking about three indexes, the author wants to find out whether there is any relationship between PX Index and the DAX, SP500. Since the author is assuming no relationship whatsoever, the null hypothesis is:

$H_0$ : There is no relationship between PX Index and the other indexes.

Therefore, the alternative hypothesis is as follows

$H_a$ : There is a relationship between PX Index and the other indexes.

The data for this analysis are on a daily basis from 31<sup>st</sup> May 1994 to 25<sup>th</sup> September 2015 – that means there are 5,371 data points in the set. For analysis, the author chooses Gretl software, which proved to be incredibly useful for statistical measurements.

### 4.2.1 Gretl Results of the Regression Analysis

Model 2: OLS, using observations 1-5371

Dependent variable: PX

	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-ratio</i>	<i>p-value</i>	
Const	<b>4.50089</b>	17.6508	25.4996	<0.0001	***
DAX	<b>0.126621</b>	0.00682491	18.5528	<0.0001	***
SP500	<b>-0.249404</b>	0.0402196	-6.2011	<0.0001	***
Mean dependent var	862.5407	S.D. dependent var	398.3286		
Sum squared resid	6.55e+08	S.E. of regression	349.2680		
<b>R-squared</b>	<b>0.231449</b>	<b>Adjusted R-squared</b>	<b>0.231163</b>		
F(2, 5368)	808.2861	P-value(F)	1.4e-307		
Log-likelihood	-39071.33	Akaike criterion	78148.66		
Schwarz criterion	78168.43	Hannan-Quinn	78155.57		
Rho	0.998828	<b>Durbin-Watson</b>	<b>0.002375</b>		

We can interpret the output in equation:

$$y_{1t} = 4.50089 + 0.126621x_1 - 0.249404x_2 + u_t$$

$R_2$ , in this case, equals 0.231, which indicates that the value of PX index is affected by 23% from SP500 and DAX. This relationship is kind of small, but it can almost explain the movement of PX by  $\frac{1}{4}$ , which is something to account for.

### 4.2.2 Economic verification of the model

- If the DAX rose by one point, the index of PX will increase by 0.12, this positive relationship is expected since the indexes are traded in direct length from each other

- However, if SP500 rose by 1 point, the PX **declines** by 0.25 points, which is surprising, but looking at the fact, that the data set has over 5,371 daily data from 1994 to 2015, it can suggest a negative relationship between European and American indexes.
- And when none of the dependent variables moves, the index will rise by 4.5, which can be explained by the risen of individual stocks inside the index.

However, this can be all ignored since there is a reasonable doubt of spurious regression, since the Durbin-Watson statistics is just 0.002, which indicates there is a significant positive autocorrelation in residuals, therefore this regression analysis can be refused, even though the null hypothesis is declined – there is a significant relationship between the dependent and independent variable.

Therefore, even though the null hypothesis was rejected, indicating there is a significant relationship between dependent and independent variables, it means nothing, since there is a significant autocorrelation among residuals.

### **4.3 Technical Analysis of DAX**

Let us now move to a technical analysis of DAX index. The tool used in for this index will remain same as for the PX index – Moving Averages, Bollinger Bands, MACD and Relative Strength Index.

#### **4.3.1 Moving Averages**

For testing whether it is time to trade the DAX index, whether to buy or sell, it is needed to test it with a combination of several moving averages. To maintain integrity through this thesis, 15,30 moving averages in 30 minutes' scale will be used to analyze this security. Since there was a recent spike in the value of the index, it is interesting to see, how the moving averages reacts through the period.

Figure 20 Moving Averages 30,15 interval



Source: investing.com, own processing

It is pretty obvious that the bullish trend among the top 30 German securities is very strong, with almost +800 in over the last month. There was a bit turmoil in the beginning the analysis. The first significant increase began in 2<sup>nd</sup> of November 2015, where the bullish trend started and ignoring few declines lasted until this day. The guess of the author is, that this trend will stay until the next. The only, what recently hold back the DAX index was a scandal with emission in Volkswagen, which is included in DAX index.<sup>41</sup>

<sup>41</sup> CNET: Volkswagen recalls 8.5M European diesels amid global probes [online]. 2015 [cit. 2015-11-01]. Retrieved from: <http://www.cnet.com/news/volkswagen-8-5-million-diesel-recall-investigation/>

### 4.3.2 Bollinger Bands

Let's see whether Bollinger Bands have something to say for an investor investing in DAX last month.

Figure 21 Bollinger Bands 30 min interval



Source: investing.com, own processing

The red circle shows us how Bollinger Bands behave with extreme distortion of upper and lower bound during the uncertainty during the Volkswagen scandal. An investor could make a fast profit with this incredible volatility. The author personally suggested during this period to bet on the rise of the Volkswagen. It can be enhanced how one stock in the index, can push the whole index into the ground, it can be seen

Figure 22 Volkswagen AG, daily during emission scandal



*Source: investing.com, own processing*

With Bollinger Band, it can be seen that the security fell deeply into oversold territory (red circle in Figure 22) and that had to be a signal for a ton of investors to watch out for this security, that the price had to climb back to its pre-scandal numbers. This whole shenanigan put a lot of pressure on the DAX index.



### 4.3.3 MACD

Figure 23 MACD, 30-min interval



Source: investing.com, own processing

As per usual MACD prove itself to be a wonderful tool in analyzing, mostly because it managed to pinpoint the right signal to buy or sold right on the money. Red and green lights indicate the crossing of 12 and 26-day MA. A positive value of MACD indicates BUY signal at the end of the period. Interesting is how good it reacts in the period from 21<sup>st</sup> November and 25<sup>th</sup> November (last two green and red signs), where the value of the DAX index went from 10,280 to 10,828 points in less than five days. More focus, in this case, was to a SELL signal., when after the period price was volatile, but it did not fell down as fast as it

was in the case of growth. After 25<sup>th</sup> November, there was only about 180-point drop in value and it was not the case for the investor who listen to the signals provided by MACD.

#### 4.3.4 Relative Strength Index

Figure 24 Relative Strength Index 30-day



Source: investing.com, own processing

The current value of Relative Strength Index is 60.35 which suggests that the DAX index is in normal territory, leaning towards overbought. That being said, with the recent trend and the combination with other indicators the author is arguing, that the DAX index will enter to overbought territory somewhere in couple days. On the other hand, it is still time to make some profit on this security, via index fund Recon Capital. On 20<sup>th</sup> October,

there was the highest value of Relative S, slightly over 90, which indicates extremely over-bought territory, and it did, as this indicator taught us, down quite rapidly. Interesting is a fact that in whole period of measurement, the security did not fell

#### 4.4 Regression Analysis of DAX

Once again let us set up the null and alternate hypothesis of this regression analysis

H<sub>0</sub>: There is no relationship between DAX Index and the other indexes.

Therefore, the alternative hypothesis is as follow:

H<sub>a</sub>: There is a relationship between DAX Index and the other indexes.

Judging by the results of PX regression analysis, there can be expected a similar outcome.

##### 4.4.1 Gretl Results of the Regression Analysis

Model 3: OLS, using observations 1-5371

Dependent variable: DAX

	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-ratio</i>	<i>p-value</i>	
const	<b>-1.21766</b>	32.1956	-37.8208	<0.0001	***
SP500	<b>5.36715</b>	0.0275116	195.0865	<0.0001	***
PX	<b>0.475893</b>	0.0256507	18.5528	<0.0001	***

Mean dependent var	5613.798	S.D. dependent var	2188.594
Sum squared resid	2.46e+09	S.E. of regression	677.1112
<b>R-squared</b>	<b>0.904319</b>	<b>Adjusted R-squared</b>	<b>0.904283</b>
F(2, 5368)	25367.41	P-value(F)	0.000000
Log-likelihood	-42626.91	Akaike criterion	85259.83
Schwarz criterion	85279.59	Hannan-Quinn	85266.73

rho                                      0.987138                                      **Durbin-Watson**                                      **0.025950**

Looking at output of Gretl, we can interpret the equation as follow:

$$y1t = -1.21766 + 5.36715x1 - 0.475893x2 + u$$

The high value of  $R_2 = 90\%$  indicates that the DAX index can be explained with 90% of the SP500 and PX index. This is expected high number taking in consideration that today's world is interconnected together. Even though that all values are statistically significant and even can be explained as follow:

#### **4.4.2 Economic Verification of the Model**

- When the SP500 rose by 1 point, the DAX index rises by 5.36 points. This fact can be supported by the idea that the DAX index, traded in the Frankfurt Stock Exchange is one of the largest in Europe, therefore there is stronger bound with the largest index in the world – Standard and Poor 500
- This is directly connected to the second phenomena and that is when PX rises by 1, the DAX index rises by 0.45 points, which is a natural relationship between indexes, which are traded in the geographically similar area.
- The most interesting fact of all is the number of the constant which is negative, that would suggest that the DAX index moves negative, when PX and SP500 don't move at all. This can be explained by the fact that the index is defendant on PX and SP500, which only shows how interconnected these index is.

However, as it was in the case with PX index, the value of Durbin-Watson is extremely low 0.02, which indicates positive autocorrelation in residuals, therefore this study can be considered as meaningless.

#### **4.5 Technical Analysis of S&P 500**

This chapter is the last chapter of technical analysis of all three indexes. As it was with the first two indexes, Standard and Poor 500 is going to get the exact same treatment as DAX and PX and that is Moving Averages, MACD, Bollinger Bands, Relative Strength Index.

#### 4.5.1 Moving Averages

As it is usual, the input was 15,30 MA 30-min to see the development of the index (Figure 25). Interestingly enough, in the whole period, which is a slightly above a month, every time when 15 MA crossed 30 MA from above, indicating the value of the index will decrease, it almost immediately follows by vice versa cross, indicating the value of the index will rise, which is really interesting, since with this combination of moving averages there is not much to find out, because as it can be seen at the last cross, the value went steadily down and did NOT follow the trend of the past days/week. For the equal period of time, it is needed to use different a bit slower moving averages to find, whether the value of an index can be described better than with 15/30 combination. Below the Figure 25, there is a different time period of MA's; 20/40 combination of moving averages. Since these moving averages are slow, it smoothed out the variance of the index to a point, where it deletes the fluctuations and informed investor correctly, where there is a buy signal and where is not.

Figure 25 15,30 MA 30 min interval



Source: investing.com, own processing

As it seen the 20/40 MA combination smoothed out the value of the index to a point, where an investor can be calm when putting money in the index early that month because the sell input came almost a month later and ignored all false flags, which were visible using 15/30 MA crossover.

However, in both studies there is a major SELL signal on 13<sup>th</sup> November and stayed up until today.

Figure 26 Moving Averages 30,15 interval



Source: investing.com, own processing

#### 4.5.2 Bollinger Bands

The second technical tool is Bollinger Bands, which shows whether the index is overbought or oversold. That helps the investor indecision, whether the index is worth of buying or selling. In this case, it shows the overall performance of US economy, since it is said that Standards and Poor Index 500 is the benchmark of the American economy.

Figure 27 Bollinger Bands SP500



Source: *investing.com, own processing*

Let us focus on the last few days in the index and see that the value of the index is almost licking the bottom of the lower band, which indicates that the index is nearing over-sold region, which could lead to an increase of a price in next few days. Otherwise, there is not much interesting in this study, which could tell us something about the movement in price. The only signal which could say something to an investor is a period between 25<sup>th</sup> of September and 9<sup>th</sup> of October, during the rally, where upper and lower band are far away from each other, indicating the volatility of an index.

In general, it can be said that for an understanding of the movement in past month, the moving averages drawled a better picture for an investor than Bollinger Bands.



### 4.5.3 MACD

The last, but a not least technical tool used is Moving Average Convergence Divergence.



*Source: investing.com, own processing*

In MACD, which tells whether to buy security or sell, there was a big turmoil in the first half of the month. On the other hand, at almost any input, the MACD could perfectly pinpoint the period of buy and sell. The reason, why there is a gap between 29<sup>th</sup> September up until 13<sup>th</sup> October is because, there was a lot of turmoil and it made the graph unreadable. However, the interesting part is the last SELL signal, which, looking at the histogram, put

the whole index in the deep SELL territory and it corresponds with Moving Averages that there is currently a signal to sell.

#### 4.5.4 Relative Strength Index

Last technical analysis tool used for Standards and Poor 500 Index is Relative Strength Index. As it was same with past two indexes, where Relative Strength Index was used, even in this study it helps us identify, whether the value of the index is in the overbought territory or oversold territory. This helps the investor to improvise or take into consideration whether there is an ability of a security (in this case index) to increase its value, therefore, create wealth for an investor.

Figure 28 Relative Strength Index 30-minute



Source: investing.com, own processing

Figure 28 there are three important milestones which led the way of the development of Standards and Poor 500 Index. Firstly, at the end of the month 29<sup>th</sup> September, the value of the index was DEEP into oversold territory, which indicated eventually that the value had to rise again and break the oversold territory and it did and the results were massive. We saw almost 200 points rise up until 5<sup>th</sup> of November, where the index went into territory known as overbought. Second with the red dashed line on 5<sup>th</sup> October, where the huge spike in the value of an index had a direct consequence of putting the whole index way above the overbought territory, which in the case of RSI is at point 70. During the whole period up until the period when it hit the oversold territory, there were very few spikes which could indicate that the value of the index is overbought (it almost never hit oversold territory in that period of time) On 12<sup>th</sup> November, the security went into oversold territory and now sits at the value of -22.93 therefore for current state, this tool indicates a BUY signal for an investor.

## 4.6 Regression Analysis of S&P 500

Since we are talking about three indexes, the author wants to find out whether is there any relationship between S&P 500 Index and the PX and DAX. Since author is assuming no relationship whatsoever, the null hypothesis is:

$H_0$ : There is no relationship between S&P 500 Index and the other indexes.

Therefore, the alternative hypothesis is as follow

$H_a$ : There is a relationship between S&P 500 Index and the other indexes.

### 4.6.1 Gretl Results of the Regression Analysis

Model 1: OLS, using observations 1-5371

Dependent variable: S&P 500

	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-ratio</i>	<i>p-value</i>	
const	<b>3.04282</b>	4.7635	63.8779	<0.0001	***
PX	<b>-0.0285177</b>	0.00459886	-6.2011	<0.0001	***

DAX	<b>0.163288</b>	0.000837001	195.0865	<0.0001	***
Mean dependent var	1196.348	S.D. dependent var	371.3849		
Sum squared resid	7.4875893	S.E. of regression	118.1040		
R-squared	<b>0.898907</b>	Adjusted R-squared	<b>0.898870</b>		
F(2, 5368)	23865.92	P-value(F)	0.000000		
Log-likelihood	-33247.70	Akaike criterion	66501.40		
Schwarz criterion	66521.16	Hannan-Quinn	66508.30		
rho	0.987312	Durbin-Watson	<b>0.025775</b>		

We can interpret the output in equation:

$$y1t = 3.04282 - 0.0285177x_1 + 0.163288x_2 + u_t$$

The coefficient of determination is at 0.89 meaning that the movement of Standard and Poor 500 can be explained by 89% from index PX and DAX. This indicates a significant relationship.

#### 4.6.2 Economic Verification of the model.

- When the PX index moves by 1 point, the S&P 500 moves negatively by -0.02851, which one could say it does not move at all. The negative relationship was already observed and could be explained that both indexes are traded on a different continent and PX index is in a value smaller by several magnitudes. However, it is still statistically significant.
- When DAX index moves by 1 point, Standard & Poor Index react positively by moving up by 0.163288 points. This positive relationship can be explained by the fact that DAX securities are traded in S&P 500 and to the value of the index they are much closer.

- When DAX and PX do not move at all, the index itself still moves by 3.042 points. Since the index itself moves on average by 11.23%<sup>42</sup> it is no surprise that it is a positive development

However, since time series are not always suitable for regression analysis, it is needed to evaluate Durbin-Watson test for autocorrelation among residuals. Unfortunately, the value is really small, standing at **0.25** indicating there is significant autocorrelation of residuals.

Therefore, even though the null hypothesis was rejected, indicating there is a significant relationship between dependent and independent variables, it means nothing, since there is a significant autocorrelation among residuals.

### 4.6.3 Relationship with US Treasury Bills

Since Standard and Poor 500 is the largest index of all in this thesis, it deserves to have a proper treatment and maybe add one more study. There are few studies saying that treasury bills are affected by economy development.<sup>43</sup> Since T-bills are essentially risk-free investments, they tend to move in opposite direction than the economy<sup>44</sup>. It can be assumed that S&P 500 hundred can act as a benchmark of American economy (see 23 3.6) Therefore let's assume following hypothesis, based on the literature review:

H<sub>0</sub>: There is an inverse relationship between treasury bills and S&P 500

And the alternative relationship:

H<sub>a</sub>: There is not an inverse relationship between treasury bills and S&P 500.

In next chapter, there is what kind of relationship there is between the index and treasury bills of 3 and 10 months. The reason for using short-term government bonds is because the

---

<sup>42</sup> Annual Returns on Stock, T. Bonds and T-bill's: 1928 - Current. *New York University Stern School of Business* [online]. [cit. 2015-11-15]. Retrieved from:

[http://pages.stern.nyu.edu/~adamodar/New\\_Home\\_Page/datafile/histretSP.html](http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/histretSP.html)

<sup>43</sup> ROSE, Peter S a Milton H MARQUIS. *Money and capital markets: financial institutions and instruments in a global marketplace*. New York, NY: McGraw-Hill/Irwin, c2008, xxxviii, 767 p. ISBN 0073405167.

<sup>44</sup> *How Treasury Bill Prices Affects Other Investments* [online]. 2015-11-15 [cit. 2015-11-15]. Retrieved from: <http://www.investopedia.com/ask/answers/012815/how-do-treasury-bill-prices-affect-other-investments.asp>

aim of this thesis is to provide information for investor investing in short-term. The input is in the Appendix.

#### 4.6.4 Gretl Results for Regression Analysis

Model 1: OLS, using observations 1928-2014 (T = 87)

Dependent variable: SP500

	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-ratio</i>	<i>p-value</i>	
const	<b>0.124191</b>	0.033943	3.6588	0.0004	***
monthTBill	<b>-0.171542</b>	0.739376	-0.2320	0.8171	
yearTBond	<b>-0.0542575</b>	0.289351	-0.1875	0.8517	
Mean dependent var	0.115270	S.D. dependent var		0.199005	
Sum squared resid	3.400847	S.E. of regression		0.201212	
R-squared	<b>0.001475</b>	Adjusted R-squared		<b>-0.022300</b>	
F(2, 84)	0.062025	P-value(F)		0.939902	
Log-likelihood	17.57428	Akaike criterion		-29.14856	
Schwarz criterion	-21.75084	Hannan-Quinn		-26.16973	
Rho	0.010936	Durbin-Watson		<b>1.948003</b>	

We can interpret the output in equation:

$$y_{1t} = 0.124191 - 0.171542x_1 - 0.0542575x_2 + u_t$$

The coefficient of determination  $R_2 = 0.001475$ , which means that the relationship can be explained with 0.14%, which is not much and kind of disappointment. On the other hand, it can be expected since treasure bills are not the main mover in the market and are on the other side of scale in world of investment

#### 4.6.5 Economic Verification of the model

- When the value of 3-month T-bill rises by one, the index moves negatively by  $-0.17$  points. The inverse relationship here is expected therefore it goes by the null hypothesis stated earlier in this chapter.
- When the value of 10-month T-bill rises by one, the index moves negatively as well as it was in the case of 3-month T-bill. It moves by  $-0.05$  points. This relationship goes by the null hypothesis, confirming the inverse relationship

However as in both cases, the results are statistically insignificant at  $\alpha = 0.05$

- Only statistically significant finding is at the constant, which says, when both treasury bills do not move, the Standard and Poor 500 index moves by 0.12, which goes with the theory mentioned in this thesis

Looking at the Durbin-Watson coefficient, which tests the model for the presence of autocorrelation in residuals sits at **1.948** which means that there is no autocorrelation in the model.

## 5 RESULTS AND DISCUSSIONS

This chapter will serve as an overview of the practical part of the thesis and looks at the three indexes individually, together with all technical tools used. To see the bigger picture, it is sometimes useful to see all the indicators together and see, whether there are any contradictions or if there are any connections among the indicators, perhaps across all indexes. This thesis used technical analysis as the main tool of analyzing the indexes and this chapter is disregarding regression analysis, which was explained to depth in individual chapters of the thesis. In sub-chapter now every index is presented together with latest data of all indicators.

### 5.1 Result of PX analysis

Figure 29 Results for PX



Source: investing.com, own processing



When it comes to final evaluation of the PX index, if an investor today want it put your money in the index, via numerous index funds, this thesis suggests **against it**. Almost all indicators are suggesting sell and therefore author of this thesis suggests selling. Taking in consideration the fact that PX index is based on Czech Stock Exchange, which is a kind of small and not suitable for individual investors

**SUMMARY: SELL**

## 5.2 Results of DAX analysis

Figure 30 Results of DAX



*Source: investing.com, own processing*

From the time the DAX was analyzed with technical tools in this thesis, it rose by another 200 points, gaining around 1,79%. Even the values of all technical tools are working in favor of this index. As it was told in chapter on how to invest. This is the ideal time to put

some money in the index fund, which is copying the performance of DAX index. It is much more profitable option for an investor (disregarding short-selling) to fast growing German economy.

**SUMMARY: STRONG BUY**

**5.3 Results of S&P 500 analysis**

Figure 31 Results of S&P 500



*Source:investing.com, own processing*

Standards and Poor 500 Index rose by the time it was analyzed by 80 points, increasing its value by 0,52% All indicators presented are more or less suggesting to buy, only difference expression are in crossover of moving averages which would suggests to sell. However, as it was mentioned in this chapter, the performance of the index is averaging

almost 12% in its existence, moreover investing in this index using index funds is one of the safest types of investments there is.

**SUMMARY: BUY**

#### **5.4 Low Durbin-Watson value**

Few comments on the situation with the fact that all the regression analysis had low Durbin-Watson value. It was partially expected with time series and comparison of indexes. There are numerous ways how to get rid of the autocorrelation, especially choosing better data set and more suitable for the regression analysis model. However, choosing different independent variables, which could definitely be exchange rate USD/EUR, GDP of the states, perhaps trade balance of countries and much more were not part of this thesis. The main focus was on technical analysis and regression analysis, tried to find some supporting evidence of interconnection between indexes. There were also some very positive coefficient of determinations touching 90% of relationship between the independent and dependent variables.

## 6 CONCLUSIONS AND RECOMMENDATIONS

The current situation in the markets are more than favorable for investors. The bull market seems to last a couple of months in future. Economic performance of the countries, where the indexes are tracked are between 2 – 5% (the highest being in Czech Republic)<sup>454647</sup> therefore it is good idea to put some resources in the index funds, which were discussed in chapter 3.7. All the assessment of these indexes were in line with good economic outlook except in PX, where the index is stagnating and only of three was recommended to sell. This thesis guarantees no definitive success in investing into those indexes, on the other hand, it shows if it makes sense to consider putting part of the investing resources into the indexes indirectly. This strategy and the thesis is suited to low-risk profile investors, who do not want to spend significant of their resources into transaction fees and looking for alternatives different from saving accounts. It is needed to take into consideration, that even though the risk in investing to index via index fund is low, it still does exist. Author of this thesis agrees with the strategy made by Benjamin Graham for defensive investor, to put money into index fund, there for automatically obtain cross-section sample of leading companies.<sup>48</sup> However, this thesis was aimed how the indexes react in short term. It looks at the most recent changes in the index and how to react in the close future. Which is something that was not done often in the past. It shows how one can smooth the volatility of the indexes and put them against stocks in predicting future development. Investors should always use technical analysis as a supporting analysis and never fully trust the results without combining with other analyses, such as fundamental analysis.

---

<sup>45</sup> Czech Republic GDP Annual Growth Rate. *Trading Economics* [online]. [cit. 2015-11-21]. Retrieved from: <http://www.tradingeconomics.com/czech-republic/gdp-growth-annual>

<sup>46</sup> German GDP Annual Growth Rate. *Trading Economics* [online]. [cit. 2015-11-21]. Retrieved from: <http://www.tradingeconomics.com/germany/gdp-growth-annual>

<sup>47</sup> USA GDP Annual Growth Rate. *Trading Economics* [online]. [cit. 2015-11-21]. Retrieved from: <http://www.tradingeconomics.com/united-states/gdp-growth-annual>

<sup>48</sup> GRAHAM, Benjamin a Jason ZWEIG. *The intelligent investor*. Rev. ed. New York: Harper Business Essentials, c2003, xiv, 623 p. ISBN 0060555661.

## 7 BIBLIOGRAPHY

### BOOKS

BOLLINGER, John. Bollinger on Bollinger bands. New York: McGraw-Hill, c2002, xxiv, 227 p. ISBN 00-713-7368-3.

BURTON G. MALKIEL. A random walk down Wall Street: the time-tested strategy for successful investing. Rev. and updated ed. New York, NY [u.a.]: Norton, 2007. ISBN 0393330338.

ELDER, Alexander. Trading for a living. New York: John Wiley & Sons Ltd, 1993. 194 pages. ISBN 0-471-59225-0.

GRAHAM, Benjamin a Jason ZWEIG. The intelligent investor. Rev. ed. New York: Harper Business Essentials, c2003, xiv, 623 p. ISBN 0060555661.

JÍLEK, Josef. *Akciové trhy a investování*, 1. Vyd. Praha: Grada. 2009. 656 s. ISBN 9788024729633.

JÍLEK, Josef. *Finance v globální ekonomice*. 1. vyd. Praha: Grada, 2013, 660 s. Finanční trhy a instituce. ISBN 978-80-247-3893-2.

MONTGOMERY, Douglas C, Elizabeth A PECK and G VINING. Introduction to linear regression analysis. 5th ed. Hoboken, NJ: Wiley, 2012, xvi, 645 p. ISBN 9780470542811.

MURPHY, John J a John J MURPHY. Technical analysis of the financial markets: a comprehensive guide to trading methods and applications. New York: New York Institute of Finance, c1999, xxxi, 542 p. ISBN 0735200661.

MUSÍLEK, Petr. Trhy cenných papírů. 2. aktualit. a rozš. vyd. Praha. Ekopress. 2011. 520 s. ISBN 9788086929705.

SHILLER, Robert J. *Irrational exuberance*. 2nd ed. New York: Currency/Doubleday, 2005, xxvii, 304 s. ISBN 0767923634.

ROSE, Peter S a Milton H MARQUIS. Money and capital markets: financial institutions and instruments in a global marketplace. New York, NY: McGraw-Hill/Irwin, c2008, xxxviii, 767 p. ISBN 0073405167.

VESELÁ, Jitka. *Investování na kapitálových trzích*. Praha: ASPI, a.s. 2007. 704 s. ISBN 9788073572976.

## ARTICLES

DAMODARAN, Aswath. The Case For Passive Investing. Retrieved from: <http://people.stern.nyu.edu/adamodar/pdfiles/invphiloh/indexN.pdf>

FRINO, Alex a David R. GALLAGHER. Tracking S&P 500 Index Funds [online]. Journal Of Finance, 2001, 2015-11-17 [cit. 2015-11-17]. Retrieved from: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.199.4563&rep=rep1&type=pdf>

FUKUSHIGE, M. 1994. Using the Durbin-Watson Ratio To Detect Spurious Regressions: Can we make a rule of thumb ?. Japan. University of Koe. [cit. 2015-11-17].

GRANGER, C.W.G a P. NEWBOLD. SPURIOUS REGRESSIONS IN ECONOMETRICS. England: Journal Of Econometrics, 1973. [cit. 2015-11-17]. Retrieved from: [http://wolfweb.unr.edu/~zal/STAT758/Granger\\_Newbold\\_1974.pdf](http://wolfweb.unr.edu/~zal/STAT758/Granger_Newbold_1974.pdf). University of Nottingham.

GREEN, T. Clifton a Russel JAME. Strategic trading by index funds and liquidity provision around S&P 500 index additions, Journal of Financial Markets, 8th March 2011 [cit. 2015-11-17].

HARRIS, L., GUREL, E., 1986. Price and volume effects associated with changes in the S&P 500 list: new evidence for the existence of price pressures. Journal of Finance 41, 815–829. [cit. 2015-11-17].

O. SYKES, Alan. An Introduction to Regression Analysis: The Inaugural Coase Lecture. Chicago, 1980. [cit. 2015-10-17].

RANGER, C.W.G a P. NEWBOLD. SPURIOUS REGRESSIONS IN ECONOMETRICS. England: Journal Of Econometrics, 1973. [cit. 2015-11-17]. Retrieved from: [http://wolfweb.unr.edu/~zal/STAT758/Granger\\_Newbold\\_1974.pdf](http://wolfweb.unr.edu/~zal/STAT758/Granger_Newbold_1974.pdf). University of Nottingham.

SHLEIFER, A., 1986. Do demand curves for stocks slope down? Journal of Finance 41, 579–590 [cit. 2015-11-17].

ZOUHAR, Jan. ZÁKLADY EKONOMETRIE: Autocorelace [online]. [cit. 2015-11-16]. Retrieved from: <http://nb.vse.cz/~zouharj/>

#### INTERNET SOURCES:

Annual Returns on Stock, T.Bonds and T.Bills: 1928 - Current. New York University Stern School of Business [online]. [cit. 2015-11-15]. Retrieved from: [http://pages.stern.nyu.edu/~adamodar/New\\_Home\\_Page/datafile/histretSP.html](http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/histretSP.html)

Bloomberg Business: PX. German Stock Index [online]. [cit. 2015-10-03]. Retrieved from: <http://www.bloomberg.com/quote/DAX:IND>

Bloomberg Business: PX. Prague Stock Exchange Index [online]. [cit. 2015-10-03]. Retrieved from: <http://www.bloomberg.com/quote/PX:IND>

Boerse Frankfurt: Basic Overview [online]. [cit. 2015-10-04]. Retrieved from: <http://www.boerse-frankfurt.de/en/basics+overview#>

CNET: Volkswagen recalls 8.5M European diesels amid global probes [online]. 2015 [cit. 2015-11-01]. Retrieved from: <http://www.cnet.com/news/volkswagen-8-5-million-diesel-recall-investigation/>

Czech Republic GDP Annual Growth Rate. Trading Economics [online]. [cit. 2015-11-21]. Retrieved from: <http://www.tradingeconomics.com/czech-republic/gdp-growth-annual>

Deutsche Börse AG. The Frankfurt Stock Exchange[online]. Deutsche Börse, 2014. [cit. 6. 4. 2015]. Retrieved from: [https://deutsche-boerse.com/dbg/disatch/en/kir/dbg\\_nav/about\\_us/20\\_FWB\\_Frankfurt\\_Stock\\_Exchange](https://deutsche-boerse.com/dbg/disatch/en/kir/dbg_nav/about_us/20_FWB_Frankfurt_Stock_Exchange)

Different Types of Stock Market Indexes. ABC of Investing [online]. [cit. 2015-11-16]. Retrieved from: <http://www.abcsinvesting.net/different-types-of-stock-market-indexes/>

DOW JONES INDUSTRIAL AVERAGE. Dow Jones Industrial Average: Fact Sheet [online]. 2015-11-17, : 1-4 [cit. 2015-11-17]. Retrieved from: [http://www.djindexes.com/mdsidx/downloads/fact\\_info/Dow\\_Jones\\_Industrial\\_Average\\_Fact\\_Sheet.pdf](http://www.djindexes.com/mdsidx/downloads/fact_info/Dow_Jones_Industrial_Average_Fact_Sheet.pdf)

Fio Banka: Burza Cenných Papírů Praha. Prague Stock Exchange Index [online]. [cit. 2015-10-03]. Retrieved from: <http://www.fio.sk/akcie-investicie/obchodovanie-akcie/akcie-cr/obchodovanie-prazska-burza>

German GDP Annual Growth Rate. Trading Economics [online]. [cit. 2015-11-21]. Retrieved from: <http://www.tradingeconomics.com/germany/gdp-growth-annual>

Guide to the Equity Indices of Deutsche Börse AG. RWE [online]. December 2014 [cit. 2015-11-21]. Retrieved from: <https://www.rwe.com/web/cms/media-blob/en/195148/data/113836/7/rwe/investor-relations/shares/shareholder-structure/Guide-to-the-Equity-Indices-of-Deutsche-Boerse.pdf>

How Treasury Bill Prices Affects Other Investments [online]. 2015-11-15 [cit. 2015-11-15]. Retrieved from: <http://www.investopedia.com/ask/answers/012815/how-do-treasury-bill-prices-affect-other-investments.asp>

Index Investing: The Standard & Poor's 500 Index. Investopedia [online]. [cit. 2015-11-16]. Retrieved from: <http://www.investopedia.com/university/indexes/index3.asp>

Investopedia: INDEX [online]. [cit. 2015-10-11]. Retrieved from: <http://www.investopedia.com/terms/i/index.asp>

Investopedia: MACD [online]. [cit. 2015-10-11]. Retrieved from: <http://www.investopedia.com/terms/m/macd.asp>

Investopedia: NASDAQ [online]. [cit. 2015-10-25]. Retrieved from: <http://www.investopedia.com/terms/n/nasdaq.asp>

Investopedia: NYSE [online]. [cit. 2015-10-25]. Retrieved from: <http://www.investopedia.com/terms/n/nyse.asp>

Investopedia: Regression Analysis – Regression [online]. 2015 [cit. 2015-10-17]. Retrieved from: <http://www.investopedia.com/terms/r/regression.asp>

Investopedia: Relative Strength Index - RSI [online]. 2015 [cit. 2015-10-17]. Retrieved from: <http://www.investopedia.com/terms/r/rsi.asp>

O. SYKES, Alan. An Introduction to Regression Analysis: The Inaugural Coase Lecture. Chicago, 1980. [cit. 2015-10-17].



PX: Prague Stock Exchange. Exchange Indexes [online]. [cit. 2015-10-03]. Retrieved from: <https://www.pse.cz/dokument.aspx?k=Burzovni-Indexy>

PX: Prague Stock Exchange. PSE [online]. [cit. 2015-10-03]. Retrieved from: <https://www.pse.cz/dokument.aspx?k=Historie-Burzy>

S&P 500: Equity Indices. Spindices [online]. [cit. 2015-11-21]. Retrieved from: <http://www.spindices.com/documents/factsheets/fs-sp-500-ltr.pdf>

SHLEIFER, A., 1986. Do demand curves for stocks slope down? Journal of Finance 41, 579–590

The Rules for the PX Index and PX-TR Index of the Prague Stock Exchange. CEE Stock Exchange Group [online]. May 2015 [cit. 2015-11-21]. Retrieved from: [http://ftp.pse.cz/Info.bas/Cz/PX\\_pravidla\\_pro\\_vypocet.pdf](http://ftp.pse.cz/Info.bas/Cz/PX_pravidla_pro_vypocet.pdf)

USA GDP Annual Growth Rate. Trading Economics [online]. [cit. 2015-11-21]. Retrieved from: <http://www.tradingeconomics.com/united-states/gdp-growth-annual>

World Exchanges: Monthly Reports [online]. [cit. 2015-10-25]. Retrieved from: <http://www.world-exchanges.org/statistics/monthly-reports>

World Exchanges: Monthly Reports [online]. [cit. 2015-10-25]. Retrieved from: <http://www.world-exchanges.org/statistics/monthly-reports>

Yahoo Finance: Stock Market News for September 24, 2015.[online]. [cit. 2015-10-18]. Retrieved from: <https://finance.yahoo.com/news/stock-market-news-september-24-141002387.html>

## 8 APPENDIX

### Appendix 1 Constituents of DAX Index

Name	Last	High	Low	Chg.	Chg. %	Vol.	Time
<b>Adidas AG</b>	71.8	72.74	70.82	0.1	0.14%	1.03M	2.10
<b>Allianz</b>	139.45	141.15	137.25	1.15	0.83%	1.64M	2.10
<b>BASF SE</b>	66.71	68.08	65.67	0.25	0.38%	4.23M	2.10
<b>Bayer AG</b>	113.15	114.4	110.9	0.5	0.44%	2.11M	2.10
<b>Beiersdorf AG</b>	78.59	78.77	77.15	0.94	1.21%	458.84K	2.10
<b>BMW ST</b>	78.21	79.73	76.12	-0.12	-0.15%	2.02M	2.10
<b>Commerzbank AG</b>	9.432	9.617	9.325	0.104	1.11%	8.54M	2.10
<b>Continental AG</b>	192.85	195.7	188.65	1.8	0.94%	486.02K	2.10
<b>Daimler AG</b>	64.58	65.49	62.91	0.13	0.20%	4.49M	2.10
<b>Deutsche Bank AG</b>	23.8	24.375	23.57	0.15	0.63%	8.46M	2.10
<b>Deutsche Boerse</b>	78.83	79.35	77.17	0.95	1.22%	673.60K	2.10
<b>Deutsche Post AG</b>	24.775	24.885	24.32	0.29	1.18%	4.58M	2.10
<b>Deutsche Telekom AG</b>	15	15.29	14.555	-0.055	-0.37%	17.49M	2.10
<b>E.ON SE</b>	7.947	8.09	7.63	0.471	6.30%	18.60M	2.10
<b>Fresenius SE</b>	58.27	59.4	57.41	-0.39	-0.66%	1.70M	2.10
<b>Fresenius ST</b>	69.66	70.39	68.27	0.23	0.33%	791.14K	2.10
<b>Heidelbergcement AG</b>	61.48	62.78	60.69	0.02	0.03%	489.29K	2.10
<b>Henkel VZO</b>	90.26	90.97	89.46	-0.65	-0.71%	904.41K	2.10
<b>Infineon AG</b>	9.751	10.175	9.722	-0.057	-0.58%	9.50M	2.10
<b>K&amp;S AG</b>	31	31.68	30.605	0.06	0.19%	1.64M	2.10
<b>Lanxess AG</b>	41.435	42.14	40.8	0.275	0.67%	378.51K	2.10
<b>Linde AG</b>	145.15	146.4	142.8	0.95	0.66%	415.79K	2.10
<b>Lufthansa AG</b>	12.675	12.935	12.52	0.495	4.06%	11.17M	2.10
<b>Merck</b>	77.37	78.33	75.55	-0.3	-0.39%	669.38K	2.10

<b>Muench. Rueckvers.</b>	163.95	166.3	162.25	-0.75	-0.46%	977.15K	2.10
<b>RWE AG ST</b>	10.43	10.59	9.999	0.667	6.83%	7.93M	2.10
<b>SAP AG</b>	57.69	58.68	56.98	0.57	1.00%	3.86M	2.10
<b>Siemens AG</b>	79.15	80.46	77.91	0.12	0.15%	2.72M	2.10
<b>Thyssenkrupp AG</b>	15.93	16.08	15.63	0.365	2.35%	2.62M	2.10
<b>Volkswagen AG VZO</b>	92.36	97.51	90.7	-4.14	-4.29%	4.30M	2.10

Source: investing.com

### Appendix 2 Durbin-Watson Statistic: 5 Per Cent Significance Points of dL and dU

n	k'=1		k'=2		k'=3		k'=4		k'=5		k'=6		k'=7		k'=8		k'=9		k'=10		
	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	
6	0.610	1.400																			
7	0.700	1.356	0.467	1.896																	
8	0.763	1.332	0.559	1.777	0.367	2.287															
9	0.824	1.320	0.629	1.699	0.455	2.128	0.296	2.588													
10	0.879	1.320	0.697	1.641	0.525	2.016	0.376	2.414	0.243	2.822											
11	0.927	1.324	0.758	1.604	0.595	1.928	0.444	2.283	0.315	2.645	0.203	3.004									
12	0.971	1.331	0.812	1.579	0.658	1.864	0.512	2.177	0.380	2.506	0.268	2.832	0.171	3.149							
13	1.010	1.340	0.861	1.562	0.715	1.816	0.574	2.094	0.444	2.390	0.328	2.692	0.230	2.985	0.147	3.266					
14	1.045	1.350	0.905	1.551	0.767	1.779	0.632	2.030	0.505	2.296	0.389	2.572	0.286	2.848	0.200	3.111	0.127	3.360			
15	1.077	1.361	0.946	1.543	0.814	1.750	0.685	1.977	0.562	2.220	0.447	2.471	0.343	2.727	0.251	2.979	0.175	3.216	0.111	3.438	
16	1.106	1.371	0.982	1.539	0.857	1.728	0.734	1.935	0.615	2.157	0.502	2.388	0.398	2.624	0.304	2.860	0.222	3.090	0.155	3.304	
17	1.133	1.381	1.015	1.536	0.897	1.710	0.779	1.900	0.664	2.104	0.554	2.318	0.451	2.537	0.356	2.757	0.272	2.975	0.198	3.184	
18	1.158	1.391	1.046	1.535	0.933	1.696	0.820	1.872	0.710	2.060	0.603	2.258	0.502	2.461	0.407	2.668	0.321	2.873	0.244	3.073	
19	1.180	1.401	1.074	1.536	0.967	1.685	0.859	1.848	0.752	2.023	0.649	2.206	0.549	2.396	0.456	2.589	0.369	2.783	0.290	2.974	
20	1.201	1.411	1.100	1.537	0.998	1.676	0.894	1.828	0.792	1.991	0.691	2.162	0.595	2.339	0.502	2.521	0.416	2.704	0.336	2.885	
21	1.221	1.420	1.125	1.538	1.026	1.669	0.927	1.812	0.829	1.964	0.731	2.124	0.637	2.290	0.546	2.461	0.461	2.633	0.380	2.806	
22	1.239	1.429	1.147	1.541	1.053	1.664	0.958	1.797	0.863	1.940	0.769	2.090	0.677	2.246	0.588	2.407	0.504	2.571	0.424	2.735	
23	1.257	1.437	1.168	1.543	1.078	1.660	0.986	1.785	0.895	1.920	0.804	2.061	0.715	2.208	0.628	2.360	0.545	2.514	0.465	2.670	
24	1.273	1.446	1.188	1.546	1.101	1.656	1.013	1.775	0.925	1.902	0.837	2.035	0.750	2.174	0.666	2.318	0.584	2.464	0.506	2.613	
25	1.288	1.454	1.206	1.550	1.123	1.654	1.038	1.767	0.953	1.886	0.868	2.013	0.784	2.144	0.702	2.280	0.621	2.419	0.544	2.560	
26	1.302	1.461	1.224	1.553	1.143	1.652	1.062	1.759	0.979	1.873	0.897	1.992	0.816	2.117	0.735	2.246	0.657	2.379	0.581	2.513	
27	1.316	1.469	1.240	1.556	1.162	1.651	1.084	1.753	1.004	1.861	0.925	1.974	0.845	2.093	0.767	2.216	0.691	2.342	0.616	2.470	
28	1.328	1.476	1.255	1.560	1.181	1.650	1.104	1.747	1.028	1.850	0.951	1.959	0.874	2.071	0.798	2.188	0.723	2.309	0.649	2.431	
29	1.341	1.483	1.270	1.563	1.198	1.650	1.124	1.743	1.050	1.841	0.975	1.944	0.900	2.052	0.826	2.164	0.753	2.278	0.681	2.396	
30	1.352	1.489	1.284	1.567	1.214	1.650	1.143	1.739	1.071	1.833	0.998	1.931	0.926	2.034	0.854	2.141	0.782	2.251	0.712	2.363	
31	1.363	1.496	1.297	1.570	1.229	1.650	1.160	1.735	1.090	1.825	1.020	1.920	0.950	2.018	0.879	2.120	0.810	2.226	0.741	2.333	
32	1.373	1.502	1.309	1.574	1.244	1.650	1.177	1.732	1.109	1.819	1.041	1.909	0.972	2.004	0.904	2.102	0.836	2.203	0.769	2.306	
33	1.383	1.508	1.321	1.577	1.258	1.651	1.193	1.730	1.127	1.813	1.061	1.900	0.994	1.991	0.927	2.085	0.861	2.181	0.796	2.281	
34	1.393	1.514	1.333	1.580	1.271	1.652	1.208	1.728	1.144	1.808	1.079	1.891	1.015	1.978	0.950	2.069	0.885	2.162	0.821	2.257	
35	1.402	1.519	1.343	1.584	1.283	1.653	1.222	1.726	1.160	1.803	1.097	1.884	1.034	1.967	0.971	2.054	0.908	2.144	0.845	2.236	
36	1.411	1.525	1.354	1.587	1.295	1.654	1.236	1.724	1.175	1.799	1.114	1.876	1.053	1.957	0.991	2.041	0.930	2.127	0.868	2.216	
37	1.419	1.530	1.364	1.590	1.307	1.655	1.249	1.723	1.190	1.795	1.131	1.870	1.071	1.948	1.011	2.029	0.951	2.112	0.891	2.197	
38	1.427	1.535	1.373	1.594	1.318	1.656	1.261	1.722	1.204	1.792	1.146	1.864	1.088	1.939	1.029	2.017	0.970	2.098	0.912	2.180	
39	1.435	1.540	1.382	1.597	1.328	1.658	1.273	1.722	1.218	1.789	1.161	1.859	1.104	1.932	1.047	2.007	0.990	2.085	0.932	2.164	
40	1.442	1.544	1.391	1.600	1.338	1.659	1.285	1.721	1.230	1.786	1.175	1.854	1.120	1.924	1.064	1.997	1.008	2.072	0.952	2.149	
45	1.475	1.566	1.430	1.615	1.383	1.666	1.336	1.720	1.287	1.776	1.238	1.835	1.189	1.895	1.139	1.958	1.089	2.022	1.038	2.088	
50	1.503	1.585	1.462	1.628	1.421	1.674	1.378	1.721	1.335	1.771	1.291	1.822	1.246	1.875	1.201	1.930	1.156	1.986	1.110	2.044	
55	1.528	1.601	1.490	1.641	1.452	1.681	1.414	1.724	1.374	1.768	1.334	1.814	1.294	1.861	1.253	1.909	1.212	1.959	1.170	2.010	
60	1.549	1.616	1.514	1.652	1.480	1.689	1.444	1.727	1.408	1.767	1.372	1.808	1.335	1.850	1.298	1.894	1.260	1.939	1.222	1.984	
65	1.567	1.629	1.536	1.662	1.503	1.696	1.471	1.731	1.438	1.767	1.404	1.805	1.370	1.843	1.336	1.882	1.301	1.923	1.266	1.964	
70	1.583	1.641	1.554	1.672	1.525	1.703	1.494	1.735	1.464	1.768	1.433	1.802	1.401	1.838	1.369	1.874	1.337	1.910	1.305	1.948	
75	1.598	1.652	1.571	1.680	1.543	1.709	1.515	1.739	1.487	1.770	1.458	1.801	1.428	1.834	1.399	1.867	1.369	1.901	1.339	1.935	
80	1.611	1.662	1.586	1.688	1.560	1.715	1.534	1.743	1.507	1.772	1.480	1.801	1.453	1.831	1.425	1.861	1.397	1.893	1.369	1.925	
85	1.624	1.671	1.600	1.696	1.575	1.721	1.550	1.747	1.525	1.774	1.500	1.801	1.474	1.829	1.448	1.857	1.422	1.886	1.396	1.916	

90	1.635	1.679	1.612	1.703	1.589	1.726	1.566	1.751	1.542	1.776	1.518	1.801	1.494	1.827	1.469	1.854	1.445	1.881	1.420	1.909
95	1.645	1.687	1.623	1.709	1.602	1.732	1.579	1.755	1.557	1.778	1.535	1.802	1.512	1.827	1.489	1.852	1.465	1.877	1.442	1.903
100	1.654	1.694	1.634	1.715	1.613	1.736	1.592	1.758	1.571	1.780	1.550	1.803	1.528	1.826	1.506	1.850	1.484	1.874	1.462	1.898
150	1.720	1.747	1.706	1.760	1.693	1.774	1.679	1.788	1.665	1.802	1.651	1.817	1.637	1.832	1.622	1.846	1.608	1.862	1.593	1.877
200	1.758	1.779	1.748	1.789	1.738	1.799	1.728	1.809	1.718	1.820	1.707	1.831	1.697	1.841	1.686	1.852	1.675	1.863	1.665	1.874

	k'	=11	k'	=12	k'	=13	k'	=14	k'	=15	k'	=16	k'	=17	k'	=18	k'	=19	k'	=20
n	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU
16	0.098	3.503																		
17	0.138	3.378	0.087	3.557																
18	0.177	3.265	0.123	3.441	0.078	3.603														
19	0.220	3.159	0.160	3.335	0.111	3.496	0.070	3.642												
20	0.263	3.063	0.200	3.234	0.145	3.395	0.100	3.542	0.063	3.676										
21	0.307	2.976	0.240	3.141		3.300	0.132	3.448	0.091	3.583	0.058	3.705								
22	0.349	2.897	0.281	3.057	0.220	3.211	0.166	3.358	0.120	3.495	0.083	3.619	0.052	3.731						
23	0.391	2.826	0.322	2.979	0.259	3.128	0.202	3.272	0.153	3.409	0.110	3.535	0.076	3.650	0.048	3.753				
24	0.431	2.761	0.362	2.908	0.297	3.053	0.239	3.193	0.186	3.327	0.141	3.454	0.101	3.572	0.070	3.678	0.044	3.773		
25	0.470	2.702	0.400	2.844	0.335	2.983	0.275	3.119	0.221	3.251	0.172	3.376	0.130	3.494	0.094	3.604	0.065	3.702	0.041	3.790
26	0.508	2.649	0.438	2.784	0.373	2.919	0.312	3.051	0.256	3.179	0.205	3.303	0.160	3.420	0.120	3.531	0.087	3.632	0.060	3.724
27	0.544	2.600	0.475	2.730	0.409	2.859	0.348	2.987	0.291	3.112	0.238	3.233	0.191	3.349	0.149	3.460	0.112	3.563	0.081	3.658
28	0.578	2.555	0.510	2.680	0.445	2.805	0.383	2.928	0.325	3.050	0.271	3.168	0.222	3.283	0.178	3.392	0.138	3.495	0.104	3.592
29	0.612	2.515	0.544	2.634	0.479	2.755	0.418	2.874	0.359	2.992	0.305	3.107	0.254	3.219	0.208	3.327	0.166	3.431	0.129	3.528
30	0.643	2.477	0.577	2.592	0.512	2.708	0.451	2.823	0.392	2.937	0.337	3.050	0.286	3.160	0.238	3.266	0.195	3.368	0.156	3.465
31	0.674	2.443	0.608	2.553	0.545	2.665	0.484	2.776	0.425	2.887	0.370	2.996	0.317	3.103	0.269	3.208	0.224	3.309	0.183	3.406
32	0.703	2.411	0.638	2.517	0.576	2.625	0.515	2.733	0.457	2.840	0.401	2.946	0.349	3.050	0.299	3.153	0.253	3.252	0.211	3.348
33	0.731	2.382	0.668	2.484	0.606	2.588	0.546	2.692	0.488	2.796	0.432	2.899	0.379	3.000	0.329	3.100	0.283	3.198	0.239	3.293
34	0.758	2.355	0.695	2.454	0.634	2.554	0.575	2.654	0.518	2.754	0.462	2.854	0.409	2.954	0.359	3.051	0.312	3.147	0.267	3.240
35	0.783	2.330	0.722	2.425	0.662	2.521	0.604	2.619	0.547	2.716	0.492	2.813	0.439	2.910	0.388	3.005	0.340	3.099	0.295	3.190
36	0.808	2.306	0.748	2.398	0.689	2.492	0.631	2.586	0.575	2.680	0.520	2.774	0.467	2.868	0.417	2.961	0.369	3.053	0.323	3.142
37	0.831	2.285	0.772	2.374	0.714	2.464	0.657	2.555	0.602	2.646	0.548	2.738	0.495	2.829	0.445	2.920	0.397	3.009	0.351	3.097
38	0.854	2.265	0.796	2.351	0.739	2.438	0.683	2.526	0.628	2.614	0.575	2.703	0.522	2.792	0.472	2.880	0.424	2.968	0.378	3.054
39	0.875	2.246	0.819	2.329	0.763	2.413	0.707	2.499	0.653	2.585	0.600	2.671	0.549	2.757	0.499	2.843	0.451	2.929	0.404	3.013
40	0.896	2.228	0.840	2.309	0.785	2.391	0.731	2.473	0.678	2.557	0.626	2.641	0.575	2.724	0.525	2.808	0.477	2.829	0.430	2.974
45	0.988	2.156	0.938	2.225	0.887	2.296	0.838	2.367	0.788	2.439	0.740	2.512	0.692	2.586	0.644	2.659	0.598	2.733	0.553	2.807
50	1.064	2.103	1.019	2.163	0.973	2.225	0.927	2.287	0.882	2.350	0.836	2.414	0.792	2.479	0.747	2.544	0.703	2.610	0.660	2.675
55	1.129	2.062	1.087	2.116	1.045	2.170	1.003	2.225	0.961	2.281	0.919	2.338	0.877	2.396	0.836	2.454	0.795	2.512	0.754	2.571
60	1.184	2.031	1.145	2.079	1.106	2.127	1.068	2.177	1.029	2.227	0.990	2.278	0.951	2.330	0.913	2.382	0.874	2.434	0.836	2.487
65	1.231	2.006	1.195	2.049	1.160	2.093	1.124	2.138	1.088	2.183	1.052	2.229	1.016	2.276	0.980	2.323	0.944	2.371	0.908	2.419
70	1.272	1.987	1.239	2.026	1.206	2.066	1.172	2.106	1.139	2.148	1.105	2.189	1.072	2.232	1.038	2.275	1.005	2.318	0.971	2.362
75	1.308	1.970	1.277	2.006	1.247	2.043	1.215	2.080	1.184	2.118	1.153	2.156	1.121	2.195	1.090	2.235	1.058	2.275	1.027	2.315
80	1.340	1.957	1.311	1.991	1.283	2.024	1.253	2.059	1.224	2.093	1.195	2.129	1.165	2.165	1.136	2.201	1.106	2.238	1.076	2.275
85	1.369	1.946	1.342	1.977	1.315	2.009	1.287	2.040	1.260	2.073	1.232	2.105	1.205	2.139	1.177	2.172	1.149	2.206	1.121	2.241
90	1.395	1.937	1.369	1.966	1.344	1.995	1.318	2.025	1.292	2.055	1.266	2.085	1.240	2.116	1.213	2.148	1.187	2.179	1.160	2.211
95	1.418	1.930	1.394	1.956	1.370	1.984	1.345	2.012	1.321	2.040	1.296	2.068	1.271	2.097	1.247	2.126	1.222	2.156	1.197	2.186
100	1.439	1.923	1.416	1.948	1.393	1.974	1.371	2.000	1.347	2.026	1.324	2.053	1.301	2.080	1.277	2.108	1.253	2.135	1.229	2.164
150	1.579	1.892	1.564	1.908	1.550	1.924	1.535	1.940	1.519	1.956	1.504	1.972	1.489	1.989	1.474	2.006	1.458	2.023	1.443	2.040
200	1.654	1.885	1.643	1.896	1.632	1.908	1.621	1.919	1.610	1.931	1.599	1.943	1.588	1.955	1.576	1.967	1.565	1.979	1.554	1.991

Source: University of Notre Dame, nd.edu

### Appendix 3 Input for t-bills regression

S&P 500	3-month T.Bill	10-year Bond	T.
43.8112%	3.0800%	0.8355%	
-8.2979%	3.1600%	4.2038%	
-25.1236%	4.5500%	4.5409%	
-43.8375%	2.3100%	-2.5589%	
-8.6424%	1.0700%	8.7903%	
49.9822%	0.9600%	1.8553%	
-1.1886%	0.3225%	7.9634%	
46.7404%	0.1750%	4.4720%	
31.9434%	0.1700%	5.0179%	
-35.3367%	0.3025%	1.3791%	
29.2827%	0.0775%	4.2132%	
-1.0976%	0.0375%	4.4123%	
-10.6729%	0.0250%	5.4025%	

-12.7715%	0.0825%	-2.0222%
19.1738%	0.3375%	2.2949%
25.0613%	0.3800%	2.4900%
19.0307%	0.3800%	2.5776%
35.8211%	0.3800%	3.8044%
-8.4291%	0.3800%	3.1284%
5.2000%	0.5675%	0.9197%
5.7046%	1.0225%	1.9510%
18.3032%	1.1025%	4.6635%
30.8055%	1.1725%	0.4296%
23.6785%	1.4775%	-0.2953%
18.1510%	1.6725%	2.2680%
-1.2082%	1.8925%	4.1438%
52.5633%	0.9625%	3.2898%
32.5973%	1.6600%	-1.3364%
7.4395%	2.5550%	-2.2558%
-10.4574%	3.2300%	6.7970%
43.7200%	1.7775%	-2.0990%
12.0565%	3.2550%	-2.6466%
0.3365%	3.0450%	11.6395%
26.6377%	2.2675%	2.0609%
-8.8115%	2.7775%	5.6935%
22.6119%	3.1100%	1.6842%
16.4155%	3.5050%	3.7281%
12.3992%	3.9025%	0.7189%
-9.9710%	4.8400%	2.9079%
23.8030%	4.3325%	-1.5806%
10.8149%	5.2600%	3.2746%
-8.2414%	6.5625%	-5.0140%
3.5611%	6.6850%	16.7547%
14.2212%	4.5400%	9.7869%
18.7554%	3.9525%	2.8184%
-14.3080%	6.7250%	3.6587%
-25.9018%	7.7775%	1.9886%
36.9951%	5.9900%	3.6053%
23.8310%	4.9700%	15.9846%
-6.9797%	5.1275%	1.2900%
6.5093%	6.9325%	-0.7776%
18.5195%	9.9375%	0.6707%
31.7352%	11.2200%	-2.9897%
-4.7024%	14.3000%	8.1992%
20.4191%	11.0100%	32.8145%
22.3372%	8.4475%	3.2002%
6.1461%	9.6125%	13.7334%
31.2351%	7.4875%	25.7125%
18.4946%	6.0350%	24.2842%
5.8127%	5.7225%	-4.9605%
16.5372%	6.4500%	8.2236%
31.4752%	8.1100%	17.6936%
-3.0645%	7.5500%	6.2354%
30.2348%	5.6100%	15.0045%
7.4937%	3.4050%	9.3616%

9.9671%	2.9825%	14.2110%
1.3259%	3.9850%	-8.0367%
37.1952%	5.5150%	23.4808%
22.6810%	5.0225%	1.4286%
33.1037%	5.0525%	9.9391%
28.3380%	4.7275%	14.9214%
20.8854%	4.5100%	-8.2542%
-9.0318%	5.7625%	16.6553%
-11.8498%	3.6725%	5.5722%
-21.9660%	1.6575%	15.1164%
28.3558%	1.0300%	0.3753%
10.7428%	1.2275%	4.4907%
4.8345%	3.0100%	2.8675%
15.6126%	4.6775%	1.9610%
5.4847%	4.6425%	10.2099%
-36.5523%	1.5850%	20.1013%
25.9352%	0.1350%	-11.1167%
14.8211%	0.1300%	8.4629%
2.0984%	0.0300%	16.0353%
15.8906%	0.0500%	2.9716%
32.1451%	0.0660%	-9.1046%
13.4774%	0.0530%	10.7462%

Source: stern.nyu.edu

---

<sup>i</sup> On the fourth birthday of the author of this thesis

<sup>ii</sup> Investopedia: NASDAQ [online]. [cit. 2015-10-25]. Retrieved from: <http://www.investopedia.com/terms/n/nasdaq.asp>