The impact of money supply on stock prices and stock bubbles

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THE IMPACT OF MONEY SUPPLY ON STOCK PRICES AND STOCK BUBBLES

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Abstract
This article is focused on the effect and implication of a change in the money supply for US capital market. This market was chosen according to his part on the global market capitalization. Namely it is the Dow Jones Industrial Average (DJIA), which was chosen according to his long history, global sense and stabile construction. The money supply will be measured by the wider aggregate M2 and aggregate MZM (money with zero maturity). The goal of this paper is detect, if the money supply influence the stock indices in period 1967 - 2011, if the impact of both money aggregates is near the same and how the money supply influence the bubble creation.

Introduction

The primary appreciation factor for stock markets investigated by **Hysek** (2009) is the ability of different societies to improve their financial indicators (mostly cash flow and/or net profit per one share). Shares and stock markets are extremely sensitive to any price-shaping information, relevant for future trends and market development. The price-shaping factors generally include macroeconomic and microeconomic factors, but also the psychological and subjective influence of investors who can affect the behaviour of the entire market and its volatility (which growths alongside the growing number of market participants), the development of new technologies and the impacts of globalisation. A major role in the determination of share prices is held mostly by various macroeconomic factors, such as a change in interest rates, money supply, inflation, political shocks, legislation amendments, etc. Monetary policy represents one of the most efficient instruments of central banks in different countries. As shown below in more detail, many economists and scholars regard monetary policy as the most important macroeconomic policy instrument. This is why central banks apply these particular monetary policy instruments to influence real business and the economy as such. Therefore, it is essential to understand the effects of monetary policy and any changes thereto on the stock market as a vital determinant of economic development. The objective of this paper is therefore to find, describe and evaluate the effects of changes to the money supply on the US stock index. With the objective of this paper defined, some other partial objectives can be identified as well. These sub-objectives are whether the effects of selected monetary aggregates on the stock index are the same or varied and whether there is a time delay in the response of a stock market to changed money supply.

1. Literature review

National stock markets, belonging to and being the basis of the global capital market, affect the global market on one hand, but on the other hand they are themselves under the influence of the global market. Some authors (**Bilson, Brailsford, Hooper,** 2000) note that national[1]

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[1] According to these authors, these factors include mostly national macroeconomic factors.

(risk) factors affect the performance of the stock market more than global factors (supranational). The basic instrument for investigating the factors affecting stock markets is the fundamental analysis which can be performed on three basic levels: global, sector-specific and corporate. Factors affecting the price behaviour not only of shares but also other securities and instruments can be further divided into macroeconomic and microeconomic (e.g. psychological effects). As **King** (1966) notes, stock markets are influenced by macroeconomic factors by an average of 50%. A similar view is shared by **Musílek** (1997) who, unlike King, stays on the general level and claims that if an investor wants to be successful, he must focus mostly on price-shaping macroeconomic factors. In regard of that the spot price of stock present future income, which are discountet, **Flannery**, **Protopapadakis** (2002), mean that macroeconomic variables are the most important indicators, which influence the stock returns, because right this factors has an impact on future company´s cash flow and influence the high of discount rate.

The first study in modern history, which focus on effect of macroeconomic variables on stock prices can we post e.g. **Nelson** (1976), **Jaffe** a **Mandelker** (1977) or **Fama**, **Schwert** (1977). The impact of national macro-economic factors on the performance of national stock market in the modern period was addressed by authors such as **Bilson, Brailsford and Hooper** (2000), who maintain that these factors determine the stock prices more than the global macroeconomic factors. According to **Veselá** (2010) the macroeconomic factors that influence the development of stock prices, include interest rate, inflation, GDP, money supply, the movement of international capital changes in exchange rates, political and economic shocks. According to **Kohout** (2010), the most important factor influencing the development of stock prices in the long term is the amount of money in the economy (i.e. money supply). Also **Flannery**, **Protopapadakis** (2002) include among the major macroeconomic factors the money supply as well as unemployment, trade balance, the number of new residential buildings and the Producer Price Index.

According to **Maskay** (2007) or **Chromec** (2006), the monetary policy or change in money supply, is one of the most effective tools available to the national central banks of individual countries in association with influencing the actual economic activity. Many authors, such as **Keran** (1971), **Gupta** (1974), **Musílek** (1997), **Poiré** (2000) or **Shostack** (2003) consider the money supply as the instrument of the monetary policy, to be the most important macroeconomic factor that influences the behavior and development of stock prices. **Maskay** (2007) and **Ioannidis**, **Kontonikas** (2006) consider the stock market to be the basic indicator of the condition and development of the economy strongly influencing and preceding it. Also these authors consider the money supply to be a strong determinant of the stock market, i.e. of the entire economy. Money supply can affect stock prices directly, when there is more money in the economy than can be utilized so they are allocated to investments. But as already mentioned, for example, by using quantitative release results indirectly in the reduction of the interest rates rendering the external financing cheaper, leading to increasing investments (growth in the demand for shares) and consumption (better economic results of companies).

By examining global factors certain associations were discovered between variables (in this case the money supply) and the development of stock prices, using which we can predict the future development and that represent an important guide for the investor. Most authors listing macroeconomic factors that influence the development of stock prices consider the monetary policy, or change of the money supply in the economy to be the most important factor.A statement by **Gupta** (1974) serves as example, when he says that the money supply can be utilised for predicting the development of stock markets. His investigation confirmed

that 59% of the value of stock indices can be predicted based on the money supply. This statement is supported by **Rapach**, **Wohar** and **Rangvid** (2005) who, in their analysis focused on the prediction of stock market development by using macroeconomic factors in 12 countries, concluded that the most trustworthy macroeconomic indicator for stock market predictions is the interest rate. **Pearce, Roley** (1985) in their research dealt with the issues of anticipative money supply and concluded that there is a reciprocal relation between the non-anticipative money supply and the development of the stock prices. As stated by these authors, the central bank will quickly respond to this growth by raising the interest rates, resulting in the reduction of stock prices, because investors will seek less risky substitutes for their investment. On the contrary, according to **Bernanke** (2003) the anticipative change in the money supply will have no effect on the development of prices of financial assets (i.e. also including equity securities - shares) because the investors included it in their decisions (the asset prices were discounted). Only non-anticipative change in the money supply may influence the prices of securities. Varying effects of anticipative and non-anticipative money supply on the development of stock prices are confirmed by the **Maskay** (2007).

There were many studies published which dealt with the analysis of the influence of the money on the stock markets, albeit with differing results. As stated by **Habibullah, Baharumshah** (1996), the first author to empirically deal with the relationship between the money supply and stock rates was **Sprinkel** (1964), who found a strong relationship between the change in the U.S. money supply and stock prices in the observed period of 1918-1960. This study became the basis for the work of **Mookerje** (1987), **Jeng, at al.** (1990), and **Malliaris**, **Urrutia** (1991). In this respect, a question arises whether this relationship holds even today, that is approximately 50 years after publication of this "pioneering study", or how massive change of the money supply (e.g. the consequences of quantitative release) during the recent financial crisis influenced the development of stock prices and how the change in the money supply affects the development of the stock price bubbles.

Other authors dealing with the correlation and link between stock markets and the money supply are e.g. **Maysami, Koh** (2000) who, in the conditions of the Asian market revealed a positive relationship between the money supply and the development of the SGX index (Singapore stock exchange), confirming the hypothesis that a growth in the money supply will cause inflation, which causes a growth in future cash-flow and share prices, as already investigated by **Fama** (1981). The same results confirm **Maysami**, **Howe** a **Hamzah** (2004), who disclose a positive dependence between money supply change and stock price evolution on Singapure stock exchange. The causality between money supply and stock markets on emerging markets was investigated also by **Brahmasrene** and **Jiranyakul** (2007), specifically in their analysis of the Thai stock market between 1992 and 2003, where they found a positive relations between money supply and stock prices. **Cagli, Halac and Taskin** (2010) dealt with the relationship between money supply and stock prices on another emerging market – the Turkish market. These authors did not confirm any co-integration between these variables. The effects of the changes in macroeconomic factors (including the money supply) on the development of stock prices were discussed also by **Shaoping** (2008), who confirmed a vary strong effect of the money supply on the development of stock prices in the period between 2005-2007. As stated, he found a long-term and stable relationship between stock prices and monetary aggregate M0, M1 and M2. Similarly, stock prices and money supply had a positive co-integration. A positive co-integration has thus resulted that the growth of money supply results in the rising prices of equity shares. The authors say that a "loose" monetary policy makes stock markets grow and, on the contrary, a restrictive policy causes share prices to fall. They show how market fluctuations correspond to changes in

monetary policy The issues of efficiency of the stock market in Malaysia and co-integration between money supply and stock prices were discussed by **Habibullah, Baharumshah** (1996), who defined a weak efficiency and non-existent co-integration between money supply and stock prices at this market. However, in a later study, **Habibullah** (1998), found a causal relationship between money supply and stock prices. In the Japanese market, **Kimura, Koruzomi** (2003) discovered no relationship between the change in the money supply and the development of stock prices.

In a stock market in Pakistan, the analysis of long-term relationship between money supply and stock prices was performed by **Husain, Mahmood** (1999), who discovered a long-term co-integration between the stock prices and money aggregates M1 and M2 using the co-integration test. The positive relationship between macroeconomic indicators (including the money supply) is also demonstrated by **Hanousek, Filler** (2000) who confirmed a positive relationship between money supply and stock prices in the conditions of Central Europe in 1993-1996. Positive correlation and causal relationship between money supply and stock prices in the U.S. market have been shown in by **Maskay** (2007) and **Flannery, Protopapadakis** (2001), **Poiré** (2000) in their respective studies. As stated by **Habibullah, Baharumshah** (1996), in the conditions of the U.S. stock market there a positive influence of the money supply on the development of stock prices was found by **Malliaris**, **Urrutia** (1991), **Mookerje** (1987) and **Jeng, et al.** (1990).

As further stated by **Husain, Mahmood** (1999), **Rozeff** (1974) in his study revealed the effectiveness of the U.S. stock market in relation to money supply, while **Kraft, Kraft** (1977) found no causal relationship between the equity returns and changes in money supply in the same market.

Based on the review of literature resources, it can be concluded that among the different authors, there is inconsistency between the change in money supply and the development of stock markets - see for example the results of **Habibullah, Baharumshah** (1996) and **Habibullah** (1998). Moreover, according to the economic theory, there should be a causal relationship between the change in the money supply and the development of stock prices (see the next section), as discovered by some authors, but not by others, alternatively they discovered only a relationship between one of monetary aggregate and stock prices, but not in case of another one. Some authors suggest a strong link (**Sprinkel** (1964), **Malliaris**, **Urrutia** (1991), **Jeng, et al.** (1990)) and the relationship between the change in money supply and the development of stock prices. On the other hand, other authors (**Kraft, Kraft** (1977), **Bianying** (2004), **Kimura** (2003)), found no causal relationship. For example, **Kulhanek** (2006) and **Veselá** (2007) identified a link between changes in the money supply and stock prices, but point out a gradual weakening of this link.

Money supply, as the most important macroeconomic factor that affects the stock prices is recognized by **Maskay (2007), Dwyer, Hafer (1999), Sprinkel (1964), Poiére (2000), Musílek (1997), Kohout (2010), Nývltová, Režňáková (2007).** According to **Veselá** (2007) the money supply also acts as the predicting indicator of the development of equity prices. There are several theoretical arguments supporting the assumption that the growth of the money supply increases the demand for stocks and hence their prices.

2. Methods and resources

To eliminate statistically deviated results in the time line analysis, **Tomšík, Viktorová** (2005) recommend testing the stationarity and subsequently using only stationary time lines. Economic time lines often have non-stationary character, i.e. the median value or spread change in time and/or the time line values show a clear tendency to returning to a certain constant. According to **Artl** (1997), there are several ways to determine the time line type, that is, to determine the time line cointegration order:

- to examine the time line chart and evaluate subjectively whether the line is stationary or not,
- to assess the shape of the autocorrelation function,
- to apply the unit root test.

The test of unit root will be provide by the extended Dickey-Fuller test (ADF test) and KPSS test. According to **Dickey**, **Fuller** (1979), this test can be recorded in the general form:

$$\Delta y_t = \beta_0 + (\rho - 1) y_{t-1} + \beta_1 \Delta y_{t-1} + \beta_3 \Delta y_{t-n} + \varepsilon_t$$

After the ADF or KPSS, test the Granger causality test will be performed, demonstrating the correlation or non-correlation between DJIA and the money supply. **Korda** (2007) classifies Granger causality test as explicit causality which says that as causal effect of a variable X on a variable Y such situations can be regarded in which the explanation of Y by using past Y values and X is better than a mere explanation of Y under its own history. The point is that as **Jochec** (2010) notes, the Granger test assumes that all information for predicting selected variables is contained in the very past values of these variables. Due to the focus of this paper, the Granger causality test will therefore examine e.g. the hypothesis that variable M2 affects variable DJIA if adding the delayed variable M2 improves the prediction model stated, explained only by its delayed values.

The Granger causality test can be described through e.g. the following equations, verifying the causal relationship between a change in the money supply measured by the M2 aggregate and the DJIA index:

$$DJIA_t = \sum_{i=1}^{j} \alpha_i \cdot DJIA_{t-i} + \sum_{i=1}^{j} \beta_i \cdot M2_{t-i} + \varepsilon$$

$$M2_t = \sum_{i=1}^{j} \alpha_i \cdot M2_{t-i} + \sum_{i=1}^{j} \beta_i \cdot DJIA_{t-i} + \varepsilon$$

$$MZM_t = \sum_{i=1}^{j} \alpha_i \cdot MZM_{t-i} + \sum_{i=1}^{j} \beta_i \cdot DJIA_{t-i} + \varepsilon$$

The equations show that e.g. the present value of the DJIA index is the result of past periods of this index and the money supply measured by aggregate M2 and/or changes to the money supply cause changes to the DJIA index.

The Granger test will be applied for the decission if the mney supply is the most important factor, which evoke a stock bubbles too. Another way how to decide is use a multiple regression model, which includes another macroeconomic variables. The multiple regression model cam be specified as follows and is derivate from **Kandir** (2008):

$$\Delta I = \beta_0 + \beta_1 \Delta IPI + \beta_2 \Delta IR + \beta_3 \Delta CPI + \beta_4 \Delta OIL + \beta_5 \Delta PPI + \beta_6 \Delta UN + \beta_7 \Delta MS + \varepsilon$$

kde:

Δ IPI is the change in industrial production indices,

Δ IR is the change in interest rates (1 month time deposit rate),

Δ CPI is the change in inflation,

Δ OIL is the change in oil price (West Texas Intermediate),

Δ PPI is the change in producers price indices,

Δ UN představuje změnu nezaměstnanost,

Δ MS is the change in money supply (monetary base M2 and MZM),

ε is the residual error.

3.   Results

The initial analysis has revealed a strong trend of all considered variables, causing an apparent and serial correlation. Therefore the first differences of input variables were made, to eliminate autocorrelation and the variables thus achieved a stationary nature. After the first differences were performed, the Durbin-Watson test was performed to determine the value of 1.89 for the first difference M2, and 1.90 for the MZM aggregate. By performing the first difference, the variables acquired a zero mean value and approximately constant scatter, as seen in the charts.

Picture 1: First diferences for DJIA, M2 and MZM
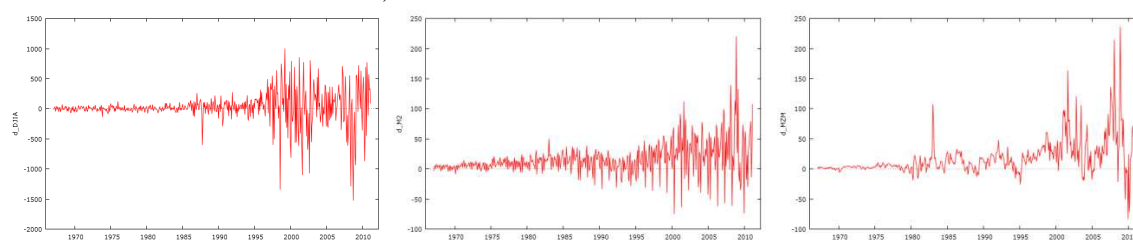
According to **Pošta** (2010) when estimating the regression model plays an important role is played by the fact that the input variables were stationary. This is confirmed by **Artl** (1997) and **Kumar** (2011), who argue that the implementation of the (equity) analysis requires only stationary time series. The fact that a stationary time series is involved can be detected by subjective assessment of time-series graphs, or through the use of expanded Dickey-Fuller (ADF) test or KPSS test.

Stationarity of time series is confirmed by the results of ADF unit root test, as in the following table. Since the DJIA index level cannot reach negative values, the Dickey-Fuller unit root test is used in standard form with constant (3.1) and a constant and trend (3.2) with zero hypothesis *a = 1*. The use of only stationary time series is recommended for example by **Tomšík, Viktorová** (2005) and **Foresti** (2007), who add that the ADF test is a very useful tool to test the unit root.

(3.1) $Y_t = b_0 + (a-1) \cdot Y_{t-1} + \varepsilon$

(3.2) $Y_t = b_0 + b_1 \cdot t + (a-1) \cdot Y_{t-1} + \varepsilon$

Table 1: ADF test

	model with constant		model with constant and trend	
	ADF statistic	**p-value**	**ADF statistic**	**p-value**
d_DJIA	-21,7664	$3,802×10^{-38}$	-21,8019	$2,883×10^{-50}$
d_M2	-19,0674	$5,558×10^{-37}$	-21,3193	$1,521×10^{-49}$
d_MZM	-9,2780	$6,197×10^{-16}$	-10,8323	$1,899×10^{-20}$

The results show that also on 1 % significance level can we confirm, that theese time series are stacionary type I(0). But executed KPSS test set first diferences as nonstacionary. Accordig this result it have to make second diferences, which ADF and KPSS test too set as stacionary.

As part of the cointegration analysis the Engel-Granger test was used to confirm long-term relationship between money supply and DJIA stock index. This confirms the unit root test regression relationship of residues whose values are given in the following tables.

Table 2: Cointegration test

dependent variable DJIA	**rezidual p-value**
Independent variable M2 (first difference)	$8,691×10^{-46}$
Independent variable MZM (first difference)	$7,031×10^{-46}$
dependent variable DJIA	**rezidual p-value**
Independent variable M2 (second difference)	8,798×10-46
Independent variable MZM (second difference)	8,241×10-46

The table shows, that residuals are also on 1 % significance level stacionary and both time series are cointegrated, whicg is according to economy theory.

To analyze the impact of money supply on the DJIA stock market index a Granger test is used, as defined in the methodology. It is a dynamic model between two variables, which seeks to uncover the fact how one variable affects another and how the second variable is affected first. As mentioned, **Korda** (2007) considered the Granger´s causality test as an explicit causality, maintaining that a situation where the explanation of Y (stock index) by using their own past values and past values of X at the same time (stock index) is better than a mere explanation of Y (share index) according to their own history is considered a causal effect of X (money supply) on the variable Y (stock index). Regression will thus be tested to confirm the causal relationship:

$$DJIA_t = \alpha_0 + \alpha_1 DJIA_{t-1} + ... + \alpha_m DJIA_{t-m} + \beta_1 MS_{t-1} + ... + \beta_m MS_{t-m} + u_t$$

The set null hypothesis that money supply does not affect the DJIA stock market index will be validated on the basis of the Wald´s F-statistics, or p-values and their comparison with the level of significance. As stated by **Baumöhl** (2008), if the null hypothesis is rejected (at a given significance level) the variables are then considered in the regression equation as independent in the sense of Granger´s causality (more details for example **Hatrák** (2007)).

As stated by **Foresti** (2007), in the implementation of Granger´s causality test it is very important to choose the magnitude of delay. Similarly, **Thornton, Batten** (1984), also claimed that the result of Granger´s test is very dependent on the length of delay. In the

publications dealing with the choice of the length of the delay there is no consensus, some reports suggest that it is appropriate to use the minimum delays in the range of 1 to 6. Other studies have considered this to be insufficient. For example **Enders** (1995) and **Hamilton, Herrera** (2000) suggest to apply a delay of 12 or more on the monthly data. On the other hand, **Sewell** (2001) states that the increasing delay results in the reduction of the validity of the test. Similarly, **Urbain** (1989) uses delays 1 and 6 in his analysis. The tests of the influence of money supply were performed with a delay of 1, 2, 3, 4, 5, 6, 12, 18, and 24 months.

The following table outlines the impact of delay duration on the results of the Granger´s test, examining the effect of the changes in the money supply on the development of the the DJIA stock market index, conducted at the 5% level of significance.

Table 3: Granger test

H_0 $\alpha = 5\%$	lag								
	1	2	3	4	5	6	12	18	24
first difference	F-st.	F-st.	F-st.	F-st.	F-st.	F-st.	F-st.	F-st.	F-st.
M2 don´t cause DJIA	1,4744	4,7768	3,1824	3,6787	3,3539	2,4995	1,6259	2,8925	3,3427
MZM don´t cause DJIA	0,1459	0,5573	0,5612	0,5468	1,3859	2,2601	3,0553	3,6735	3,9633
second difference									
M2 don´t cause DJIA	9,4261	4,0999	5,6253	4,0460	3,2092	2,6255	1,8963	3,0705	3,5560
MZM don´t cause DJIA	0,6265	0,2821	0,9658	1,8402	2,7986	3,5374	3,0236	4,6682	3,9522

The achieved values confirm that when using the first differences at the 5% level of error probability, the money supply measured by M2 monetary aggregate, begins to affect the DJIA stock index with a delay of 2 months. Even though at a delay of 12 months, the null hypothesis of the Granger´s tests was not rejected, because the tested statistics was 0.145 lower than the critical value, in the terms of economic interpretation and really a minimum difference, I don't consider this to be significant.

In case of money aggregate MZM, the situation is completely different. In this case there is a demonstrable effect on the aggregate stock market only after certain time interval. Specifically, there is evidence of an effect of this aggregate on the DJIA index only after application of 5 delays for the first differences, or 4 delays in the case second differences. This result – as opposed to money aggregate M2, thus agrees with the above authors, who recommend the application of 12 delays as well as with the described regarding changes in money supply measured by MZM aggregate in the period of VI. 2008 - VI. 2009, where the DJIA index responded with approximately 10-month delay. Similar situation is found in relation to the use of the second differences of the MZM money aggregate, with the only difference being that there was a shift of the response of the stock index to change of the money supply by one month to respond and it begins to respond after 5-month delay.

According to my opinion, the fact first or second differences of the money supply is used is not so crucial in this case. Based on the results we can conclude is that the influence of money supply measured by M2 on the DJIA index was demonstrated almost immediately with minimal delay, while the influence of monetary aggregate, MZM has been demonstrated with a time delay. From the perspective of the liquidity of individual aggregates, we can talk about surprising results, which should be exactly the opposite, ie. the monetary aggregate M2

should have effect after a time delay. In both aggregates the effect was demonstrated starting from a delay of 6 months, which is in line with the results of the analysis of the American market in 2007-20011, when the DJIA index indeed reacted to the change in the money supply (regardless of the type of aggregate) with delay of about half a year.

Based on the results, it can be concluded that according to the completed Engel-Granger test, there is a long-term relationship (co-integration)between DJIA share index and the money supply as measured by M2 and MZM, whereas the M2 money aggregate has a faster effect on the stock market, especially in the short-term horizon of several months. This monetary aggregate begins to influence the DJIA stock market index with a delay of 1 to 2 months. In case of MZM money aggregate, its influence on the DJIA index was demonstrated only with longer time delay, ie. it influenced the DJIA index slower. The results of Granger test also confirmed that it is very sensitive to the selection of the length of delay, as stated by **Thornton**, **Batten** (1984) and **Foresti** (2007). From a statistical point of view, the results are of course under the effect of the significance level, or the error probability, or the range of input data.

When analyzing the impact of money supply on stock bubble formation, and when verifying the hypotheses that *the money supply is not the main determinant of stock price bubbles*, it is first necessary to identify the stock price bubbles in the U.S. market, represented by the DJIA index. Throughout the observed period, several rises and subsequent drops can be identified in the market. From empirical viewpoint there is a problem to discover a bubble, or rather to determined what is and what is not a bubble. **Kohout** (2010) defines bubble as the condition where there is excessive growth for a period 5 to 10 years before its burst. But the question remains, what is excessive. For empirical analysis, the recent subprime bubble was selected for the reasons of recency and general awareness.

Low interest rates were determined to be the main cause of this crisis, which enabled less sound clients to apply for mortgage loans, which they were unable to repay following the rise in interest rates. But the bubble but did not occur only in the real estate market, but also in the stock market, which grew steadily approximately until second half of 2007 at the average monthly rate of 0.965% after three years of stagnation and decline after the bursting of dot-com bubble and after the attacks of September 11. This rate of growth is approximately half the average rate of growth before the bubble burst in 1987. The average monthly growth rate of money supply over the same period amounted to 0.41% for the M2 aggregate, and 0.44% for aggregate MZM, which are values comparable to the growth rate of money supply before the 1987.

Table 4: ADF test

	model with constant		model with constant and trend	
	ADF statistic	p-value	ADF statistic	p-value
d_DJIA	-7,5490	$2,966 \times 10^{-8}$	-7,5238	$2,713 \times 10^{-7}$
d_M2	-7,9114	$1,009 \times 10^{-8}$	-7,9694	$7,097 \times 10^{-8}$
d_MZM	-2,5725	0,1051	-3,3605	0,0681

The p-value of tha ADF test show that the first diferences on monetray base MZm is no stacionary, so we have to make a second diferrences of this variable. All other variables are stacionary yet by first diferences.

The following tables show the results of Granger test, which tested the impact of money supply on stock indices DJIA on a 5 % significance level, by several lags[2].

Table 5: Granger test, period 2004 - 2008

H_0 $\alpha = 5\ \%$	lag						
	1	2	3	4	5	6	12
první / druhá dif.	F-st.	F-st.	F-st.	F-st.	F-st.	F-st.	F-st.
d_M2 don´t cause DJIA	2,9545	1,4031	0,8290	0,5693	0,3847	0,8235	3,0152
d_d_MZM don´t cause DJIA	7,0124	4,0595	3,2403	3,3431	2,5705	2,6293	1,6232

Based on the results of Granger´s test it can be argued that in the period when the current financial crisis began to form, the money supply, measured by MZM aggregate affected the development of the DJIA index. The influence of the monetary aggregate M2 has been shown only when a delay of one year was applied. From this perspective it is an entirely different result than for the entire period, where the influence of the MZM aggregate on the DJIA index was demonstrated only when a longer delay – in the order of several months - was applied. A higher liquidity of this monetary aggregate is thus apparent in this period. This aggregate has greater effect than M2 especially thanks to the fact that in this period it reached higher values, accumulatively exceeding the volume of M2 aggregate.

Based on the achieved results it can be concluded that the money supply measured by M2 monetary aggregate is not a significant factor in the development of the speculative bubble of 2007, while money supply represented by the MZM aggregate is a major factor in the development of this bubble. TO verify this statement, a multivariate regression analysis is used, to confirm the importance of the MZM aggregate on the development of the stock bubble. Even before the actual analysis, individual time series of variables are presented, that are used in the regression analysis. Their functional relationship with the dependent variable (DJIA) can be described as follows:

$$DJIA = f\left(\overset{+}{IPI}\ \overset{-}{IR}; \overset{+/-}{CPI}; \overset{+}{OIL}; \overset{+}{PPI}; \overset{-}{UN}; \overset{+}{MS} \right)$$

The following tables present the results of the performed multivariate regression analysis, which was also performed on the second difference values of the MZM money aggregate, which appeared to be non-stationary using the KPSS tests on the first differences.

Table 6: OLS model, MS = M2

$R^2 = 0,176$	constant	IPI	IR	CPI	OIL	PPI	UN	M2
coeficient	166,32	-23,59	-438,85	-28,54	-15,49	-22,46	-22,65	0,20
p-value	0,005	0,21	0,19	0,82	0,17	0,65	0,85	0,84

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[2] Because of short time period, the maximum applicable lag is 12.

Table 7: OLS model, MS = MZM

$R^2 = 0,195$	constant	IPI	IR	CPI	OIL	PPI	UN	MZM
coeficient	112,56	-20,20	-189,66	-34,51	-17,79	-18,28	-24,66	1,42
p-hodnota	0,12	0,27	0,64	0,78	0,12	0,72	0,82	0,29

In multivariate regression analysis, both models again achieved comparable results – in case of the first model confirming the statistical insignificance of the monetary aggregate M2, which corresponds with the results of Granger test. It was in the case of the second model that showed apparent growth of the regression coefficient and reduction of the p-value compared to the money aggregate. Based on these results it is possible to conclude that the money supply, as measured by MZM money aggregate was an important factor in the development of the recent bubble in the stock market, represented by the DJIA index.

Based on the results of Granger test it can be argued that in the formation of the modern financial crisis in 2004 - 2008, the money supply, measured by MZM aggregate had an effect on the change of DJIA index. This is in accordance with the results achieved through multidimensional regression analysis in which the lowest p-values were measured for oil prices, industrial production index and the monetary aggregate MZM, while for M2 in the first model the p-value was equal to 0.84 demonstrating the statistical insignificance of this variable. From this perspective it can be argued that money supply measured by the monetary aggregate MZM was an important determinant of the modern stock bubble. Based on these results it can also be argued that the money supply as measured by MZM money aggregate is an important determinant of the development of the DJIA stock index, especially in the last approx. 25 years, with the increase in market volume and volatility of the market, when the monetary aggregate appears to be statistically significant in explaining the development of the DJIA index during the *Dot.com* bubble formation. The use of the monetary aggregate was (as well as bubble of 2000) has lead to the increase in the determination index. To conclude this analysis, we provide the charts of the actual and balanced values using regression equation.

Conclusion
This paper dealt with the effects of the money supply on changes in the American stock index Dow Jones Industrial Average. The results of the performed Durbin-Wattson test demonstrated the auto-correlation of values. After that, the first differences of variables were performed, which appeared to be stationary using graphic analysis, with approximately zero mean and constant variance, a was confirmed by the results of ADF unit root test. To make sure we performed the KPSS test, which however, determined the first difference of the monetary supply to be non-stationary and therefore it was necessary to perform the second differences (differences of the first differences). From this perspective, I find CPSS to be more reliable in carrying out unit root test and I recommend it for the performance of the stationarity test because of higher reliability.

During cointegration analysis the Engel-Granger test of residues was used to confirm long-term relationship between money supply and DJIA stock index, where the differences between the money aggregates and their link to DJIA index were minimal. After demonstration of long-term relationship between money supply and share index DJIA, which confirmed the hypothesis of the relationship between these variables. This was followed by the analysis of the impact of a money supply on the change the DJIA index.

An analysis of the influence of changes in money supply on change of the stock index was performed using a dynamic model of Granger test to verify the hypothesis that money supply does not affect the DJIA index. This hypothesis is then accepted or rejected based on comparison of the calculated F-statistic with a critical value or by comparing the obtained p-value with the level of significance. Granger test, which was used to detect the effect of the money supply on the DJIA index, was used for the entire period, but also in sub-periods, to demonstrate the influence of macroeconomic factors on the emergence of stock bubbles. For the entire observed period from 1967 to 2011, which included 530 monthly observations, the effect of the change of the money supply on the development of DJIA index was confirmed for both monetary aggregates, pointing out the fact that an important role in this test is played by the applied length of delay. From the results it can be concluded that when applying delay to delay up to 6 months, the effect of the money supply measured through money aggregate M2 on DJIA stock index was confirmed, while the effect of the MZM money aggregate on the stock prices can be demonstrated only with a delay of 6 or more months. The fact that for the entire period the effect of MZM on DJIA was shown only with application of 6 (or 5-month delay for second differences), is in conflict with the assumption that this is a more liquid money aggregate, i.e. that the response of the stock market to changes of this aggregate should be faster. On the other hand, the graphical analysis confirmed that in the period VI.2008-VI.2009 the stock index responded to change in MZM money with approximately 10-month delay.

The final part of the analysis attempted to determine whether money supply is the main cause of the equity bubble or not. The period of analysis was the period of so-called subprime bubble, the burst of which had an effect not only on the American market but also resulted in global fall of all stock markets. The bubble did not occur only in the real estate market but also in the stock market which grew steadily approximately until second half of 2007 at the average monthly rate of 0.965% after three years of stagnation and decline after the bursting of dot-com bubble and after the attacks of September 11. This rate of growth is approximately half the average rate of growth before the bubble burst in 1987. The average monthly growth rate of money supply over the same period amounted to 0.41% for the M2 aggregate, and 0.44% for aggregate MZM, which are values comparable or even lower than the growth rate of money supply before the 1987 and 2000. From this perspective it is beneficial to realize that while the stock index was growing at a relatively high rate throughout individual time periods when the bubble was formed, the money supply in all three bubbles was growing at approximately comparable rate. The completed Granger test demonstrated the effect of MZM aggregate - as opposed to money aggregate M2 on the formation of the recent price bubble in the stock market. This fact could be attributed to the situation that the money aggregate achieved higher accumulative growth in this period compared to M2. This means that the money supply measured by M2 monetary aggregate is not a significant factor in the development of the speculative bubble of 2007, while the money supply represented by the MZM aggregate is an important determinant of this bubble. This conclusion was confirmed by the performed regression analysis, in which approximately same values were found in both models, except for the money aggregates, where in case of MZM – compared to M2, there was a growth of the regression coefficient and reduction of the p-value. Based on the analysis of the bubbles it can also be argued that with the gradual growth of the market and its volatility the importance and impact of the MZM monetary aggregate on the development of the DJIA index is growing.

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