

IMPACT OF MONEY SUPPLY ON STOCK BUBBLES

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Abstract

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This article focuses on the effect and implications of changes in money supply in the US on stock bubble rise on the US capital market, which is represented by the Dow Jones Industrial Average index. This market was chosen according to the market capitalization. The attention of the paper is drawn to issues – if according to the results of empirical analysis, the money supply is a significant factor which causes the bubbles and if during the time the significance and impact of this macroeconomic factor on stock index increase.

money supply, stock market, stock bubbles, granger causality, Dickey-Fuller test

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. In last two decades growth the important of psychological and subjective factors, which can cause growing the market volatility. That the volatility is growing confirm e.g. Ambrosio, Kinniry (2009), in their study from US market, where is significant growth of standard deviation of stock index from 90th. The same view has Eichengreen, Tong (2003). So, thanks to the growing of market capitalization are the implications of bubble bursting still more significant. According to representatives of an Austrian economic school, was the cause of “welfare” or feeling of wealth growing, which slowly goes into a bubble, a cheap credit policy. These credits cause, that new liquidity can be used as investment on capital markets, which will be at standard conditions (without cheap credit) unviable (closely Kohout, 2007). Novotný (2012) mention, that vacant monetary policy create environment in which investors prefer more risky investments as consequences of bull mood (euphoria, future expectations). From the investors point of view are safe and more conservative investments not so attractive, because they would not pay a “hidden tax” in shape an inflation. According to low real profit, the investors inflate the bubble too, because if they want a real profit, they have to search and

invest into more risky assets (stocks), but with these instruments they don't have enough experience. So they can make their investment decisions according to other market members (crowd effect).

From the investor's point of view (no matter if retail or institutional investor) it is very important to notify, by which fundamentals they enters in his position, and if these fundamentals really changed so much that is time to close these positions or if is not the right time e.g. to expand his positions, by buying new assets and so decline the average price. Period of massive selling or buying orders is characteristic thereby, that in this period play the psychology and other behavioural factors the main role. Fundamentals and their impact on stock prices are the most important factors in long investment period, which influence the price evolution. Investor who makes the decision whether to enter or not in long position, make the decisions not only according to other market members (crowd effect) or according to subjective factors (intuition), but first of all according to macroeconomic and/or microeconomic fundamentals. Just accepting the fundamentals and their projection into investment decisions can lead to bubble elimination and elimination of its consequences.

King (1966), which made his analysis of 64 listed companies from 6 industries branch, mentions that stock prices are significantly influenced (in average from 40–50%, author note) by macroeconomic factors. A similar view has

Musílek (1997) who, claims that if an investor wants to be successful, he must focus mostly on price-shaping macroeconomic factors. In regard to that the spot price of stock present future income, which are discounted, Flannery, Protopapadakis (2002) mean that macroeconomic variables are the most important indicators, which influence the stock returns, because just these factors has impact on company's future cash flow and influence the amount of the discount rate.

From these views we can recognise, that macroeconomic factors are the most important factors which explain the stock prices movements and that these factors have the biggest impact on these assets. The impact of national macroeconomic factors on the performance of national stock market in the modern period was addressed e.g. by 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 includes interest rate, inflation, GDP, money supply, the movement of international capital changes, exchange rates, political and economic shocks. Chen, Roll, Ross (1986) or Benaković, Posedel (2010) as other important macroeconomic factor name the oil price or industrial production. According to Kohout (2010), the most important factor which influences 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.

Important factor, which influence stock prices and according to e.g. Musílek (1997), Kohout (2010) or Shostack (2003), the most important factor is money supply. In case of expansive monetary policy, flowing more and more money into the economy which the consumers are not able to rationally use and these money don't end only in consumption, but on capital markets too, where can be invest in high risk assets (closely e.g. Kohout, 2010). So the price grows over its intrinsic (fundamental) value and the bubble is raising. The simple question is, if we can set the money supply as the trigger of stock bubbles. According to theoretically background if the money supply grow should grow the prices in economy (inflation) too. Positive relationship between the money supply and the stock prices can be found in the studies by e.g. Rogalski, Vinso (1977), Shostack (2003). But can we consider the impact of the money supply on the stock prices during the time for constant or not? Some authors, e.g. Kulhánek, Matuzsek (2006) or Veselá (2007) mention, that during the time the intensity of positive relationship between money supply and selected European stock markets sinks. Other question is, if there exists a positive relationship, if these nexus express immediately or with lag. That

the markets should react on money supply changes with lag explain e.g. Veselá (2007), Rejnuš (2009) with the liquidity effect, transmission and not direct transmission mechanism.

Just the positive relationship between the money supply and the stock prices is a frequently mentioned topic of scientific studies and financial analysis. Alatiqi, Fazel (2008) mention, that this basic relation comes from a negative relationship between money supply changes and interest rates and that from negative relationship between interest rates and stock prices.

Bubble raising is according to Kohout (2010) signalisation for investors that the stock market is not effective and as mentioned by Polanský (2010) financial bubbles verify that the market does not function perfectly. Zamrazilová (2010) mentions that central banks should by setting the monetary policy consider the stock prices evolution and changes on capital markets.

Dillén, Sellin (2003) define three basic reasons why should central banks consider stock bubbles, which can be created as consequences of money supply growth: (a) bubbles represent financial instability, (b) bubbles can lead to fluctuation in real activity, (c) bubbles cause price instability.

If the investor is a stickler of market efficiency theory or not, one thing is clear. Price bubbles existed, are existing and (probably) will exist (the same position mentions Posen (2003)). For example on the market evolution in 20. and 21. century can be identified bubbles such as USA 1929, Japan, Austria late 80th, Asia 1997, USA 2000, Sweden 2000, Finland 2000, China 2007, USA 2007/2008. Tregler (2005) defines the stock bubble as price growing over its intrinsic value. His statement is confirmed by Baker (2000), who mentions that the market overvaluation during the IT bubble from year 2000 was 7,79 to 13,64 bil. US dollars. The problematic of price bubbles in the new era (financial crisis) pursue in their works e.g. Deev, Kajurová, Stavárek (2012), Alatiqi, Fazel (2008), Jiang *et al.* (2009), Hanousek, Novotný (2012). As causes of stock bubbles mentions Cecchetti (2001) growth of bank reserves (monetary base M2, vide infra).

According to Kubicová, Komárek, Plašil (2012) or Greenspan (2004) it is very complicated to identify the bubble rise ex post but also ex ante. This statement confirms Kohout (2010) and mentions that factors which signalise the bubble rise are: (a) very high P/E ratio (see Shiller, 2010 or England, 2003), (b) inadequate growth of market capitalisation during 5 or 10 years before the bubble burst.

METHODS AND RESOURCES

Markets entered into the empirical analysis was set according to its market cap and its share in the global market capitalisation, because as mentioned by Veselá (2007), market cap and trade volumes are factors by which we can explore the sense, size and position of stock exchanges on world market. As

mentioned by the WFE (2011) the US market was the biggest market on the world according to market cap with capitalisation 19 789 bil. US dollars (42 % global market cap), following by Asia capital markets with capitalization of 14 670 bil. US dollars (31 % global market cap).

The US capital market is represented by the Dow Jones Industrial Average (DJIA) stock index. For empirical analysis are used moment time series of selected variables. The input variables are the monthly closing prices of DJIA adjusted of dividends and splits. The money supply is represented with the monetary base M2 and MZM (money with zero maturity), all in nominal values.

In the empirical analysis are used only stationary time series, so as recommended by e.g. Tomšík, Viktorová (2005). The original data (in levels) was not stationary order to make the the first differences as recommended by e.g. Artl (1997) and which were set as stationary time series. According to Artl (1997), there are several ways to determine the time line type, that is, to determine the time line cointegration order: (a) to examine the time line chart and evaluate subjectively whether the line is stationary or not, (b) to assess the shape of autocorrelation function, (c) to apply the unit root test. The test of the unit root will be provided by the augmented Dickey-Fuller test (ADF test). According to Dickey, Fuller (1979), this test can be recorded in the general form:

$$\Delta Y_t = \beta_0 + (\rho - 1)Y_{t-1} + \beta_2 \Delta Y_{t-1} + \beta_3 \Delta Y_{t-m} + \varepsilon_t,$$

where:

ΔY tested variable,

β constant,

ρ level of cointegration.

Regarding to the character of input data is ADF test do in this forms:

a) random walk with constant (model stationary in constant) $\Delta Y_t = b_0 + \beta Y_{t-1} + \varepsilon$

b) random walk with constant and trend (model stationary in constant and trend) $\Delta Y_t = b_0 + \beta Y_{t-1} + b_2 t + \varepsilon$.

After the ADF test the Granger causality test will be performed and demonstrating the correlation or non-correlation (if there is a relation or not) between DJIA and the money supply.

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

$$y_t = \alpha_0 + \sum_{i=1}^m \alpha_i y_{t-i} + \sum_{i=1}^m \beta_0 x_{t-i} + u_t,$$

where:

y_tdependent variable (in this case stock index),

x_tindependent variable (in this case nominal money supply),

α and β regression coefficients,

t number of observation,

U_t random error,

m number of lag.

In empirical analysis, where will be tested the causal relationship between money supply and stock market are tested two regressions:

$$I_t = \alpha_0 + \alpha_1 I_{t-1} + \dots + \alpha_m I_{t-m} + \beta_1 MS_{t-1} + \dots + \beta_m MS_{t-m} + u_t$$

$$MS_t = \alpha_0 + \alpha_1 MS_{t-1} + \dots + \alpha_m MS_{t-m} + \beta_1 I_{t-1} + \dots + \beta_m I_{t-m} + u_t$$

where:

I stock index (DJIA),

MS nominal money supply represented by monetary base M2 or MZM.

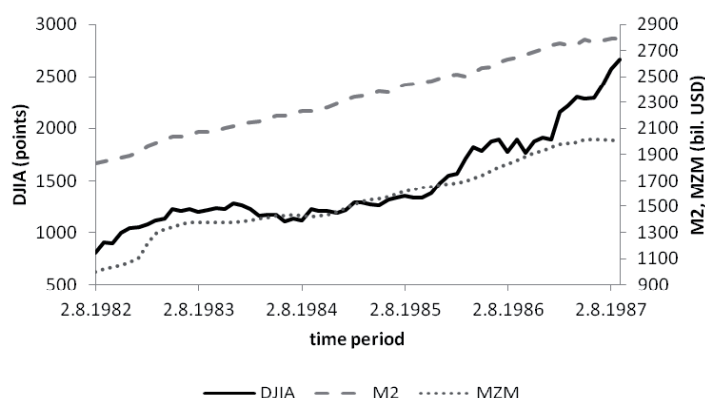
For empirical analysis are used stock bubbles which fulfil the conditions of high P/E ratio before burst and inadequate growth in period from 5 to 10 years in face of the peak. In addition, these bubbles are in broad awareness of all investors and by these bubbles is no doubt that these bubbles are really bubbles: (a) market crash in year 1987 („Black Monday“), (b) period before burst the technological bubble *Dot.com* in year 2000, (c) period before burst of real estate bubble in year 2007 (*Subprime bubble*).

RESULTS

Fig. 1 shows evolution of the US capital market represented by DJIA index from half of 1982 to the bubble burst in year 1987, when till mid 1982 was the volatility of the stock index constant and since the year 1982 started growing. So the market cap and the bubble was risen. This corresponds with Kohout (2009), whoset the inadequate growth of market (measured by market cap) as a warning signal of the bubble rise. In the chart was the development illustrated in levels, but in the empirical analysis enter the stationary first differences. In period 1967–1982 was the monthly growth rate of DJIA 0,0653 %, while in period 1982–1987 was it 1.9873 %, that is 30 times higher than in the previous period. In the same time period was the monthly growth rate of monetary base M2 0.7189 % for years 1967–1982, let us say 0,4646 % in period 1982–1987. For the monetary base MZM monthly growth rate for period 1967–1982 was 0.6817 % and in next period (1982–1987) it was 1.1433 %. Higher growth rate by monetary base MZM was caused by the growth of this aggregate in year 1983. So the question is, if the money supply is significant factor which causes this bubble or not.

Tab. 1 shows the results of Granger causality test (provided on stationary first differences) which measures the impact of money supply on the US stock market DJIA by 5 % significance level and different length of lags.

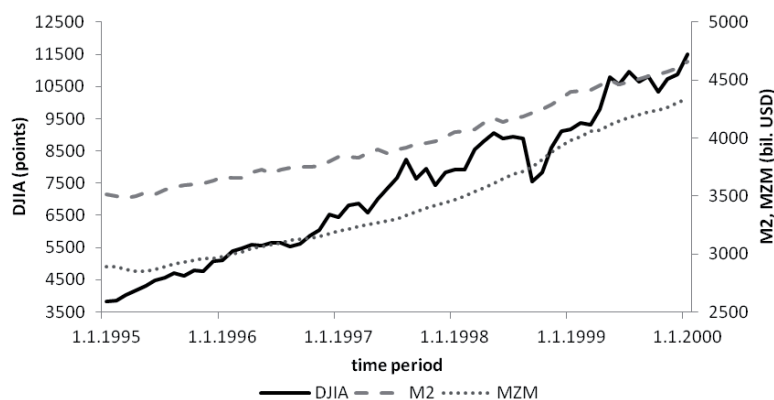
On the basis of the results I can determine that in the period from 1982 to 1987 the money supply represented by monetary base M2 or MZM has not a significant impact on DJIA development. Meaning



1: DJIA and money supply, 1982–1987

I: Granger causality test, period 1982–1987

Hypothesis $\alpha = 5\%$	lag							
	1	2	3	4	5	6	12	18
	F-st.	F-st.	F-st.	F-st.	F-st.	F-st.	F-st.	F-st.
M2 unaffect DJIA	0.2231	0.3258	0.3513	0.4238	0.6253	0.5293	0.6461	1.0160
MZM unaffect DJIA	0.0434	0.0871	0.3398	0.4999	0.5683	0.5293	0.4224	0.5847



2: DJIA and money supply, 1995–2000

II: Granger causality test, period 1995–2000

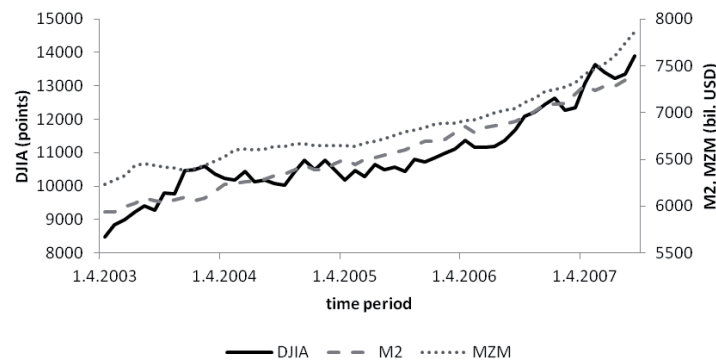
Hypothesis $\alpha = 5\%$	lag							
	1	2	3	4	5	6	12	18
	F-st.	F-st.	F-st.	F-st.	F-st.	F-st.	F-st.	F-st.
M2 unaffect DJIA	0.1941	0.1816	1.9657	1.4016	1.0487	0.8300	0.8524	1.5250
MZM unaffect DJIA	0.1058	0.0716	0.8867	1.3306	1.0737	1.3074	1.2239	1.2702

that this macroeconomic determinant wasn't according to Granger test the significant factor which caused this bubble.

Other bubble which was analyzed was the bubble of IT companies Dot.com, which wasn't connected only with the NASDAQ market, but consequences of its burst feel the investors on "industrial" DJIA index too. This bubble is suitable example of irrational bubble, where thanks to oversized expectations, the prices of IT companies were growing inadequately in years 1995–2000 and

so the whole market was growing. That this bubble is an example of irrational bubble confirm Komárek, Kubicová (2011) in their study. Fig. 2 shows the situation before the market hit the peak in year 2000.

Implemented ADF test identify all variable stationary and this first differences enter into Granger causality test with the goal disclose if the money supply influence the DJIA index in period of Dot. com bubble rise. Tab. II contain results of this test made also by 5% significance level with several lags.



3: DJIA and money supply, 2003–2007

III: Granger causality test, 2003–2007

Hypothesis $\alpha = 5\%$	lag						
	1	2	3	4	5	6	12
	F-st.	F-st.	F-st.	F-st.	F-st.	F-st.	F-st.
M2 unaffected DJIA	2.9545	1.4031	0.8290	0.5693	0.3847	0.8235	3.0152
MZM unaffected DJIA	27531	3.4553	3.5947	2.7345	3.5827	3.1458	1.9681

Granger test doesn't find that in this period, when the IT bubble was rising, the impact of money supply measured by monetary base M2 or MZM on DJIA index. So in this period is strong premise that money supply wasn't a significant factor which caused this bubble too. This result correspond with Komárek, Kubicová (2011), who as the starter of this bubble assign oversize future expectations, that's meaning the first of all psychological and subjective factors.

The last analyzed bubble was the Subprime bubble, which is connected with the real estate bubble and the financial crisis which started in year 2007/2008. As the main factor which caused the real estate (mortgage) bubble were low interest rates, which allowed that the clients with low bonity or credibility reached these mortgages. These clients were not able to repay the mortgage in period when the interest rates began to rise and the bubble was created. But the bubble didn't rise only on real estate market, but also on capital market which over three years of stagnation after the IT bubble and attacks from September 11 till second half of 2007 rapidly growth. The monthly growth rate of DJIA index was 0.9650%, what is approximately only half value then growth in year 1987. Average monthly growth rate in this period of money supply was 0.41% by monetary base M2 or 0.44% by monetary base MZM. These values are comparable with monthly growth of money supply in period before burst in year 1987.

Fig. 3 shows the development of money supply (both monetary base) and DJIA index since started the growth trend in year 2003 till the collapse in second half of 2007.

Results of ADF test for first differences by the variable MZM demonstrated that on 5% significance level this first differences are not stationary. Although this variable was set as non-stationary, was

in next empirical analysis use these first differences by reason of losing information value of this variable. In addition, Artl (2003) warn against "over-differencing", when we can reach stationary data, but the additional difference can cause a trouble with interpretation (else we have a stationary series, but the curve is very plain, so we lose the information value of this variable).

Tab. III shows the results of Granger causality test of the impact of money supply changing on DJIA index on 5% significance level during years 2003–2007 when the Subprime bubble was rising.

Upon to results of Granger causality test can I say, that during the period when rise the new age financial crisis had the nominal money supply measured by the monetary base MZM impact on evolution of DJIA index. Effect of this monetary base was found already from lag 1 month, but only on 10% significance level, and on 5% significance level from lag 2 month. Only with one year lag was confirm the hypothesis that money supply don't affect stock prices. The effect of monetary base M2 was confirmed only with the lag of one year. In this period can we recognise higher liquidity of this monetary base and so not so long reaction on changes in money supply. These results confirm results of Croushore (2006) study, which mentions narrower relation between monetary base MZM and economic evolution.

Pursuant to these results can I say, that nominal money supply measured by monetary base MZM is significant factor, which effect DJIA evolution, first of all in last 10–15 years, when growth the market volatility and market volume. That is meaning that in last two decade growth the impact of central bank activities on capital markets, first of all action as Quantitative easing.

DISCUSSION

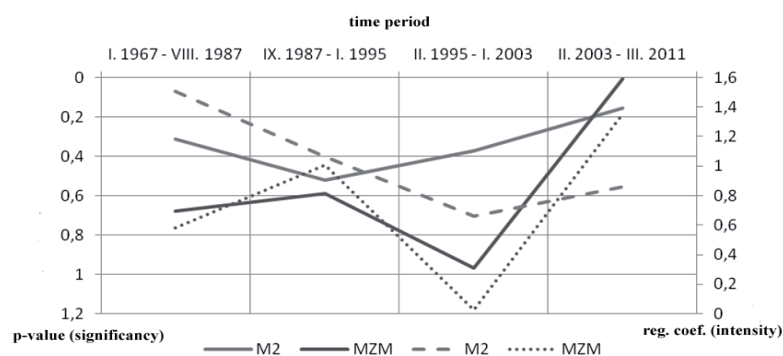
This paper was focused on the topic, if the money supply is a significant factor, which causes stock bubbles or not. As was written, Kohout (2009) defines a stock bubble as a period in which the stock prices grow with oversize rate during 5–10 years in face of the peak. England (2003) mentions that investors have only one way how to recognise the bubble and that is the according to P/E ratio and its growth. Following these information, were as analysed bubbles selected the period before crash in year 1987 (Black Monday), period when the IT bubble rose till year 2000 and period before burst of the last financial crisis – Subprime bubble, which started on the real estate market. Upon to Granger causality test wasn't money supply represented by monetary base M2 and MZM marked as macroeconomic factor, which effected the bubble rise in period 1982–1987.

Next analysed bubble was the IT Dot.com bubble from year 2000, its consequences didn't affect only the NASDAQ market but also the "industrial" Dow Jones index, and other capital markets too. Before the burst of this bubble in year 2000 grew the stock prices first of all of the IT and other companies from technology and innovative branch. The growth was supported with excessively future expectations, so the Granger causality test didn't reject the hypothesis, that money supply unaffected the stock index. In other words, the money supply wasn't set as factor which effect the stock prices in period 1995–2000 and which caused the IT bubble. Similarly Bordo, Wheelock (2007) mention, that in this period rapidly the productivity grew by lower inflation rate.

The productivity growth was connected with the IT boom and future expectations. So it can be the productivity growth which can affect the bubble rise, eventually important role can be played by other non-quantifiable factors, such as just the investors' expectations. Ofek, Richardson (2001) mention other reasons for the bubble rise, such as limited possibilities of short sell by new listed IT companies. Němec (2012) mentions that since 2000 can FED and his low interest rate policy during economy growth helped with blow out this bubble. The same mistake can we found several year later by the collapse of real estate market.

Last analysed bubble was the Subprime bubble, which started on the real estate market and burst in year 2007. The period of the bubble rise were set years from 2003, when the market stopped the stagnation from year 2001, till third quarter 2007. During this period Granger causality test identified causality relationship between monetary base MZM and DJIA index since 2 month lag. That is meaning by this monetary base was rejected the hypothesis that money supply unaffected the stock prices. Also this test confirm, that in last 10–15 years growth the effect and sense by this monetary base, what showing Fig. 4.

Results which were achieved correspond with Humayum (2012), who evaluates monetary base MZM as significant factor of stock markets evolution and first of all as factor which cause the new financial crisis and Subprime bubble. Growing sense of money supply by explanation of stock market development confirm Lucca, Moench (2012), who mention that under the stock profits in last 15 years stay FED and his policy of lower interest rates.



4: Money supply significance and intensity during the time

SUMMARY

This paper analyzed the effect of money supply on stock bubbles rise. Stock market was represented by the US capital market, which was selected according to its market capitalization, concretely by the Dow Jones Industrial Average stock index in monthly close price adjusted of dividends and split. Money supply was represented by the nominal monetary base M2 and MZM. On the US capital market was found effect of money supply (first of all of monetary base MZM) on bubble rise from year 2007. Other way in the period when the Dot.com bubble rose and the bubble which was ended at the Black Monday crash wasn't money supply set as significant factor, which influenced the bubbles to rise. In period of the Subprime bubble rising react the stock market on the money changes practically immediately, because it was found that the MZM monetary base effect the stock market with 1 month

lag (on 10 % significance level) or from the lag 2 month on 5 % significance level. Pursuant to the results I can say that with the growing of market volume and market volatility is the money supply and its significance and effect on stock prices more and more relevant (first of all monetary base MZM). So investors should implement this macroeconomic factor into their investment decisions, just in the period of high market fluctuations. Similar viewpoint also is also held by Lucca, Moench (2012).

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