Impact of monetary policy on US stock market

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Dopady monetární politiky na americký akciový trh

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Abstract (250-300 slov)
Purpose of the article The present article deals with associations between the development of money supply measured by the money aggregate M2 and the development of the American stock index Dow Jones Industrial Average. The objective of the article is to determine, describe and assess the impact of the changes of money supply (as measured by the money aggregate M2) on the development of the American stock market. Another objective is to find out whether the changes in money supply are reflected in the changes of stock prices immediately or with a time delay of several weeks.
Methodology/methods Regarding to the aim of the article was all useful historic data of money suplly (measured with money aggregate M2) and close values of DJIA obtain in monthly frequence, since 1959 to 2011. From econometric methods, will be using Pearson correlation index, Dickey-Fuller stationary test and test of Granger causality, which will be focus on realtionship between money supply (M2) and stock prices (DJIA index).
Scientific aim The aim of this article is by using econometric methods find, describe and analyze ipact of changing money supply to selected stock market. The second aim is disclose, if stock market react immediately or with time delay (in week).
Findings The correlation analysis shows, that between change of money supply and stock index is high dependence (correlation index 0,9224). By calculating with time delay, was correlation index high too, but slowly decrease. By market colaps in year 2007 and 2008, was correlation index negative with value -0,9477, no matter to money supply rasing, that is meaning, that investors have to calculate with psychologic factors, which are very strong in nervous time and market crashes. The result of Granger causality test for 1 month delay failed to show a relationship between money supply and DJIA index. With application of 2, 3 and 6 month delay the dependence was demonstrated, rejecting the null hypothesis stating that the M2 money aggregate does not affect the DJIA stock index
Conclusions (limits, implications etc) Reached results can be biased by using first diferention of raw data and in correlation analysis was using raw (non-sesonally adjusted) data of development DJIA index and sesonally adjusted data of money supply. The weak spot is using Dow Jones Index in place of S&P 500 index, which is more wider. By changes in analysis is possible to measure the impact of money supply (measured by Money with Zero Maturity aggregate) on stock index and compare both results and make decision, which aggregate is better for forecasting.

Keywords: Money supply, stock market, correlation, Dickey-Fuller test, Granger causality

JEL Classification: G11, G15, G18

Introduction

Stock markets have always been sensitive to the relevant information that reflected on the development of individual stock prices. Such information may include practically any news that the investors project into their decisions to buy or sell a particular stock. Especially in the recent period, with markets affected by great upheavals, the investors have been very wary of any information that could affect the future development of stock prices. There is a multitude of factors that affect the behavior of stock indexes, be it the official announcements of company management, general situation in a particular segment, market structure, political decisions, insider information, etc.

A very important role in determining the stock prices is played by various macroeconomic factors such as changes of interest rates, money supply, inflation, political shocks, legislative changes, etc. The monetary policy is one of the most efficient instruments available to central banks of individual states. As discussed below in detail, many economists and scientists consider the monetary policy to be one of the most important tools of the macroeconomic policy. Therefore individual central banks use the instruments of the monetary policy in association with impact on real activities. Therefore it is important to consider the effects of the monetary policy on the stock market as an important factor of economic development.

1 Related literature

On one hand, the national stock markets that represent a part and a foundation of the global capital market affect this market, on the other hand they are affected by the development on this market. Some authors (Bilson, Brailsford, Hooper, 2000) point out the fact that the national[1] (risk) factors affect the performance of the stock market to a greater degree than the global factors (international). The basic instrument used to examine the factors that determine the development of stock prices is the fundamental analysis that can be performed at three basic levels: global, segment, and corporate. Based on the selected type of fundamental analysis, there can be a whole series of factors that we would like to observe. According to Veselá (2007) these factors include economic, political, social, demographic and geographical circumstances and events that determine the development on stock markets. As she further states, the objective of the global fundamental analysis is to survey and assess the effects of the entire economy and market on individual stock prices. Important macroeconomic aggregates, factors and values are used to describe the condition and development of economy and the market, including – according to Veselá (2010) for example the interest rate, inflation, GNP, money supply, transfer of international capital, exchange rate shifts, political and economic shocks, etc. King (1966) arrived at a similar conclusion, stating that the most important factors that affect the stock prices are the global (macroeconomic) factors. This author maintains that the stock prices are affected by macroeconomic effects up to 50%.

As mentioned, most authors listing the macroeconomic factors affecting the development of stock prices, include the monetary policy or changes of the money supply within the economy. For example according to Gupta (1974), money supply can be used to predict the development of stock prices. His research confirmed that 59 % of the achieved value of stock indexes can be predicted on the basis of the development of money supply. This statement is disapproved by authors Rapach, Wohar, Rangvid (2005), who – in their analysis focused on the prediction of the stock market trends using macroeconomic factors in 12 countries – reached the conclusion that the most reliable macroeconomic parameters that can be used to predict the trends in the development of stock markets is the interest rate. Pearce, Roley (1985) in their research focused n the issue of anticipated money supply and reached the conclusion that there is a negative relation between the non-anticipative money supply and the development of stock indexes. As they state, an unexpected growth of money supply will be seen by the investors as bad news, followed by the fall of stock prices. The same position is defended by authors Corrado, Jordan (2005), who maintain that anticipative changes of money supply will have the same effect on the stock prices. Maskay (2007) also focused on different effects of the anticipative and non-anticipative money supply.

Based on the published articles, it can be concluded that there is disagreement among au-

[1] According to the authors these national factors usually include national macroeconomic factors.

thors with respect to the effects of the money supply on the stock prices. According to Sellin (2001), the positive shock of money supply will lead to growth of stock prices. His argument includes the fact that the changes in money supply include the information on demand based n future anticipations. If the money supply is growing, it is a signal of growing economic activity, with increased cash flow and growing stock prices. Sellin (2001) explains the reduced economic activity as the result of the growing interest rates that cause reduction of the stock prices.

Multiple studies were published involving the analysis of the effects of the monetary policy on stock markets – however with different conclusions. The first author to empirically analyze the causal relation between the money supply and stock prices was Sprinkel (1964), who discovered a strong relation between the stock prices and money supply in the USA. Other authors who analyzed the relation and association between stock prices and money supply included for example Maysami, Koh (2000), who discovered a positive association between money supply and development of SGX (Singapore stock exchange index) at the Asian market, thus confirming the theory that the growing money supply will result in increasing inflation, thus resulting in the growth of future cash flow and stock prices, presented by Fama (1981). The association between the money supply and stock prices at the emerging Asian markets was the topic of the work by authors Mookhejee, Yu (1997), who also confirmed mutual interaction between the money supply (as measured by money aggregate M2) and stock prices. The causality between the money supply and stock prices at the emerging markets was also of interest to authors Brahmasrene, Jiranyakul (2007). Specifically, in their analysis they focused on the Thai stock market in the period of 1992 - 2003. Also Shaoping (2008) analyzed the effects of the changing macroeconomic factors (including money supply) on the development of stock prices. This author demonstrated a very strong influence of the money supply on the stock prices in the conditions of the Chinese market in the period of 2005 - 2007.

Similar results were observed at the Chinese market also by Yuanyuan, Donghui (2004), who also arrived at the conclusion that the monetary policy also affects the stock prices. The authors observe, that "loose" monetary policy results in growing stock markets and on the other hand restrictive policy results in the reduction of stock prices. As the authors state, the stock markets fluctuate in proportion with the changing money supply. The situation at the Asian market was also a topic for Ho (1983), who demonstrated direct unidirectional association between the money supply and stock markets in Japan and in Philippines.

The causality between the money supply and development on the Malaysian stock market was also confirmed by Habibullah (1998). A positive correlation between money supply and stock prices was demonstrated in the studies performed by Shostak (2010), Poiré (2000), Mukherjee, Naka (1995). A positive association between macroeconomic indicators (including money supply) was demonstrated also by Hanousek, Filer (2000), who confirmed a positive relation between money supply and stock prices in central Europe in the period of 1993 - 1996. In the conditions of the American market, a positive association between money supply and stock prices was demonstrated by early authors such as Rozeff (1974), Hancock (1989), Abdulah, Hayworth (1993), Lee (1994). Also the authors Dhakal, Kandil, Sharma (1993) analyzed the American market and used vector autoregression (VAR) model to demonstrate a positive association between money supply and stock prices. On the other hand Kraft, Kraft (1977) did not discover any causal relation between money supply and stock prices. Alatiqi, Fazel (2008) also rejected the idea of a long-term association between money supply and stock prices.

If we were to discuss the money supply as a very important factor determining the stock prices, Musílek (1997) defines a very close association between the two, and a highly positive association is defined also by Borkovec (2001). Studies[2] performed in 1970s demonstrated that in the short run, changes of money supply have a positive effect on the stock prices. Bianying (2004), however, opposes this idea – discovering an inverse relation between money supply, which rose markedly and the SSE[3] index dropped in the short period of 2001- 2003. On the other hand, by analysis of a longer period of 1993 - 2001 the same author discovered a synchronous development of the Chinese SSE index and money sup-

[2] For more details see **Rogalski, Vinso** (1977), **Keran** (1971), **Homa, Jaffee** (1971).

[3] Shanghai Securities Composite Index.

ply. On the other hand Kulhánek, Matuzsek (2006) maintains that the intensity of this positive association is slowly dropping. Similar conclusions were reached by Veselá (2010), who tested the correlation at the Czech market, discovering a weak negative association. A negative association between the money supply and the development of the Czech securities index was demonstrated also by Yong (2004) using negative correlations.

2 Methods

American stock market was chosen for the present study, which according to WFE (2011) represents about 30 % of the global market capitalization. The American stock market will be represented by the Dow Jones Industrial Average index. The money supply will be measured by money aggregate M2, and the necessary data will be acquired from the FED database. The DJIA index values and money supply parameters will be analyzed on the basis of a monthly interval.

Initially this study used the correlation analysis using Pearson´s correlation coefficient, followed by the stationarity test – a single root test. For this purpose we used the extended Dickey-Fuller stationarity test (ADF test), to test the stationarity on original time series and their first order differences.

After completion of the ADF test, a Granger causality test was carried out, to demonstrate the correlation or lack thereof between the DJIA index and money supply measured by M2 aggregate. The Granger causality test shows that the variable M2 affects the variable DJIA if adding the delayed M2 variable improves the prediction model that was explained only using its delayed values.

The used Granger causality test can be described by the following formulas:

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

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

Source: own analysis

Graph 1 Trends of DJIA and M2

3 Results

The first part of the analysis focused on the link between the development of the money supply and the stock index. The trend of both variables based on real data can be seen in Figure No.1. From the graph it is clear that the money supply in the USA is continuously growing. However, when the average annual increase was calculated, it was discovered that the average annual increase of the money supply was only 0,54% (using chain indexes). However, over the 52-year period of interest, the money supply in the USA grew by about 2998,45% (using basic index).

In the same period the DJIA index rose by 0,48% per year on average (chain index) and over the subject period the total increase was 1974,17% (basic index).

The calculated value of the correlation coefficient 0,9224 indicates a very strong correlation between the money supply and the growth of DJIA index. The determination index is 0,8508, which means that 85,05% of the change in the value of DJIA index can be explained by a particular linear trend with independent variable M2. The value of Durbin-Watson´s test is 0,0247. According to Granger, Newbold (1974) if the value of R^2 > DW it means an apparent regression. In this case it means that the value of DW (0,0247) is lower than the determination index (8,8508), i.e. an apparent regression.

With application of a time delay, the test was carried out with delayed effect of the money supply on DJIA – of 1, 2, 3 and 6 months. Based on the results, it was discovered that with increasing delay the correlation coefficient diminishes. With 1 month delay the value of the coefficient was 0,9221, in case of 2 months of delay the value of the correlation coefficient is 0,9218 (with greater delays it was further reduced). This confirmed – as presented by Veselá (2007) – the delayed reaction of the stock markets to changes in money supply.

The correlation analysis also included data from the recent financial crisis. The correlation analysis was carried out for the period immediately before the bubble burst, during the deepest fall of the index and subsequent gradual growth. Table 1 shows the values of the correlation coefficients in these periods.

Table 1 Sliding correlation, detailed analysis

VII. 2006 - X. 2007	XI. 2007 - II: 2009	III. 2009 - III. 2011
0,9513	-0,9477	0,8361

Source: own analysis

The table confirms a close link between the money supply and the stock index, in the pre-and post-crisis period it corresponds to the above mentioned value of the correlation coefficient for the entire period. A greater deviation in the third period was caused by the reduction of the index value in the period of April 2010 – September 2010.

At the time of the bubble burst when all world stock indexes rapidly dropped, the value of the correlation coefficient indicates a direct linear independence of the DJIA index from the money supply. This confirms the fact that the reduction of the stock index was caused by other factors than the change of money supply. It also means that in situations with great shocks and market collapse, the investors tend to make decisions based on psychological effects, regardless of the government assurance and increased liquidity in the market. The collapses may also be accentuated by the activation of so-called stop-losses.

As already mentioned the purpose of this analysis is to determine whether the changes in money supply affect a specific securities index. In order to carry out the test, it is necessary to acquire stationary time series to perform the Granger causality test. The stationarity test was performed using the extended Dickey-Fuller test (ADF test) of a unit root.

The results of the ADF test of model I. (with constant) and model II. (with constant and trend) over the acquired data have demonstrated that the used time series are integrated at first level, i.e. their first differences are stationary. The ADF test was performed without time delay and with a time delay of 1 month. The first differences were thus used for the subsequent Granger test.

3.1 Granger test of causality

The Granger test was applied to 622 observations that represented the first differences of the monthly closing values of the DJIA index and the values of money supply in the USA measured by the M2 aggregate. Due to the results of the correlation analysis, the test was first performed with a time delay of 1 month and then with a time delay of 2 months, because according to Veselá (2007), the increase of money supply should be followed by the increase of the stock prices over the course of several weeks. The results of the completed test are presented in table No.2.

Table 2 Granger test, time delay of 1 month

Null hypothesis	F-statistics	p – value	Hypothesis
M2 does not affect DJIA	2,0582	0,1519	Not rejected
DJIA does not affect M2	16,4359	0,0001	Rejected

Source: own analysis

The results of the performed Granger causality test based on one month delay show that at the 5% significance level there was no association between the development of the DJIA stock index and the development of the money supply in the USA, i.e. that the money supply does not affect the development of the stock market represented by the DJIA index.

On the contrary, it has been demonstrated that the stock index affects the development of the money supply. This was in line with BIS (1998), stating that the prices of securities affect the monetary policy but the significanct should not be overestimated.

With application of the time delay of 2 month, a causal association between the money supply and stock index was demonstrated. The results of the Granger test with 2 months of delay can be seen in the following table 3.

Table 3 Granger test, time delay of 2 months

Null hypothesis	F-statistics	p – value	Hypothesis
M2 does not affect DJIA	5,4153	0,0047	rejected
DJIA does not affect M2	12,630	0,0000	rejected

Source: own analysis

With application of the 2-month time delay on the effect of the money supply on the stock prices, an association was demonstrated between the change of money aggregate M2 and the value of DJIA index. Once again, this is a confirmation of the thesis by Veselá (2007). Similar to the first scenario, a causal association was confirmed between the value of the DJIA index and the M2 aggregate, i.e. that the development of stock prices affects the money suply.

When considering longer delays of 3 and 6 month, in both cases a hypothesis was confirmed at the 5% significance level, that M2 affects the DJIA index (p-value = 0,0139 and 0,0065 respectively). At the same time, a hypothesis was confirmed that the DJIA index affects the development of hte M2 money aggregate in the USA.

4 Discussion

A correlation analysis was performed on the acquired data, confirming a strong correlation (0.9224) between the changes in money supply and changes in the DJIA index. These results are similar to those of Shostak (2010) or Poiré (2000). With application of the time delay of 1 and 2 months, the association was still strong, but slightly reduced – confirming the thesis by Veselá (2007), that the stock markets respond to the changes of money supply within weeks. A more detailed analysis of the pre-crisis, crisis and post-crisis development in the period of 2006 - 2011, a strong independence was found at the moments of the greatest market drops (correlation coefficient -0,9477).

The results of all performed Granger causality tests, with or without delay, a reverse relation was found between the DJIA index and change in money supply. This result is in compliance with Zmrazilová (2010), who presented a question what should be the role of securities in the monetary policy and how should the monetary policy respond to credit expansion.

At first the Granger causality tests with application of the corresponding time delays failed to demonstrate the correlation between the changes of money supply and the DJIA index, however, over time this correlation was shown, failing to confirm the results of Kulhánek, Matuzsek (2006) on gradual reduction of the intensity of the correlation (Table No. 4).

Conclusion

The Granger causality test was applied to the first differences of the variables with time delay of 1, 2, 3 and 6 months. The results for 1 month delay failed to show a causal relationship between the changes of money supply measured by the M2 money aggregate and the development of DJIA index. This means that the development of the money supply in the USA as measured by the M2 money aggregate, does not affect the Dow Jones index with one month delay at the 5% significance level (however the test failed to show a strong independence).

With application of the time delay of 2, 3 and 6 months, the dependence was demonstrated, rejecting the null hypothesis stating that the M2 money aggregate does not affect the DJIA stock index. It seems that the most reliable model is the model with the 3-month delay. The summary results of the Granger tests can be found in the table below. The tests thus demonstrated the effects of the changes in money supply on the development of stock prices.

Table 4 Granger test, delay

	Time delay, p-values			
Null hypothesis	**1 month**	**2 months**	**3 months**	**6 months**
M2 does not affect DJIA	0,1519	0,0047	0,0139	0,0065
DJIA does not affect M2	0,0001	0,0000	0,0000	0,0000

Source: own analysis

By a simple modification of the performed analysis, a test of causal association could be performed with respect to the effects of the change of money supply on the development of stock prices in various industrial sectors. This would confirm the thesis of the so-called "Austrian school", as presented by Šíma, Lipka (2004), that the companies producing capital goods with remote end use will go through an artificial boom due to monetary expansion, while the companies producing goods with nearer end use will probably not be affected by this boom. As the authors say, this will result in the inflation of assets, but the CPI will not necessarily reflect any inflation at all.

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