Effect of money supply on the Dow Jones Industrial Average stock index

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EFFECT OF MONEY SUPPLY ON THE DOW JONES INDUSTRIAL AVERAGE STOCK INDEX

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Abstract

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This focus of this paper are the effects and implications of a change in the money supply for share price indices in the USA during 1959–2011. The money supply will be measured by the M2 and MZM aggregates (money with zero maturity). The US stock market is represented by the Dow Jones Industrial Average index. The objective of this paper is to find, describe and evaluate the effects of changes to the money supply (M2 and MZM) on the US stock market. A partial objective of this paper is to determine whether a change in the monetary aggregate shows in the stock index immediately or with a delay of several weeks. Another aim is to determine whether asset prices influence the money supply.

money supply, stock market, correlation, Dickey-Fuller test, Granger causality

Investing in shares is one of the possibilities of letting someone's money grow. Unlike with other financial instruments, the majority of share investors share certain basic characteristics. Shares are generally seen as a risk instrument. In the long-term investment horizon, however, they are the most profitable basic financial assets, as documented e.g. by Wadell & Reed (2005) on the US market conditions.

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.

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] (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. Already here the effect of mostly macroeconomic factors on share prices is evident. We can deduce from this that it is these factors that investors should pay attention to. Some macroeconomic factors affecting share prices named by e.g. Veselá (2010) and Rejnuš (2009) are the interest rate, inflation, GDP, monetary reserves, changes to foreign exchange rates, political and economic shocks, etc. Kohout (2010) extends the listing and adds the impact of corruption, while Červinek (2008) adds the state budget balance.

Kohout (2010) also differentiates between different "drivers" and determinants of stock indices based on the time horizon. In the short turn, he states individuals' psychology as the main determinant. So-called social polarisation[2] is a major determinant for stock markets over the medium turn, he claims. The very existence of medium-term trends is considered by the author as the implication of crowd action: due to these trends, capital markets behave differently than what the efficient market hypothesis indicates. In the long-term horizon, the volume of money in an economy is of vital importance. He adds that the importance of these determinants grows with their long-term effect.

An essential macroeconomic factor affecting stock markets and the most significant one for Gupta (1974), Musílek (1997), Poiré (2000), Borkovec (2001), Kohout (2010) and/or Shostack (2003) is the money supply and the changes thereto. 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. Pearse, Roley (1985) were dealing with anticipative money supply in their investigations and concluded that there is negative relation between non-anticipative money supply and stock market development. They claim that any unexpected growth in money supply will be perceived by investors as a negative message, followed by a fall in stock markets. The same view is shared by Corrado, Jordan (2005) who state that anticipative changes to the money supply will have the same effect on stock markets. The different impacts of anticipative and non-anticipative money supply were investigated closely also by Maskay (2007).

We can deduce from these papers that the authors do not share one view of the money supply effect on stock markets. A positive shock of a change in the money supply will lead to growth in stock indices, according to Sellin (2001). He argues that changes to the money supply contain information on the money supply which rests upon future expectations. When the money supply grows, it is also a signal for growing economic activity and share prices. Sellin (2001) explains a fall in economic activity as the result of growing interest rates which make share prices drop.

A large number of studies analysing the effect of money supply on stock markets have been published, but with varying results. Empirical investigations of the causal relationship between money supply and share prices, summarised in a study, were carried out by Sprinkel (1964) who discovered a strong correlation between share prices and the money supply in the USA. 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 correlation between money supply and share prices on emerging Asian markets was also investigated by Mookherjee and Yu (1997) who could also confirm interaction between the money supply (measured by aggregate M2) and share prices. The causality between money supply and stock markets on emerging markets was investigated also by Brahmasrene and Jiranyakul

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

2 Social polarisation and/or mutual influence between opinions and/or crowd behaviour is when investors succumb to moods, euphorias and depressions.

(2007), specifically in their analysis of the Thai stock market between 1992 and 2003. The effect of changing macroeconomic factors (including money supply) on share prices was also investigated by Shaoping (2008) who, in the conditions of the Chinese market from 2005 to 2007, demonstrated a very strong impact of the money supply on these share prices. Similar results on the Chinese market were achieved by Yuanyuan, Donghui (2004) who also reached the conclusion that monetary policy has an impact on share prices behaviour. 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 causality between the money supply and stock markets in the conditions of the Malaysian market was confirmed by Habibullah (1998). A positive correlation between money supply and share prices was demonstrated also in the studies of Shostak (2003), Poiré (2000), Mukherjee and Naka (1995). Positive dependence between macroeconomic indicators (including money supply) is also demonstrated by Hanousek, Filler (2000) who confirmed the positive correlation between money supply and share prices in the conditions of central Europe between 1993 and 1996. For the conditions of the US market, positive correlation between money supply and share prices was confirmed already by e.g. Rozeff (1974), Hancock (1989), Abdulah and Hayworth (1993), Lee (1994). The US market was analysed by Dhakal, Kandil and Sharma (1993) who adopted the vector autoregression model (VAR) for demonstrating the positive correlation between money supply and share prices. On the contrary, Kraft, Kraft (1977) did not find any causal relationship between money supply and share prices. Also Alatiqi and Fazel (2008) take the position that there is no long-term correlation between money supply and share prices.

If we deal with the money supply as a major factor determining share prices, then Musílek (1997) defines a very close relationship between them. Positive correlation is also defined by Borkovec (2001). Studies[3] from the 1970s showed positive correlation between money supply and share prices over the short run. This is however contradicted by Bianying (2004) who, over the short period from 2001 to 2003 reveals an inverse relationship between money supply which was growing rapidly and the SSE[4] index which was falling. On the other hand, over the long period from 1993 to 2001, this author came to the conclusion that synchronous changes occurred in the development of the Chinese SSE index and changes to the money supply. This is contradicted by Kulhánek, Matuzsek (2006) who claim that the intensity of positive correlation is slowly fading. One scholar who came to similar results is Veselá (2010). She tested the correlation on the Czech market and the result was slight negative dependency. A negative relationship between money supply and the development of the Chinese stock index was demonstrated by Yong (2004) through negative correlation.

METHODS AND RESOURCES

For this study the US stock market was chosen which makes about 30% of global market capitalisation according to WFE (2011). The reason is that, as Veselá (2007) points out, it is the very market capitalisation and trade volumes that represent the factors under which the significance, size and positions of different stock exchanges all over the world can be measured. The US stock market will be represented by the Dow Jones Industrial Average index. The DJIA index was selected mostly for its long history, global significance on capital markets and its permanent structure, but also for the mechanisms of how it is calculated. Also, this index is regarded as a certain mood indicator on capital markets and as Gobry (1996) notes, it is the representative of average price development on international markets. The money supply will be measured by the M2 and MZM aggregates (money with zero maturity) and required data will be collected from the FED database. As Marhinsen (2008) says, money supply does not have to represented by the "conventional" monetary aggregates M1, M2 and/or M3, but also by the monetary aggregate MZM, used in the USA. FEDSL (2011) defines MZM (money at zero maturity) as instant liquid resources representing monetary aggregate M2 less term deposits which includes money market funds. But for the reason of virtually zero maturity period and highly liquid resources which are immediately available to investors, also this aggregate will be considered in this paper. Croushore (2006) says that the correlation between MZM and the real economy is even closer than with aggregate M2. Adopting the MZM aggregate for share analysis is also recommended by Shostak (2003). The value of the DJIA index and money supply will be indicated with monthly frequency.

The fundamental time line analysis method will be a correlation analysis. The Pearson correlation coefficient will be used for the correlation analysis, showing the extent of stochastic dependency between two variables. As explained by Hendl (2004), this coefficient, despite its drawbacks, represents the most important extent of power of random variables X and Y. The Pearson correlation coefficient can be expressed as the share between mutual spread (covariation) and selection spread of selected variables:

3 See more details on this e.g. with Rogalski, Vinso (1977), Keran (1971), Homa, Jaffee (1971).
4 Shanghai Securities Composite Index.

$$r_{yx} = r_{xy} = \frac{s_{xy}}{s_x s_y}.$$

Artl (1997) suggests that since the time lines analysed show certain specific characteristics, interpretation problems arise when analysing them and construing their regressive modules. These problems are caused by, among other things, so-called apparent regression. Artl (1997) defines this state as a situation when statistically significant parameter estimations of the regression function can be obtained by adopting the OLS method when analysing time lines not related to each other in any respect. This can then lead to wrong results. A simple rule applies to testing of the apparent regression. According to Granger, Newbold (1974), there will always be apparent regression when:

$$R^2 > DW.$$

The regression model created in a regression analysis can reach high determination index values, but another problem can appear with a closer analysis of residues. This problem can be called "serial correlation" and/or "autocorrelation of residues". This state occurs when the residues lack the so-called "white noise" property and are predictable to a certain degree. For residues autocorrelation testing the so-called Durbin-Watson statistics will be applied in the form:

$$DW = \frac{\sum_{t=2}^{T}(\varepsilon_t - \varepsilon_{t-1})^2}{\sum_{t=2}^{T}\varepsilon_t^2}.$$

The values of these Durbin-Watson statistics range between 0 and 4. Any value greater than 2 starts indicating negative autocorrelation and any value smaller than 2 starts indicating positive autocorrelation. A value of the test statistics equalling 2 indicates that this is not a case of serial correlation.

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 cointegration order will be determined in the next phase in a unit root test. To this end, the extended Dickey-Fuller stationarity test (ADF test) will be adopted. 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 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 dissertation, 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:

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

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

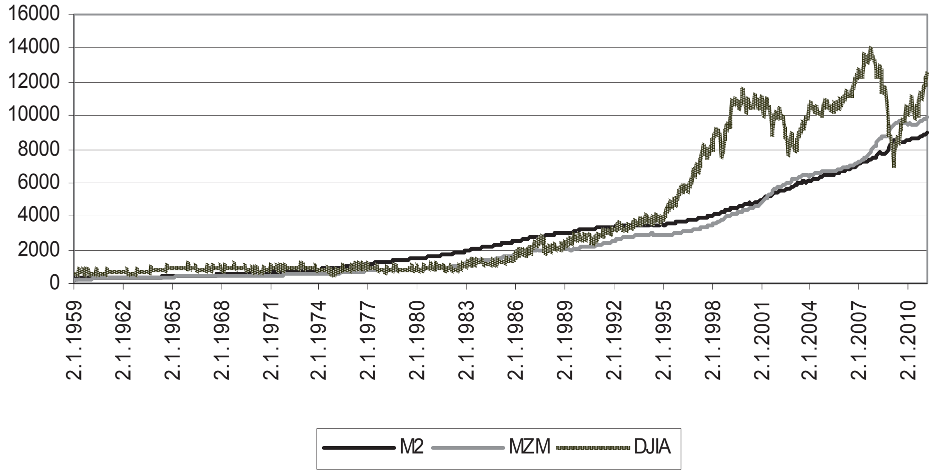
resp.

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

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.

RESULTS

The first part of the analysis followed the correlation between money supply and share prices. The progress of both variables on real data can be seen in Fig. 1. The chart shows clearly that the money supply has been growing constantly (measured by aggregates M2 and MZM) in the USA. Especially interesting is that the MZM monetary aggregate grew more slowly than M2 throughout the analysis period until halfway through 2001, but after that moment it exceeded the pace of growth of M2.



1: *DIJA and money supply evolution*

The value of the correlation index which measured how tight the dependence is between DJIA and the money supply measured by aggregate M2 and/or MZM on the level 0.9224 and/or 0.9263, signals a very strong dependence between changes to the money supply and DJIA progress. The determination index value equals 0.8508 and/or 0.8580, which means that 85.05% and/or 85.8% of the change to the DJIA index is explained by the linear trend selected, with independent variable M2 and/or MZM. The results demonstrate closer correlation between the stock market index and money supply, measured by the more liquid monetary aggregate MZM. The values measured for DW statistics amounting to 0.0247 for M2 and/or 0.0263 for MZM indicate serial correlation. This is also confirmed by the determination index value which is higher than the DW statistics.

When applying the time delay, the correlation analysis was performed gradually with a time delay of the effect of money supply measured by aggregate M2 and/or MZM on the DJIA index lasting one month, two months, three months and six months. Based on the data collected it was found that the correlation coefficient drops (worsens) with growing delay. With a one-month delay the value measured for this coefficient was 0.9221 and/or 0.9255. With a two-month delay the correlation index value equals 0.9218 and/or 0.9247 (it fell constantly as the delay grew). Despite the falling correlation coefficient value, the correlation is still very strong. On top of that, changes to the correlation coefficient range within decimals and centesimals of a percent if a one-month and two-month delay is applied. We can therefore assume that, as stated by Veselá (2007), stock markets respond to changes in the money supply within several weeks and/or the correlation analysis did not reject this correlation.

As stated above, the objective of this analysis was to determine whether the money supply affects the share index selected for this analysis. Stationary time lines on which the Granger causality test is subsequently performed have to be obtained for the test. The stationarity test was performed by using the extended Dickey-Fuller unit root test (ADF test).

The ADF test of the model indicated that the time lines are integrated by degree one, i.e. their initial differences are stationary. This means that the zero hypothesis saying that the time line is integrated by degree one cannot be rejected. Therefore, initial variable differences were applied to the Granger test, which also eliminates the serial correlation problem.

The Granger test was applied to 625 observations which, given the result of the ADF test, represented initial differences of monthly closing values of the DJIA index and the money supply in the USA, measured by aggregates M2 and MZM. Having the result of the correlation analysis and assuming that, as explained by Veselá (2007), stock markets respond to changes in the money supply with a delay, a time delay of one month and two months was applied first for the test despite the fact that the correlation coefficient values were lower than if no delay had been applied. An explanation for the delayed response of stock markets to changed

I: *Granger test, one-month delay*

Zero hypothesis	F-statistics	p-value	Hypothesis
M2 does not affect DJIA	1.5615	0.1975	not rejected
DJIA does not affect M2	46.4886	$4.11e^{-27}$	rejected
MZM does not affect DJIA	1.6263	0.1821	not rejected
DJIA does not affect MZM	272.0292	$1.1e^{-112}$	rejected

II: *Granger test, two-month delay*

Zero hypothesis	F-statistics	p-value	Hypothesis
M2 does not affect DJIA	4.2515	0.0008	rejected
DJIA does not affect M2	36.6362	$6.64e^{-33}$	rejected
MZM does not affect DJIA	2.2186	0.0509	not rejected
DJIA does not affect MZM	167.3111	$2.4e^{-112}$	rejected

money supply might be that commercial banks need a certain amount of time for recounting their statutory reserves, so that they are able to determine what liquid resources they have (for their own investments or as loan capital).

The results of the Granger test with a time delay applied are presented in Tab I.

The results of the Granger causality test with the one-month delay show that on a 5% significance level, no correlation between the DJIA index and the money supply in the USA could be verified (this applies to both aggregates M2 and MZM) and/or that the money supply does not affect stock market growth, as represented by DJIA. Even when no correlation between the money supply and the DJIA index was demonstrated, the importance and impact of the MZM monetary aggregate appears to be greater than that of M2.

On the contrary, reverse correlation was demonstrated: the share index affects the money supply. This corresponds to BIS (1998) which says that asset prices affect monetary policy, but their significance should not be overstated.

When applying a time delay of two months, causal correlation between the money supply and share prices was already demonstrated. The results of the Granger test with a two-month delay are shown in the following Tab. II.

When applying the two-month delay to the money supply's effect on share prices, correlation was demonstrated between changes to monetary aggregate M2 and the DJIA index. This, again, confirms the statement of Veselá (2007) about the time delay of the money supply effect on stock markets. As for the effect of the MZM monetary aggregate on share prices, the zero hypothesis was not rejected and/or it was only tight that on a 5% significance level no causal correlation between MZM and DJIA with a two-month delay was confirmed. Like in the first case, causal correlation between DJIA and M2 and MZM was confirmed – share prices do affect the money supply.

If a longer delay of three to six months is assumed, then the hypothesis that M2 and MZM do affect DJIA on a 5% significance level was confirmed in both cases. At the same time, the hypothesis that DJIA affects the M2 and MZM monetary aggregates in the USA was confirmed as well. Table III summarises the results for all time delays applied to the effects of changes in monetary supply on the DJIA index.

DISCUSSION

A correlation analysis was performed on the data collected. It showed strong correlation (0.9224 and/or 0.9263) between money supply measured by monetary aggregates M2 and MZM and the DJIA index. In this respect, the results are similar to those of Shostack (2003) and Poiré (2000). When applying a one-month or two-month time delay, the correlation was also strong, but slightly falling. This also confirmed the claim of Veselá (2007) that stock markets respond to changes in the money supply within weeks.

In all Granger causality tests, with a delay or without, however, strong reverse correlation between DJIA and the money supply was demonstrated. This result corresponds with Zmrazilová (2010) who asks what role asset prices should have in monetary policy and how monetary policy shall respond to credit expansion.

In Granger causality tests where the time delay was gradually applied, first there was no correlation verified for changes in the money supply and DJIA. Gradually, however, correlation was confirmed and the results of Kulhánek, Matuzska (2006) showing a gradual fall in correlation intensity could not be confirmed (see Tab. III).

III: *Granger test, application of time delay*

	Time delay, p-values			
Zero hypothesis	**One month**	**Two months**	**Three months**	**Six months**
M2 does not affect DJIA	0.1975	0.0008	0.0010	0.0002
DJIA does not affect M2	$4.11e^{-27}$	$6.64e^{-33}$	$1.06e^{-41}$	$5.29e^{-38}$
MZM does not affect DJIA	0.1821	0.0509	0.0490	0.0022
DJIA does not affect MZM	$1.1e^{-112}$	$2.4e^{-112}$	$7.6e^{-112}$	$1.4e^{-108}$

SUMMARY

The Granger causality test was applied on initial differences of variables with an incremental time delay of one, two, three and six months. The results of the one-month delay did not reveal any causal relationship between a change in the money supply measured by aggregates M2 and/or MZM and the DJIA index. This means that the money supply in the USA, measured by aggregates M2 and/or MZM, does not affect the Dow Jones index with a one-month time delay on a 5% significance level (the non-correlation revealed in the test is rather weak, however).

For the two, three and six-month delay, correlation was already demonstrated and/or the zero hypothesis saying that the monetary aggregate M2 does not affect DJIA was rejected. It is interesting that when the two-month delay was applied, no correlation between MZM and DJIA could be verified, while for the M2 monetary aggregate this correlation could be verified. The most trustworthy model (in terms of achieved results) appeared to be the model with the three-month delay in which correlation between monetary aggregates M2 and MZM and DJIA could be demonstrated. Even better values were obtained when the six-month delay was applied, which contradicts Veselá (2007), and this period of time is too long. On the other hand, as stated by Holman (2005), a change to the money supply shows in the price level in 12 to 18 months, according to Friedman. Therefore, the question is whether assets and/or share prices change only over such a long period of time. Despite the slightly unfavourable result, I consider the two-month delay, which includes approx. 40 trading days, as the most suitable one from the economic and methodological point of view.

Through a simple modification of the analyses we could test the causal effect of changes in the money supply on share prices for different industrial sectors. This would verify the claim of the Austrian school as stated by Šíma and Lipka (2004) that businesses producing capital goods remote from end consumption will experience an artificial boom as a result of monetary expansion, while companies closer to final consumption will hardly be affected by such a boom. This, as the authors say, will lead to asset inflation, but the CPI and the actual inflation does not have to take notice of this whatsoever.

The objective of this paper was to find, describe and evaluate the effect of changes to the money supply on the Dow Jones Industrial Average share index. Money supply was represented by the "conventional" monetary aggregate M2, but also aggregate MZM (money with zero maturity) which represents highly liquid cash to be used e.g. for investments. Using this aggregate for the purpose of analysis is also recommended by Croushore (2006). In the opening section of this paper a correlation analysis was done for the above-mentioned monetary aggregates and the DJIA index. This analysis confirmed that it is desirable to apply the MZM monetary aggregate in which the correlation coefficient identified stronger dependence. Correlation analysis was applied also to the simulation of a time delay of monetary supply's effect on share prices: with growing delay, the correlation coefficient was falling, but the correlation was still strong. In the case of the MZM monetary aggregate, the correlation coefficient values were higher where the time delay was applied than in the case of the M2 aggregate. Also, the ADF test was performed for the unit root, based on which initial variable differences were used for further analysis. These stationary time lines were then used in the Granger causality test which revealed that where a one-month delay is applied, monetary supply has no effect on the DJIA index. With a longer time delay, correlation between money supply (M2, MZM) and the share prices of the Dow Jones index was already demonstrated. Here, the p-values measured were rather in favour of using monetary aggregate M2. It was therefore here that a discrepancy with Croushore (2006) was found. The results could confirm the statement of Veselá (2007) about the delayed response of the stock market to changes in the money supply within several weeks. The question is how many weeks is the "ideal" time delay. From this perspective and in view of the results, the right time delay appears to be two months, a period spanning approx. 40 trading days and/or six weeks. The test however identified reverse correlation between DJIA and the money supply as well – i.e. the statement of Zmrazilová (2010) that asset prices must be taken into account when setting monetary policy was confirmed.

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