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Abstract

This focus of this paper are the effect, implication, impact and realtionship between selected macroeconomic variables and wider US indices S&P 500 and industrial Dow Jones Industrial Average (DJIA). Considered are inflation, interest rates, money supply, producer price index, industrial production index, oil price and unemployment and their impact on selected stock indices in the USA between 1999 and 2012. The hypotesis of this paper is, that between selected macroeconomic variables, namely producer price index, industrial production index, oil price and Dow Jones index is strongly relationship than between these factors and S&P 500. The paper is organising as follows. First section reviews the related literature. In section two are materials and methods which are use explained. Section 3 provides the empirical results and the last part presents the conslusions.

Keywords: *Macroeconomic factors, correlation, cointegration, ADF test.*

1. Introduction

Investing in shares is one of the options how to appreciate disposable financial resources. Unlike other financial assets, investors link this instrument with certain features – stocks and shares are claimed to be a risky investment instrument as they can be subject to dramatic price swings over a short period of time. Over the long horizon, however, they represent the most profitable financial assets (see more in Wadell&Reed (2005)).

Among price-shaping factors with an impact on where stock markets are heading and how volatile they are we can generally find macroeconomic as well as micro-economic factors, but also psychological and subjective factors. The effect of psychological factors is characteristic for the short-term and medium-term investment horizon, while a long-term investor should pay attention mostly to fundamental factors and realise the fundaments on which he/she was entering the position.

It is the fundaments and their impact on the price of a particular title that are the most well-known factors over the long run. Evidence of this is provided e.g. by King (1966) who says that share prices and affected by macroeconomic factors up to 50% on average (so 50% is left for micro-economic and psychological factors, author's note). A similar view was expressed by Musílek (1997) who stays on the general level and says that if investors want to be successful, they need to focus mostly on price-shaping macroeconomic factors. As the current price of stocks and shares expresses discounted future expected revenues from their sale, Flannery and Protopapadakis (2002) consider macroeconomic factors as the most significant indicators determining the income from shares, because these factors have an impact on future cash flow of the society and on discount rates. This means that it is macroeconomic factors that have a dominant impact on the share prices. Therefore, anyone investing in shares should pay attention to these factors when analysing stocks and compiling his/her portfolio.

The correlation between macroeconomic factors and share prices is a frequently discussed topic and has been covered by numerous studies, no matter if in the context of the emerging markets in eastern Asia (Mookerjee, Yu (1997), Chung, Shin (1999), Ibrahim, Aziz (2003)) or of developed markets such as the USA or Japan (Mukherjee, Naka (1995), Shiratsuka (2003), Nelson (1976), Jaffe and Mandelker (1976), Fama, Schwert (1977) or Bilson, Brailsford and Hooper (2000).

In the centre of attention of this paper is the impact of selected macroeconomic factors on the development of the S&P 500 stock index and the narrower (industrial) Dow Jones Industrial Average (DJIA) index. These selected macroeconomic factors include interest rates, inflation, oil price, producer price, industrial production index, unemployment and money supply. The paper follows the hypothesis that there will be stronger correlation between selected factors (price index of industrial manufacturing and oil price) and DJIA than in the case of S&P 500. The correlation will be analysed by adopting the OLS methodology and a multi-dimensional regressive model that – when analysing correlations between

macroeconomic factors and share yields – is adopted e.g. by Kandir (2008).

2. Previous research

The primary factor of share price growth stated by Hysek (2009) is as the ability of companies to improve their financial indicators (mostly free cash flow and/or net profit per share). Shares and stock markets are very sensitive to any price-shaping information relevant for the future direction of the market development. These price-shaping factors generally count macroeconomic and micro-economic factors, but recently also psychological and subjective factors have been gaining ground. Macroeconomic factors are significant and fundamental determinants over the long investment horizon, because, as expressed by King (1966), share prices are subject to the impact of macroeconomic factors by an average of 50%. Kandir (2008) adds that the correlation between macroeconomic factors and share yields started receiving more attention only after 1986. Macroeconomic factors with an impact on share prices are e.g. interest rates, inflation, GDP, money supply (stock), flow of international capital, foreign exchange rates and political and economic shocks, as said by Veselá (2010). Kohout (2010) believes that the most significant factor affecting share prices in the long term is the volume of money in the economy (i.e. money stock). Flannery and Protopapadakis (2002) count also the money supply and unemployment, trade balance, number of new homes and producer price index among important macroeconomic factors.

The impact of macroeconomic factors on the development of stock markets was the subject of numerous studies, such as Bodie (1976), Fama (1981), Pearce, Roley (1985). These studies provide clear evidence of strong causal correlation between macroeconomic factors and share yields. Some studies further reveal that the future development of the stock market may also be predicted based on macroeconomic factors (see more in Chen (1991), Chuang (2007)). The aim of this paper is to reveal whether macroeconomic factors are a strong determinant of share prices also today, about 30 years since first studies were published.

The impact of 18 selected macroeconomic factors on the stock market in Great Britain was investigated e.g. by Clare and Thomas (1994) who came to the conclusion that there is strong correlation between the yield of the local stock market and oil price, inflation and the volume of bank loans. Positive correlation between oil price and real economic activities was demonstrated by Gjerde and Saettem (1999) in the conditions of the Norwegian stock market. Cheung, Ng (1998) have also confirmed positive correlation between oil prices, the money supply and GDP in Germany, Italy and Japan. For selected countries from central Europe, positive correlation between share prices and money supply was confirmed by Hanousek, Filler (2000).

On the emerging market in Pakistan, Akmal (2007) applied the ARDL model to reveal the impact of inflation, industrial production, money supply, interest rates and oil price on the development of the KSE index between 1971 and 2006. The same conclusion was reached by Husain, Mahmood (1999), in a co-integration test. They revealed strong correlation between share prices and money aggregates M1 and M2. Kandir (2008) revealed the impact of interest rates and foreign exchange rates on share prices in Turkey and said that industrial production, money supply and oil price do not affect share yields on this market. Similar results were reached by Cagli, Halac and Taskin (2010) who did no confirm any co-integration between money supply and Turkish share prices. These studies support the results to which e.g. Mukherjee, Naka (1995) and Cheung, Ng (1998) came as well when studying the same market. These scholars even revealed positive correlation between changes in the money supply and share prices.

Correlation between macroeconomic factors and share prices in the conditions of the Asian market was studied by Mookerjee and Yu (1997) who realised positive correlation between the volume of foreign exchange reserves and money aggregates M1 and M2 and the development of the SSE index in Singapore. Similar results were reached by Cooper, Howe, Hamzah (2004) who confirmed long-term correlation between the SSE index, money supply, inflation, interest rates and industrial production. Maysami, Koh (2000) confirm also the positive correlation between the money supply and the SGX index. The impact of changes to the money supply on share prices was also investigated by Shaoping (2008) who demonstrated very strong correlation between the money supply and share prices in the conditions of the Chinese market between 2005 and 2007. Similar results were reached by Yuanyuan, Donghui (2004) on the Chinese market. Mukherjee, Naka (1995) demonstrated positive correlation between growing industrial production and the development of the Japanese stock market that corresponded to the findings of Cutler, Poterba, Summers (1989). Humpe, Macmillan (2007) confirm positive correlation between the Japanese stock index and industrial production index, but also revealed negative correlation between changes to the money supply and share prices. Similarly, Kimura, Kurozumi (2003) could not find any causal correlation between the money supply and development of the Japanese stock market. Positive correlation between share prices and trade balance, money supply, foreign exchange rates and industrial production was found by Chung and Shin (1999). Ibrahim and Aziz

(2003) confirm positive correlation between the stock market and the CPI index, industrial production and, on the contrary, negative correlation between foreign exchange rates and the money supply in Malaysia. In his study Ibrahim (1999) was investigating short-term impacts of macroeconomic factors on the development of the stock market in Kuala Lumpur. He revealed a negative link between the industrial production index, money supply, inflation, changes in foreign exchange reserves, foreign exchange rates and the KLSE index[1]. Causality between money supply and share prices on emerging markets was also investigated by Brahmasrene and Jiranyakul (2007) who focused on the Thai stock market from 1992 to 2003 and found positive correlation between the money supply and share prices. Wongbangpo (2002) found strong correlation between GDP, inflation, money supply, interest rates and foreign exchange rates in ASEAN countries[2]. For the Indian market he revealed long-term positive correlation between share prices, inflation and foreign exchange rates Kumar (2011). Also Pethe, Karnik (2000) confirm positive correlation between the Indian stock market and the foreign exchange rate INR/USD, the money supply and volume of industrial production.

A large amount of studies investigating the impact of macroeconomic factors on share prices and share yields concentrated on developed markets, mostly on the US market. As noted by Habibullah, Baharumshah (1996), the first scholar to empirically investigate the causal correlation between money supply and share prices was Sprinkel (1964) who presented in his study strong correlation between share prices and money supply in the USA between 1918 and 1960. This "pioneering" study was later followed e.g. by Mookerje (1987), Jeng, Butler, Liu (1990), or Malliaris, Urrutia (1991). Also Cheung, Ng (1998) found correlation between oil prices, the money supply, GDP and share yields in USA. According to Flannery, Protopapadakis (2002), the unemployment, inflation, PPI, money supply (M1), trade balance and construction of new homes impact the development of share prices on the US market. On the contrary, for GDP and the volume of industrial production, they could no confirm any link to share prices.

The research of available literature clearly shows that macroeconomic factors are an important determinant for share prices on all capital markets. When taking into account the results of those studies, a discrepancy in the impact on selected factors on the different markets has to be realised based on the findings. Some authors will claim that the same factors affect share prices in a positive way, while others will claim the opposite or say that they have no impact on share prices at all.

3. Empirical data, methodology and hypotheses

For studying the relationship between US stock indices and macroeconomic variables, we test the hypotheses, that between selected macroeconomic variables (producer price index, industrial production index, oil price) and Dow Jones index is strongly relationship than between this factors and S&P 500.

For analysing the impact of macroeconomic factors on the development of share prices, monthly data from 1999 to 2012 (total 157 monthly observation) were taken that also include the share bubble of 2000 and the financial crisis of 2007/08. The data can be divided into two groups – the first one being a dependably variable one, represented by the S&P 500 (value weighted index) and DJIA (price weighted index). The second group are macroeconomic factors, namely inflation, oil price, producer price index, industrial production, index, unemployment and money supply, measured by M2 and MZM aggregates (money with zero maturity). The paper assumes a difference in the impact of selected factors (oil price, PPI) on the respective indices depending on their structure – the wider S&P 500 and industrial Dow Jones. By using the OLS method, the paper will work with the standard regressive multi-dimensional model derived from the study of Kandir (2008) and other coherent mathematic-statistical methods.

$$I = \beta_0 + \beta_1 IPI + \beta_2 IR + \beta_3 IN + \beta_4 OP + \beta_5 PPI + \beta_6 UN + \beta_7 MS + \varepsilon \quad (1)$$

I	is the change in stock index (S&P 500, DJIA),
IPI	is the change in industrial production index,
IR	is the change in interest rate (1 month time deposit rate),
IN	is the change in inflation,
OP	is the change in oil price (barrel west texas intermediate),
PPI	is the change in production price index,
UN	is the change in unemployment,
MS	is the change in money supply (monetary base M2 and MZM),
ε	residual error .

The basic instrument to investigate the correlation between two variables is the correlation analysis and is recommended for share analyses e.g. by McCandless,

[1] Kuala Lumpur stock exchange

[2] Indonesia, Malaysia, Singapore, Thailand, Philippines

Weber (1995). This correlation will be tracked by the Pearson correlation coefficient.

$$r_{yx} = r_{xy} = \frac{s_{xy}}{s_x s_y} \tag{2}$$

Related standard tests will be used within the analysis and compilation of the regressive model as well. They will include firstly the Durbin-Watson statistical test of seemingly unrelated regression that will subsequently be benchmarked against the determination index value.

$$DW = \frac{\sum_{t=2}^{T} (\varepsilon_t - \varepsilon_{t-1})^2}{\sum_{t=2}^{T} \varepsilon_t^2} \tag{3}$$

ε_t residual values.

Also, the time sequence stationarity test will be carried out by using an ADF test of the unit root, adopted e.g. by Kumar (2011). As the level of S&P 500 and DJIA cannot reach negative values, the Dickey-Fuller unit root test is used in the standard form with a constant and constant and trend.

ADF with constant

$$Y_t = b_0 + (a-1) \cdot Y_{t-1} + \varepsilon \tag{4}$$

ADF with constant and trend

$$Y_t = b_0 + b_1 \cdot t + (a-1) \cdot Y_{t-1} + \varepsilon \tag{5}$$

4. Empirical results

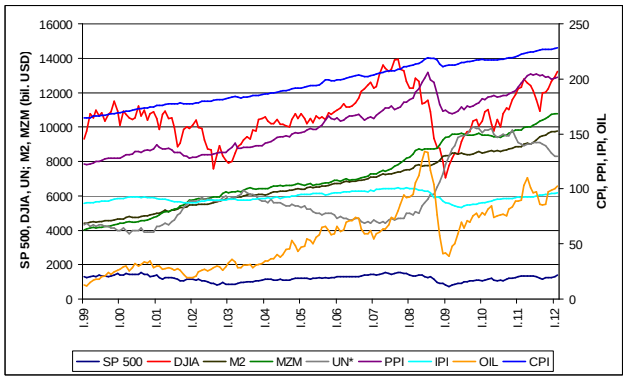
As said above, the fundamental method for analysing stocks and shares is the correlation analysis. This analysis will be done by using the Pearson correlation model. The values are summarised in the following table.

Table 1: Correlation analysis

	IR	CPI	OIL	PPI
S&P 500	0,6727	-0,0191	0,2490	0,1278
DJIA	0,3082	0,3715	0,5481	0,4718

	IPI	UN	M2	MZM
S&P 500	0,6319	-0,441	-0,1062	-0,1721
DJIA	0,7306	-0,1088	0,3012	0,2388

The values reached for correlation coefficients confirm the positive correlation between interest rates, oil prices, producer price index and industrial production index. They also confirm negative correlation for unemployment, which corresponds to the economic theory. Interesting are the values for money supply with index S&P 500 suggesting slightly negative correlation, which contradicts economic theory. Given the resulting values, a stronger impact of selected variables on DJIA can be assumed (inflation, oil price, producer price index and industrial production, money supply). The following chart shows the progress of selected variables (with the interest rate missing) which clearly shows the almost identical progress for the oil price, producer price index, industrial production index and the Dow Jones index. The chart also provides evidence of an inverse progress of the share index in respect of unemployment, particularly during the growth period from 2003 to 2008.



* number of unemployment on 100 000 inhabitant.

Fig. 1 US stock indices and macroeconomic variables

With the correlation coefficients calculated, this still does not have to be real functional dependence, but only seeming dependence. It is therefore to be found whether the time lines followed are stationary. Artl (1997) says that by studying the time line chart, it can be subjectively assessed and decided whether the series is stationary or not. A similar procedure is employed by Kumar (2011) in his study.

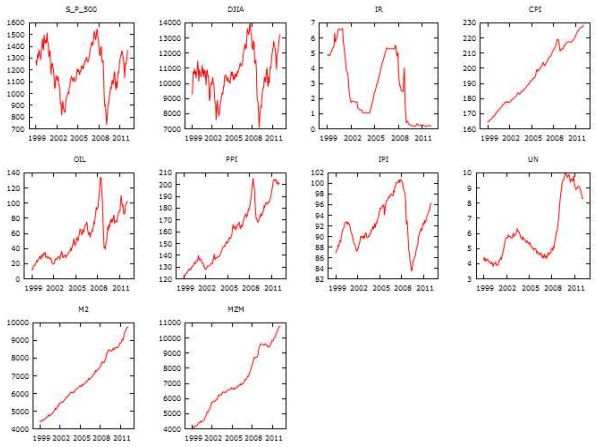


Fig. 2 Dataset graph

Apart from visual inspection, we can say that S&P 500, DJIA, OIL, PPI, IPI, IR or UN contain some cycle component and by money supply development and inflation we can recognize a linear trend. All this signs of a non constant mean.

The following DW statistical test will demonstrate whether the correlation is real or only seeming. The tables below shows the analysis of linear regressive model residues.

Table 2: Correlation analysis

dependent variable S&P 500	p-value	DW statistic
IR	$3{,}67\times10^{-22}$	0,1637
CPI	0,812	0,0861
OIL	0,0016	0,0811
PPI	0,1095	0,0867
IPI	$5{,}43\times10^{-19}$	0,1505
UN	$6{,}65\times10^{-9}$	0,1053
M2	0,1843	0,087
MZM	0,0306	0,0887

dependent variable DJIA	p-value	DW statistic
IR	$8{,}15\times10^{-5}$	0,1183
CPI	$1{,}55\times10^{-6}$	0,1224
OIL	$9{,}01\times10^{-14}$	0,1481
PPI	$3{,}93\times10^{-10}$	0,1343
IPI	$1{,}24\times10^{-27}$	0,2092
UN	0,1735	0,1063
M2	0,0001	0,1166
MZM	0,0025	0,1124

Given the DW values for original time lines, it can be assumed that this is only seeming correlation, because as said by Phillips, Perron (1986), the DW statistics converges into zero values for seeming regression and into non-zero values for real correlation of variables. To eliminate autocorrelation and a trend, the first value differentiation will be applied for original input data, as recommended by Artla (1997). This way, input variables will obtain the character of white noise with zero mean value and constant variance

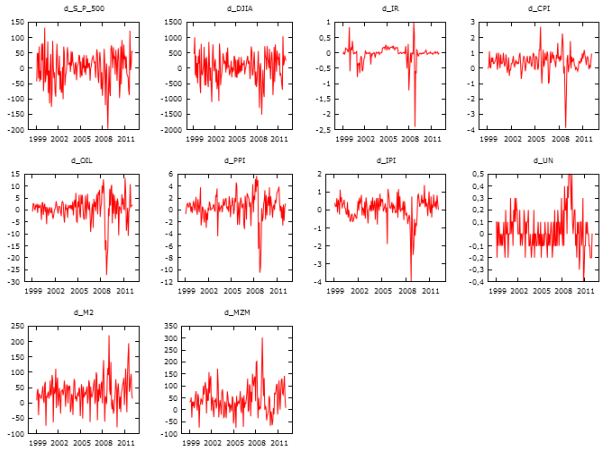


Fig. 3 Dataset graph (first diferences)

Subsequently, DW statistical values for independent variables ranged from 1.82 to 1.99 for dependent variables of S&P 500 and 1.87 – 1.95 for the dependent variable of DJIA. According to Granger, Newbold (1974), this means that the residues of first differences are stationary because DW > R^2. As a result, first differentiation is used for further analysis and compilation of the linear regressive model.

The following table shows p-values and critical values τ of the extended ADF test carried out for the model with a constant and constant and trend.

Table 3: ADF test

	model with constant		model with constant and trend	
variable	**p-value**	**τ value**	**p-value**	**τ value**
d_SP&500	$8{,}13\times10^{-18}$	-11,3075	$7{,}78\times10^{-17}$	-11,2892
d_DJIA	$1{,}72\times10^{-18}$	-11,7081	$1{,}58\times10^{-17}$	-11,6877
d_IR	$6{,}95\times10^{-15}$	-9,7486	$8{,}34\times10^{-14}$	-9,7196
d_CPI	$1{,}12\times10^{-10}$	-7,7457	$1{,}47\times10^{-9}$	-7,7207
d_OIL	$1{,}12\times10^{-11}$	-8,2118	$1{,}47\times10^{-10}$	-8,1856
d_PPI	$5{,}34\times10^{-12}$	-8,3638	$6{,}79\times10^{-11}$	-8,3426
d_IPI	$4{,}04\times10^{-14}$	-9,3728	$4{,}98\times10^{-13}$	-9,3455
d_UN	$2{,}08\times10^{-13}$	-9,027	$2{,}51\times10^{-12}$	-9,0121
d_M2	$3{,}47\times10^{-17}$	-10,9505	$1{,}25\times10^{-16}$	-11,1735
d_MZM	$1{,}24\times10^{-11}$	-8,1918	$1{,}23\times10^{-10}$	-8,2213

Based on the ADF test on a 5% significance level, it was verified that all variables (i.e. difference of original values) are stationary, i.e. the original time line is integrated by degree one.
The table below presents the coefficients of independent variables and their p-values in a multi-dimensional regressive model created by adopting the OLS method for the dependent variables of S&P 500 and DJIA on a 5% significance level.

Table 4: Linear regression model

dependent variable	**const.**	**IR**	**CPI**	**OIL**
	koef.	**koef.**	**koef.**	**koef.**
S&P 500*	5,5638	21,2165	-18,9679	2,4140
S&P 500**	5,2392	23,4090	-19,5234	2,3535
DJIA*	11,6313	-41,1703	-28,3757	17,5865
DJIA**	10,9492	-15,5577	-34,5384	16,8910
dependent variable	**PPI**	**IPI**	**UN**	**MS**
	koef.	**koef.**	**koef.**	**koef.**
S&P 500*	2,8437	-0,5998	-22,3457	0,0035
S&P 500**	3,1899	-0,2515	-23,123	0,0374
DJIA*	-11,6321	159,06	-228,056	0,4610
DJIA**	-9,3552	160,056	-233,518	0,4427

* by monetary base M2
** by monetary base MZM

The conclusion to be made based on the data is that with the values of the different coefficients, the S&P 500 index is mostly affected by changes in interest rates, inflation and unemployment, while the DJIA index if mostly affected by the industrial production index, producer price index, oil prices, inflation and unemployment. This confirms the hypothesis that DJIA is more affected by changes to those variables to which development industrial sectors are linked. What should not go unnoticed is the fact that for both indices the least significant element was the money supply (through aggregate M2 or MZM), which contradicts economic theory. On the other hand, this result is in line with the findings of Širůček (2012) who found causal correlation between changes in money supply and DJIA development when applying a one-month delay of the index response to changes in the money supply. The non-existence of any co-integration between the money supply and share prices is also confirmed by Habibullah, Baharumshah (1996) and Kimura, Koruzomi (2003).
Following a closer analysis of the different variables and assessment of their statistical significance, we will reach the conclusion that only the oil price for the S&P 500 index and the producer price index for the DJIA are statistically significant. When assessing the overall significance of the model, it is the second model that appears to be significant (p-value F = 0.0108 with variable M2 and/or 0.0137 with variable MZM), with the first model reaching a lower significance level (p-value F = 0.0988 with variable M2 and/or 0.0917 with variable MZM).
Interest rates have a positive impact on S&P 500, which contradicts economic theory – external funding is becoming more expensive and demand for stocks and shares is falling with growing interest rates. This was verified for DJIA where the value of the interest rate coefficient suggests a negative effect of this variable on the share index. The values however confirm the strong link (positive or negative) of interest rates to share prices and hence comply with the theory of Akmal (2007), Kandir (2008), Cooper, Howe, Hamzah (2004), Wongabgpo (2002). Correlation regarding the negative effect of inflation and unemployment on share price growth was confirmed for both share indices. The negative impact of unemployment is obvious mostly for Dow Jones. Also changes to the index of industrial manufacturing have a negative impact on this index. This is of interest because when the index grows, the revenues of industrial manufacturers are growing as well, but also the price of their inputs rises, depressing profits. As expressed in the economic theory of Clare, Thomas (1994), Gjerde, Saettem (1999), Cheung, Ng (1998), positive correlation between oil prices and strong negative correlation between growing unemployment and the DJIA index were confirmed. On the other hand, the impact of oil prices contradicts the findings of Kandir (2008). This "industrial" index is also heavily and positively affected by

the producer price index, which corresponds e.g. to the theory of Mukherjee, Naka (1995) and Humpe, Macmillan (2007). With the values found for the different variables and by taking into account the overall significance of the model (p-value F=0.01), it is the second model with the dependent variable of the Dow Jones Industrial Average index that appears to be the more suitable one for analysing macroeconomic factors. The impact and significance of the different coefficients therefore fully complies (depending on their values) with economic theory. A certain exception is only the money supply where stronger correlation was expected.

4. Summary and conslusion

Many studies were investigating the impact of macroeconomic factors on share prices and yields. The studies however provide different results. Some authors confirmed positive correlation between selected macroeconomic factors, but others rejected any such correlation. This paper analysed the impact of selected variables (interest rates, inflation, oil price, producer price, industrial production index, unemployment and money supply) on the S&P 500 and Dow Jones Industrial Average indices. Based on the results of the linear regressive model compiled by adopting the OLS method, the model tracking the impact of selected variables on DJIA appears to be statistically significant. This model also confirms the economic theory justifying the impact of variables on share prices. No neutral, but rather negative impact was however found for inflation, as said e.g. by Boudoukh, Richardson (1993) – growing prices are reflected in a lack of disposable resources that could be used for investment. Negative correlation between inflation and share prices corresponds to the results of Sharpe (2002), Ritter, Warr (2002). What should also be mentioned is the relatively minor significance of the money supply regarding share prices – here this factor is regarded by some authors (Musílek (1997), Poiré (2000), Shostack (2003)) as the most significant one.

The most significant factor for both models was inflation and unemployment (both with a negative impact). The most significant determinant of the S&P 500 index were interest rates and unemployment, while industrial manufacturing and unemployment, followed by changes to interest rates and oil prices, had the biggest impact on DJIA. This is obvious also in the chart. As a result, the hypothesis about a stronger link of "industrial" variables to the Dow Jones index was confirmed. It must be however noted that even though this index bears the name "industrial", the industrial sector is represented by DJIA only by approx. 16% and contains shares also from the technological, financial and consumer goods sectors. Given the results presented in this paper that correspond to economic theory and confirm the statistical significance (p-value of F significance) for DJIA, I recommend employing Dow Jones for analysing stocks and shares on the US market for the reasons of its long history and structure (price weighted index). Also, as said by Gobry (1996), this index is regarded as the sentiment indicator on world markets.

This paper investigates the role of macroeconomics factors in explaining US stock market development (stock index S&P 500 and Dow Jones) in period 1999 – 2012. For expansion of this analysis of causal relationship between stock prices and macroeconomic variables it can be use e.g. Granger causality test, or Error correction model (ECM), which can recognise short and long time relatonship between time series.

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