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Empirical evaluation of monetary policy transmission to stock markets and further transfer of macroeconomic shocks to the real sector

Yevgenii Sova
Department of Finance,
National University of "Kyiv-Mohyla Academy", Ukraine
ye.sova@ukma.edu.ua
ORCID 0000-0001-8158-7031

Iryna Lukianenko
Department of Finance,
National University of "Kyiv-Mohyla Academy", Ukraine
iryna.lukianenko@ukma.edu.ua
ORCID 0000-0002-4128-5909

Abstract. The study focuses on revealing key monetary policy instruments that can influence stock market development and elaborating whether shocks from financial markets and other macroeconomic conditions are further transferred to the real sector, as expected under the monetary transmission mechanism. This paper is an extension of our previous theoretical and empirical research expanding to ten developed and eight developing economies for the period of 1999-2020 using panel data and vector autoregressive models, impulse response functions, and scenario analysis. Firstly, it was examined that actions of monetary policymakers were efficient for stimulating the development of stock markets mostly for developed countries, whereas stock indices in most developing countries seemed not to be sensitive to changes in monetary conditions. Using scenario analysis and impulse response functions, it was discovered that in developing countries, including Poland and Ukraine, an expansionary policy focused on increasing money supply would mitigate deceleration and facilitate the growth of stock indices in the next four quarters, whereas, in developed countries, including the USA, a decline in interest rates under expansionary regime would stimulate the development of stock markets. Finally, the evolution of financial markets together with macroeconomic, social, and political conditions was concluded to be a statistically important factor of economic growth, as initially expected.

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1. INTRODUCTION

Policy makers and researchers around the globe have been concerned for decades whether central banks can influence the development of stock markets providing stimulus for their growth, mitigating macroeconomic shocks and controlling asset bubbles. During the last decades many studies generally supported the idea on significant relationship between monetary indicators and stock market indices grounding on existing financial concepts described later in the current paper. However, the empirical research on this topic appears to be quite fragmentary covering only specific time periods and focusing mostly on economies where capital markets are highly liquid and have efficient infrastructure.

This paper is an extension of work originally presented in 10th International Conference on Advanced Computer Information Technologies (Sova & Lukianenko, 2020). In current paper, the relationship between monetary policy and stock market indices is further investigated for ten developed and eight developing countries during the most recent period of 1999-2020 using extensive mathematical models and methods. A particular focus is placed on discovering the efficiency of monetary instruments in economies with stock markets undergoing establishment or a transformation, which have not been analyzed comprehensively in the literature and requires further empirical research. In addition, one of the key aims of this paper is to elaborate on shocks transferred from financial markets to the real sector taking into account other macroeconomic conditions such as volume of investments, control of corruption, overall political and social stability.

The primary purpose of our paper is to discover the most efficient monetary policy instruments to stimulate stock markets development as well as stabilize short-term and long-term consequences of their fluctuations during periods of uncertainty currently observed globally, using a comparative country-level empirical analysis of the relationship between monetary and stock market indicators in economies with different levels of development and background, especially in developing ones such as Ukraine. Revealing the most efficient monetary instruments in different future macroeconomic scenarios is highly important for policymakers responsible for mitigating internal and external economic risks and their consequences, which is especially crucial during the periods of disturbances and high volatility on stock markets as well as currently observed social, political and economic uncertainty around the globe.

It is assumed that central banks can actually influence the pricing of financial instruments traded on capital markets, as financial theory implies. However, a significant relationship is not expected for developing countries where stock markets are undergoing a transformation and lacking liquidity. In turn, stock markets are hypothesized to be important factors influencing the dynamics of monetary indicators. Finally, it is expected that financial markets, along with investments, social, political and macroeconomic conditions, further affect the real sector, namely the economic growth.

2. LITERATURE REVIEW

Existing empirical studies focused mostly on constructing a set of macroeconomic and monetary variables that reflect actions of economic policy makers and used them to investigate the relationship between macroeconomic and stock market indicators in developed countries. In the study of Ioannidis and Kontonikas (2006) two approaches for analyzing central banks' actions were applied. As the first proxy for

interest rate the US treasury bonds rate was chosen. An alternative approach involved the construction of a binary dummy variable reflecting changes and direction of monetary policy: a dummy variable equals 1 in case of an interest rate increase, or 0 otherwise.

According to Khan, Qingyang and Khurshid (2017), money supply should be used as a proxy variable for reflecting monetary policy. It was concluded by Chen, Roll and Ross (1986) that the most relevant indicators for analyzing macroeconomic policy and its influence on stock markets include the spread between long-term and short-term interest rates, anticipated and unanticipated inflation, industrial production, the spread between investment-grade and speculative-grade bonds. Macroeconomic shocks were modelled using such variables as inflation, logarithm of consumer price index, US federal funds rate, logarithm of non-borrowed reserves, logarithm of total reserves, return on stocks, industrial production growth rate (Christiano et al., 1994). In the study of Pilinkus (2010) the following set of macroeconomic variables was constructed: GDP, unemployment rate, foreign direct investment, public debt, consumer price index, money supply, export, import, trade balance, short-term interest rates and stock indices. Similar indicators were suggested by Cassola and Morana (2004), including real GDP, inflation, M3 monetary aggregate, short-term interest rate, return on bonds.

Using a narrative approach and data of Federal Open Market Committee (FOMC) for the period from January 1953 to December 1991, Boschen and Mills (1995) developed an index for classifying monetary policy between five categories: strong anti-inflationary (-2), anti-inflationary (-1), neutral (0), stimulating an economic growth (1), strongly stimulating an economic growth (2).

In contrast, the research of Ehrmann and Fratzscher (2004) revealed an identification problem of monetary policy. It was noted that changes in market or official interest rate may not always reflect the actual actions of monetary regulators, as variation in interest rates may be driven by business cycles or other factors.

3. METHODOLOGY

Current empirical study involves using a range of mathematical and econometric models and methods, which are described below. Monthly and annual indicators are sourced mostly from OECD, World Bank, IMF, NBU and Ukrstat open access databases for the period from 1999 to 2020 for subsets of developed (ten countries in total) and developing (eight countries in total) countries.

During the first phase of analysis different panel data models were applied to identify the significance and direction of monetary indicators' influence on stock indices, separately for developed and developing countries. The same approach was utilized when analyzing the relationship between economic growth and other macroeconomic conditions such as level of investments and corruption, dynamics of stock indices, political and social stability. The panel data estimators used in this study included pooled (1), fixed effects (2), random effects (3) and Fama-MacBeth (4), where y_{it} is a dependent variable (stock index) for country i in the year t, x_{it} is a vector of independent variables (monetary indicators) for country i in the year t, α - intercept independent from i and t, β – slope independent from i and t, α_i – vector of countries' individual characteristics, u_{it} and ε_{it} – error terms, as specified below:

$$y_{it} = \alpha + x'_{it}\beta + u_{it} \tag{1}$$

$$y_{it} = \alpha_i + x_{it}\beta + \varepsilon_{it} \tag{2}$$

$$y_{it} = x'_{it}\beta_i + (\alpha_i + \varepsilon_{it}) \tag{3}$$

$$y_{it} = \beta' x_{it} + \varepsilon_{it} \tag{4}$$

Using standard vector autoregressive models (VAR) and vector error-correction models (VECM) short-term and long-term relationship between monetary and stock market indicators were investigated for each of eighteen countries under analysis verifying the initial hypotheses. Standard vector autoregression is defined in (5), as follows:

$$\begin{bmatrix} Y_{1t} \\ \dots \\ Y_{nt} \end{bmatrix} = \begin{bmatrix} A_{10} \\ \dots \\ A_{n0} \end{bmatrix} + \begin{bmatrix} A_{11}(L) & \dots & A_{1n}(L) \\ \dots & \dots & \dots \\ A_{n1}(L) & \dots & A_{nn}(L) \end{bmatrix} \begin{bmatrix} Y_{1,t-1} \\ \dots \\ Y_{n,t-p} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \dots \\ \varepsilon_{nt} \end{bmatrix} \quad (5)$$

where $\{Y_{jt}\}$ – vector of endogenous variables, A_{i0} – vector of constants in each equation of VAR system, $A_{ij}(L)$ – lag operator polynomial of order p; $j = 1, 2, \dots, n$; $i = 1, 2, \dots, n$; $t = 1, 2, \dots, T$.

Equation (6) represents a general vector error-correction model in accordance with Johansen (1991), which was used in the research:

$$\Delta Y_t = \sum_{i=1}^{p-1} \varphi_i * \Delta Y_{t-i} + \pi u_{t-1} + \varepsilon_t \quad (6)$$

where ΔY_t – matrix of endogenous variables included to the model in first differences, ΔY_{t-i} – matrix of variables of lag i in first differences, φ_i – coefficients before lagged variables, π – matrix of coefficients before the cointegration equation which represents the speed of adjustment, u_{t-1} – a cointegration equation, ε_t – error term (white noise); $t = 1, \dots, T$.

For three selected economies, which were analyzed in the conference paper (Sova & Lukianenko, 2020), namely the USA, Poland and Ukraine representing developed and developing countries, the impulse response functions were constructed to model the changes in monetary and stock market indicators in case of different macroeconomic shocks. Further in the research four monetary policy scenarios are developed for 2021 for each of the selected countries in order to model the dynamics of stock market indices during different expansionary and restrictive monetary regimes.

When constructing monetary policy scenarios for Ukrainian economy, which tends to be less stable than economies of the USA and Poland as well as more exposed to political risks, the Markov switching dynamic regression model was applied assuming two regimes (high interest rate environment and low interest rate environment), based on approach of Hamilton (1989) and Kim and Nelson (1999). This approach enhanced our understanding of Ukrainian monetary landscape, its historical tendencies, average duration of high and low interest rate regimes. The chosen specification, which is presented in (7) and (8), models short-term interest rates as noise around a constant intercept, where r_t denotes a trend component of short-term interest rates, S_t is the unobserved two-state Markov-switching variable (states of high or low interest rate regimes) evolving based on transition probabilities defined in (8), $S_t \in \{0, 1\}$, μ is an intercept, ε_t denotes independent and identically distributed random variables.

$$r_t = \mu S_t + \varepsilon_t,\ \varepsilon_t \sim N(0, \sigma^2) \quad (7)$$

$$P(S_t = s_t \mid S_{t-1} = s_{t-1}) = \begin{bmatrix} p_{00} & p_{10} \\ 1 - p_{00} & 1 - p_{10} \end{bmatrix} \quad (8)$$

4. EMPIRICAL RESULTS

Our empirical research of monetary policy (basically, interest rates and money supply management) and stock market indices is based on theoretical assumptions regarding their relationship and channels of

interaction. In financial literature many researches use the following model for theoretical analysis of monetary policy channels that influence prices for financial assets:

$$S_t = E_t\left[\sum_{j=1}^{K}\left(\frac{1}{1+R}\right)^j D_{t+j}\right] + E_t\left[\left(\frac{1}{1+R}\right)^K S_{t+K}\right] \quad (9)$$

where, S_t is a financial asset's price at time t, E_t is the operator of expected value, R is the rate of return, D_{t+j} is related to future dividends, K is a time horizon for assets holder.

In (9) it is demonstrated how monetary policy channels influence the dynamics of financial assets and, as a result, stock indices. By managing interest rates (e.g. discount rates) central banks can theoretically influence the value of stocks both directly and indirectly. A direct effect is a result of changes in the discount rate while indirect effect is exercised through guidance of expectations on future economic activity and respective cash flows of firms. The two channels are related and mutually reinforcing. During the restrictive monetary policy regime, the discount rate increases with simultaneous decrease in firms' future cash flows, which has a negative effect on the financial assets' market value. In contrast, an expansionary monetary policy is perceived by economic agents as a positive signal of future economic activity and growth (Ioannidis & Kontonikas, 2006).

4.1. Estimation of the relationship between monetary and stock market indicators in developed and developing economies using panel data models

First stage of our empirical research involved the analysis of the interaction between monetary policy and stock markets in countries with different level of economic development. Using the United Nations classification, OECD's monthly data of monetary and stock market indicators were sampled for ten developed and seven developing countries to construct several panel data models separately for each group covering the period from January 1999 to December 2019.

As demonstrated in Table 1, short-term interest rates, which generally reflect monetary policy actions, was the important factor of stock markets growth in developed economies during the Analyzed period. In fact, the increase in interest rates contributed to the upward trend in stock indices contrary to basic theoretical assumptions described above, which would be further analyzed in detail based on country-level vector autoregression models. Another important indicator of monetary policy, namely broad money (M3), also had a direct and statistically significant effect on stock markets development. Under Hausman test the preferred specification would be the fixed effects model (as compared to random effects), which assumes a likely correlation between unobserved individual characteristics of countries and independent variables represented by monetary indicators.

Similar to previous results, in developing economies short-term interest rates and money supply appeared to be significant instruments for stimulating growth of the stock indices. However, it was noted that short-term rates affected the stock markets in a different direction: restrictive monetary policy (increasing average interest rates) led to the decrease in stock indices and vice versa. Contrary to the sample of developed countries, individual characteristics of selected developing economies did not influence the monetary indicators based on Hausman test.

Based on comparative analysis of estimation results for different groups of countries, the following conclusions were made:

- Estimation results for both samples revealed a strong influence of monetary policy instruments (including interest rates, money supply, nominal and real exchange rates) on stock indices at 1% or 5% alpha levels of statistical significance.

– Changes in short-term interest rates demonstrated an oppositely directed impact on stock markets depending on the level of countries' economic development. In developed economies (where interest rates are comparatively lower on average) the increase in short-term rates by 1 p.p. would lead to the increase in stock index by 4.8 points on average, whereas in developing countries a 1 p.p. interest rate increase would result in average decline of stock index by 1.6 p.p. (based on preferred specifications: fixed effects model for the sample of developed countries and random effects model for developing ones).

– In developed economies such country-specific characteristics as economic growth, liquidity of financial markets, infrastructure development, rich natural resources, etc. exert influence on both monetary indicators (independent variables of the model) and further stock market development (the dependent variable). Individual attributes of developing countries did not reflect a significant correlation with monetary policy instruments. Instead, they appeared to be distinct factors of stock market development.

While panel data models generally confirmed the initial assumption on the relationship between monetary and stock market indicators in countries with different level of economic development, the study further involved application of vector autoregressive models to refine the understanding of their interaction on a country-by-country level.

Table 1

Estimation results of key monetary indicators' influence on stock market indices in developed and developing countries based on panel data models

Country group:	**Developed**				**Developing**			
Models:**	**Pooled**	**FE**	**RE**	**FMB**	**Pooled**	**FE**	**RE**	**FMB**
Observations	2,268	2,268	2,268	2,268	1,764	1,764	1,764	1,764
R^2	0.219	0.597	0.415	0.665	0.761	0.836	0.836	0.917
F-statistics	127.2	667.7	320.2	897.8	1,112	1,188	1,187	3,872
p-value (F-statistics)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Regressors***								
Constant	-138.85*	64.374*	-51.924*		-2.804	-4.450	-4.743	
	(-11.41)	*(6.05)*	*(-3.99)*		*(-0.82)*	*(-1.27)*	*(-0.80)*	
NEER	0.267*	-5.053*	-3.014*	1.102*	0.000	-0.001*	-0.001*	0.000
	(5.89)	*(-47.73)*	*(-29.49)*	*(9.46)*	*(-0.32)*	*(-2.39)*	*(-2.19)*	*(-1.87)*
REER	1.433*	0.168	0.967*	0.343*	0.267*	0.325*	0.325*	0.405*
	(12.85)	*(1.86)*	*(9.30)*	*(7.13)*	*(-9.24)*	*(-12.01)*	*(-12.03)*	*(-6.82)*
CPI	8.406*	3.226	5.694*	1.404	4.263*	0.921	0.938	-3.785
	(2.78)	*(1.67)*	*(2.44)*	*(0.50)*	*(-5.28)*	*(-1.34)*	*(-1.36)*	*(-1.35)*
ST_intrate	5.885*	4.846*	6.104*	2.535*	-1.316*	-1.570*	-1.566*	-3.111*
	(11.28)	*(12.23)*	*(12.89)*	*(5.25)*	*(-11.35)*	*(-14.81)*	*(-14.79)*	*(-5.66)*
M3_index	0.770*	1.032*	0.981*	0.447*	0.809*	0.827*	0.826*	0.662*
	(14.67)	*(29.06)*	*(22.94)*	*(7.36)*	*(-59.40)*	*(-69.00)*	*(-69.35)*	*(-11.06)*

Source: Authors' calculations based on OECD data. * Indicates significance level at 0.01 or 0.05 levels. ** Models: Pooled – a pooled panel data model; FE – a fixed effects panel data model; RE – a random effects panel data model; FMB – a Fama-MacBeth model. *** Regressors: NEER – nominal foreign currency exchange rate; REER - real effective exchange rate; CPI – Consumer Price Index; ST_intrate – short-term interest rates; M3_index – money supply or broad money (M3).

4.2. Country-level analysis of the interaction between monetary policy and stock markets using vector autoregressive models

Based on OECD and IMF data and the system of vector autoregressive models, including vector error-correction models, it was generally confirmed that monetary policy instruments were effective for stimulating the evolution of stock markets in many developed economies during the period under analysis. A summary of estimation results is presented in the Table 2.

Table 2

Estimation results of key monetary policy indicators' influence on stock market indices, and vice versa, in developed countries based on VAR/VECM models

	Influence of monetary policy on STOCK INDICES		**Influence of stock indices on MONETARY INDICATORS**	
Country	***Interest rates***	***Money supply***	***Interest rates***	***Money supply***
Canada	·	·	(+)	-
Czech Republic	·	·	·	·
Poland	·	(+)*	·	(-)
Denmark	(-)	·	·	(+)
Iceland	(+)	(+)	(+/-)	·
Norway	(-)	·	(+)	·
Sweden	·	(+/-)	·	(+/-)
Switzerland	(-)	·	(+)	(+/-)
United Kingdom	(-)	·	(+)	(+/-)
USA	(-)	·	(+)	(-)

Source: Authors' calculations based on OECD data. * Statistically significant at 10% alpha level, other variables are significant at 5% alpha level

Based on empirical research, it was revealed that control of interest rates is one of key and the most effective tools of central banks for influencing the dynamics of stock indices. For most sampled countries with high level of GDP per capita (exceeding $60 thousand in 2019) as well as the United Kingdom (approximately $42 thousand in 2019), a statistically significant influence of short-term interest rates on stock markets dynamics was observed: expansionary monetary policy focused on cutting short-term interest rates facilitated a gradual growth of stock indices in short-term and medium-term perspectives (except for Iceland where a positive impact of restrictive monetary policy on stock markets was observed, i.e. increase in interest rates led to the growth of stock indices). For other countries where GDP per capita was below $55 thousand in 2019 (except for the United Kingdom), changes in short-term interest did not have a significant effect on the dynamics of stock indices. The efficiency of another monetary policy tool, namely money supply, was confirmed only for Iceland and Poland (direct positive effect) as well as Sweden (both direct and indirect effects depending on the period).

Our empirical analysis also demonstrated that growth of stock indices, in turn, reinforces the growth of short-term interest rates in most of developed countries (for 6 of 10 countries in the sample). In contrast, the development of stock markets has differently directed effects on money supply dynamics depending on the country: positive – for the economy of Denmark; negative – for the USA and Poland; mixed – for Switzerland, Norway and the United Kingdom; statistically insignificant – for Norway, Iceland and Czech Republic. It was also noted that short-term interest rates in most developed countries had a tendency for rapid decline after 2009, whereas in certain countries (in particular, Switzerland, Denmark and Sweden) average interest rates dropped below zero, which reduces the flexibility of central banks in applying standard monetary tools. In such macroeconomic conditions central banks of many developed countries constrained and compelled to introduce other mechanisms for stimulating the development of financial and real sectors, including fiscal policy instruments.

Similar analysis was conducted with regard to the sample of developing economies, which is presented in the Table 3. Only in several developing countries a significant impact of monetary policy on stock indices was confirmed based on our empirical analysis. While in South Korea declining interest rate (in course of expansionary monetary policy) induced the positive dynamics of stock indices, in Mexico and South African Republic a mixed effect was observed in case of changes in short-term interest rates. Another widely used monetary tool, in particular money supply, appeared to be effective only for economies of Ukraine and Mexico. In most developing countries in our sample, the stock market itself had a significant influence on monetary indicators (interest rates and money supply). However, the direction of stock market's impact varied among countries depending on their unique macroeconomic conditions.

The next subsection elaborates on the most effective instruments of monetary policy in selected countries (the USA, Poland and Ukraine) with different level of economic development taking into account future possible macroeconomic shocks and scenarios.

Table 3

Estimation results of key monetary policy indicators' influence on stock market indices, and vice versa, in developing countries based on VAR/VECM models

	Influence of monetary policy on STOCK INDICES		**Influence of stock indices on MONETARY INDICATORS**	
Country	***Interest rates***	***Money supply***	***Interest rates***	***Money supply***
Ukraine	·	(+/-)	·	(-)
Columbia	·	·	(-)	(-)
South Korea	(-)	·	·	·
Russia	·	·	(-)	(+)
Israel	·	·	(+)	(-)
Indonesia	·	·	(-)*	·
South African Republic	(+/-)	·	·	(+)
Mexico	(+/-)	(+)	(-)	(+/-)

Source: Authors' calculations based on OECD data. * Statistically significant at 10% alpha level, other variables are significant at 5% alpha level

4.3. Analysis of potential monetary policy impact on stock market in different macroeconomic scenarios for selected economies

The following analysis covers three selected economies with different level of economic development, social and political environment, namely the USA, Poland and Ukraine, which were originally covered in Sova and Lukianenko (2020). Please note that current paper expands a set of monetary variables and time frames as compared to Sova and Lukianenko (2020).

Based on previously developed vector autoregression and vector error-correction models, impulse response functions were firstly constructed to analyze how stock indices would evolve during the next 10 months responding to different monetary shocks in the amount of one standard deviation. As demonstrated in the Figure 1, the stock index in Ukraine is mostly sensitive to its own shocks during the first two forecast periods. By the end of the tenth forecast period, the stock index tends to stabilize at the baseline level after the shocks in other monetary indicators.

Similar reaction of stock index can be observed for the economy of Poland: shocks in stock index itself have the most significant impact on the development of stock markets. On average, it takes less than a year for stock index to flatten out and reach the initial level, as demonstrated in the Figure 2.

While US stock index dynamics was mostly affected by shocks from the stock market, as in other economies under our analysis, it reacted differently to one standard deviations of other macroeconomic indicators. As shown in Figure 3, the stock index in the USA did not stabilize within a year after

macroeconomic disturbances but rather reached a new level in the long run. The next step of our research involved the construction of several potential scenarios of stock index dynamics in response to monetary policy actions in 2021 for each of selected countries stated above.

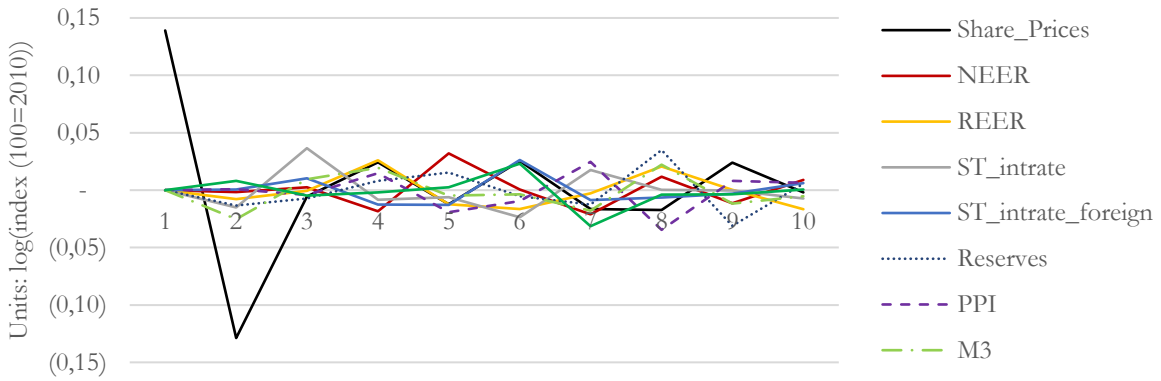

Figure 1. Impulse response of the stock index (Share_prices) to one standard deviation shocks in stock index and monetary indicators for the economy of Ukraine

Source: own evaluation based on IMF, Ukrstat and NBU data. Variables: stock index (Share_prices), real effective exchange rate (REER), short-term interest rates for instruments in foreign currency (ST_intrate_foreign), Producer Price Index (PPI), Consumer Price Index (CPI), nominal foreign currency exchange rate (NEER), short-term interest rates (ST_intrate), foreign exchange reserves (Reserves) and broad money (M3)

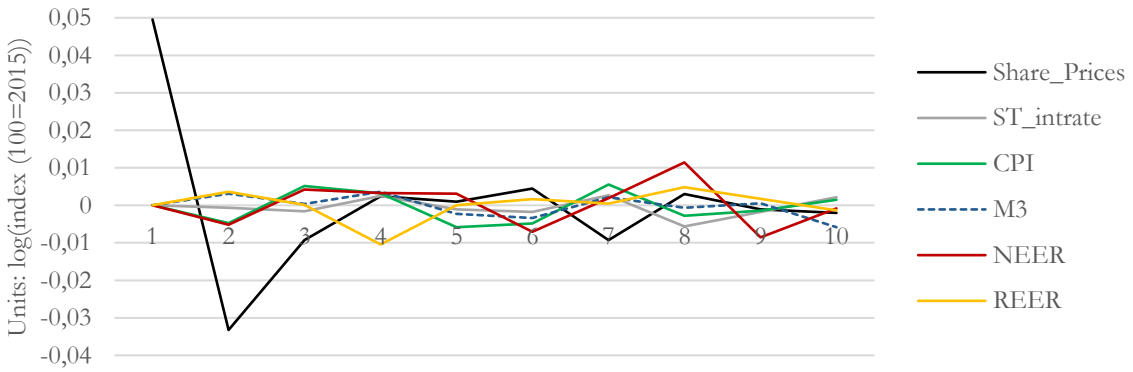

Figure 2. Impulse response of the stock index (Share_prices) to one standard deviation shocks in stock index and monetary indicators for the economy of Poland

Source: own evaluation based on OECD data. Variables: similar to Figure 1.

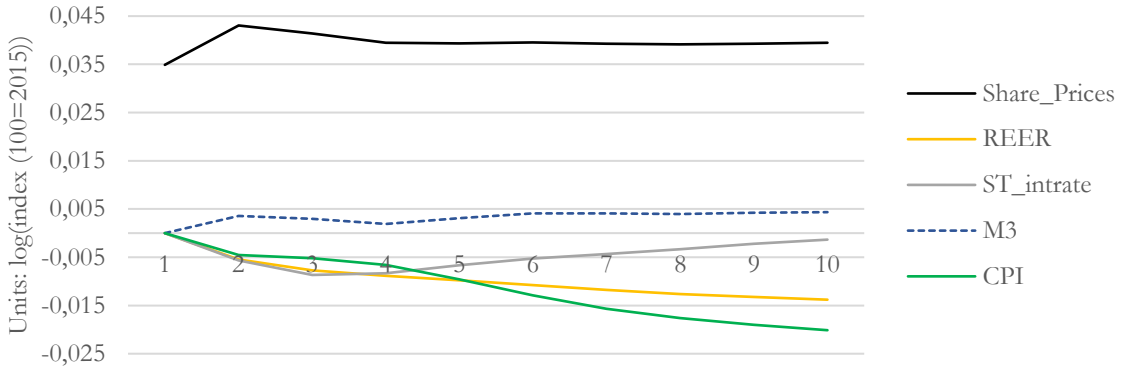

Figure 3. Impulse response of the stock index (Share_prices) to one standard deviation shocks in stock index and monetary indicators for the economy of the USA

Source: own evaluation based on OECD data. Variables: similar to Figure 1

Before formulating scenarios for Ukrainian economy, the evolution of its monetary policy was firstly analyzed during 2000-2020 using Markov-switching regression with a two-state variable that reflects two main monetary regimes: restrictive (increase in interest rates) and expansionary (decrease in interest rates). The results are presented in Figure 4. Historically, average periods of high and low interest rates comprised 18 months and 26 months, respectively. As model estimation results imply, monetary policy in Ukraine could be defined as expansionary in 2020 shifting from high to low interest rate regime since the first quarter of 2020, which is generally in line with other developed and developing economies.

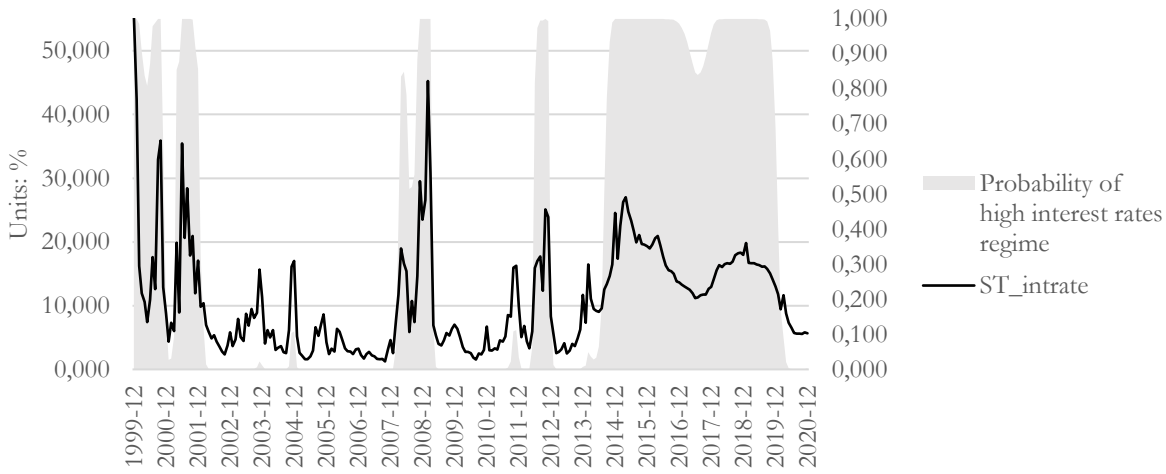

Figure 4. Evolution of monetary policy regimes in Ukraine based on two-state Markov-switching regression model

Source: own evaluation based on IMF data.

Figure 5. Dynamics of the stock index in Ukraine in case of different monetary policy scenarios
Source: own evaluation

Considering historical changes in Ukrainian monetary environment, the following monetary policy scenarios were proposed for 2021:

- Scenario 1 (moderate expansionary policy using interest rates): in 1Q2021 interest rates comprise 5.68% remaining at the level of December 2020, in 2Q2021 decrease to 5%, in 3Q2021 – 4%, in 4Q2021 – 3%.
- Scenario 2 (moderate expansionary policy with money supply): M3 aggregate increases by 0.25% each month.
- Scenario 3 (moderate restrictive policy using interest rates): in 1Q2021 interest rates remain at 5.68%, in 2Q2021 increase to 5%, in 3Q2021 – 7%, in 4Q2021 – 8%.
- Scenario 4 (moderate restrictive policy with money supply): M3 aggregate gradually decreases by 0.25% monthly.

Baseline projection based on model estimation results is presented for comparison.

The forecast dynamics of stock indices in case of four different monetary policy scenarios is shown in Figure 5. The stock index appears to be sensitive to changes in money supply, whereas almost no significant reaction is observed in response to volatility of short-term interest rates. In such conditions the scenarios 3 and 4 (management of money supply) would be more beneficial for stimulating the stock market development in the short term.

Following the same approach as for Ukraine, five possible monetary scenarios were assumed for the economy of Poland, which can affect the stock market evolution:

- Scenario 1 (moderate expansionary policy using interest rates): in 1Q2021 interest rates comprise 0.21% remaining at the level of December 2020, in 2Q2021 decrease to 0.15%, in 3Q2021 – 0.10%, in 4Q2021 – 0.05%.
- Scenario 2 (moderate expansionary policy with money supply): M3 aggregate increases by 1% each month.
- Scenario 3 (moderate restrictive policy using interest rates): in 1Q2021 interest rates increase up to 0.25%, in 2Q2021 further increase to 0.75%, in 3Q2021 – 1.25%, in 4Q2021 – 1.75%.
- Scenario 4 (moderate restrictive policy with money supply): M3 aggregate gradually decreases by 1% monthly.

Scenario 5 (active expansionary policy with money supply): M3 aggregate increases by 3% monthly.

Similar to Ukraine, the stock market in Poland is projected to be more sensitive to changes in the money supply than interest rates' dynamics, as presented in Figure 6 below. An active monetary policy focused on expanding the monetary base is expected to be more beneficial in order to decelerate the declining stock prices on Polish financial markets in the short run.

The scenario analysis was also conducted for the USA representing a developed economy. The constructed scenarios are listed below:

- Scenario 1 (moderate expansionary policy using interest rates): in 1Q2021 interest rates remain as in December 2020 at the level of 0.17%, in 2Q2021 decrease to 0.15%, in 3Q2021 – 0.10%, in 4Q2021 – 0.05%.
- Scenario 2 (moderate expansionary policy with money supply): M3 aggregate increases by 0.5% each month.
- Scenario 3 (moderate restrictive policy using interest rates): in 1Q2021 interest rates increase to 0.25%, in 2Q2021 – 0.75%, in 3Q2021 – 1.25%, in 4Q2021 – 1.75%.
- Scenario 4 (moderate restrictive policy with money supply): M3 aggregate gradually decreases by 0.5% monthly.

As demonstrated in Figure 7, the US stock market is projected to follow an ascending trend in all assumed monetary scenarios. In contrast to economies of Ukraine and Poland, the US stock market indicates a strong sensitivity to short-term interest rates, which are the key instrument of central banks in many developed countries. In order to support the further growth of stock markets, especially in uncertain economic and social conditions currently observed globally, the US monetary policy makers would need to extend an expansionary regime using interest rates.

Figure 6. Dynamics of the stock index in Poland in case of different monetary policy scenarios

Source: own evaluation

Figure 7. Dynamics of the stock index in the USA in case of different monetary policy scenarios
Source: own evaluation

4.4. Transfer of macroeconomic shocks to the real sector

Final step of our research involved the analysis of macroeconomic conditions such as foreign direct investments, stock market development, control over corruption and uncertainty, which can potentially influence the economic development, using panel data models. Such analysis is essential to better understand whether actions of monetary policy makers are further transferred to the real sector from financial markets and other macroeconomic conditions through monetary transmission mechanism channels.

As in previous models, the analyzed economies were divided into two samples of developed and developing countries. The following basic macroeconomic conditions were included as factors to panel data models, which broadly reflect basic economic, social and political situation in any given country: net foreign direct investments (as share in GDP, %), stock indices, control of corruption index based on Kaufmann et al. (2010) (one of the World Bank's worldwide governance indicators) and global uncertainty index measuring uncertainty among economic agents due to elections, wars, climate changes or crisis (Ahir et al., 2018). The dependent variable is represented by GDP per capita index.

The estimation results for the sample of developed and developing countries are shown in Table 4. Based on all constructed models, share prices had a statistically significant influence on the level of economic development: an increase in stock index by 1 point led to the growth of GDP per capita index by 0.5 point on average. Another statistically significant driver of economic growth was the control over corruption (e.g. mitigation of situations where public power is used for private gain). It was also found that the level of net foreign direct investments made a negative or not statistically significant contribution to economic growth of developed countries depending on the model used, which was not previously expected. However, one of possible explanations for this is the already high level of investments into developed economies: new capital inflows may yield much less significant benefits.

Based on estimation results for the second sample, it was noted that stock prices had even higher impact on economic growth in developing economies: a one point increase in stock indices caused the growth of GDP per capita index by 0.52 – 0.74 points depending on the model. Similar to the countries with high level of economic development, the real economy of developing countries was significantly affected by institutional control over corruption in both petty and grand forms.

Table 4

Estimation results of panel data models for stock indices in developing countries

Country group:	**Developed**			**Developing**		
Models:**	**Pooled**	**RE**	**FMB**	**Pooled**	**RE**	**FMB**
Observations	189	189	189	168	168	168
R^2	0.452	0.458	0.959	0.668	0.710	0.912
F-statistics	37.9	38.9	1,079.8	81.8	100.0	422.8
p-value (F-statistics)	0.00	0.00	0.00	0.00	0.00	0.00
Regressors***						
Constant	15.204	14.338		38.820*	34.059*	
	(1.27)	*(0.90)*		*(7.97)*	*(4.58)*	
FDI	-1.200*	-1.128*	0.039	0.989	0.511	4.936*
	(-3.71)	*(-3.49)*	*(0.12)*	*(1.12)*	*(0.52)*	*(2.78)*
Share_Prices	0.497*	0.515*	0.514*	0.696*	0.737*	0.523*
	(10.29)	*(10.64)*	*(6.40)*	*(17.04)*	*(18.96)*	*(2.84)*
Control_corruption	0.409*	0.410*	0.454*	0.131*	0.205	0.365*
	(3.50)	*(2.51)*	*(4.83)*	*(2.07)*	*(1.70)*	*(4.15)*
WUI	43.443	30.580	68.494	-81.739*	-82.236*	113.270*
	(1.59)	*(1.11)*	*(1.94)*	*(-3.37)*	*(-3.43)*	*(2.55)*

Source: Authors' calculations based on OECD, IMF and Worldbank data. * Indicates significance level at 0.01 or 0.05 levels. ** Models: same as in Table 1. *** Regressors: FDI – foreign direct investments; Share_Prices – stock indices; Control_corruption – control of corruption indicator; WUI – world uncertainty index

In contrast, the net inflows of foreign investments exerted a positive effect (according to Fama-Macbeth model) on economic growth of developing countries which may currently lack capital resources. Positive impact of FDI on economic growth may be explained by transfer of new technology, stimulation of the infrastructure enhancement, institutional development and attraction of other foreign investments to countries undergoing economic and political transformation. In addition, the model results imply that economic growth of developing economies is highly sensitive to global and internal political, social and macroeconomic shocks and risks (reflected in WUI) due to their unstable economic environment.

5. DISCUSSION AND CONCLUSIONS

Based on theoretical analysis of financial literature, basic assumptions regarding the relationship between monetary policy, stock market and the real sector of economy were defined taking into account the level of economic development in different countries. Using a set of macroeconomic variables and stock indices, which are widely utilized in studies, a range of mathematical models and methods was constructed to validate the initial hypotheses.

Our empirical study and modelling allowed us to arrive at the following conclusions regarding the relationship between monetary policy and stock market development:

As initially assumed, our study confirmed that key monetary variables, including interest rates and money supply, were important drivers of the dynamics of stock indices in samples of developed and developing economies. However, the direction and magnitude of their impact differed between two groups: a one percentage point increase in short-term rates would induce, on average, the increase in stock indices of developed countries by 4.8 p.p. or a 1.6 p.p. decline in developing countries, holding other factors constant.

Based on country-level analysis using vector autoregressive models, it was revealed that key monetary instruments (interest rates and money supply) exerted a statistically significant influence on stock indices in

8 out of 10 developed economies from our sample. It is worth noting that in most countries interest rates were a dominant and most efficient tool in stimulating the development of stock markets (as compared to managing money supply): the decrease in short-term rates under expansionary policy regime led to the growth of stock indices in the short term.

In contrast to the developed countries, such key monetary instruments as money supply and interest rates appeared to be effective only in several developing economies with a mixed contribution to stock markets evolution: expansionary policy led to the growth or decline in different periods. This tendency supports our initial assumption that in most developing countries monetary policy tools are not currently powerful enough to influence the stock markets, which may be due to an undergoing economic transformation, low liquidity, poor market infrastructure and transparency and other macroeconomic factors.

Stock indices, in turn, exerted a statistically significant reciprocal influence on the dynamics of interest rates and money supply in both developed and developing countries, which is generally in line with financial theory: a fall in stock values may lead to the deterioration of wealth and purchasing power, negative investment sentiment, decrease in consumption, deflation and, as the result, economic growth; whereas increasing business activities and spendings driven by growth of stock markets may cause inflation.

Using impulse response functions, it was recognized that stock index of the developed economy (the USA) would be sensitive to potential shocks transferred from monetary indicators or stock market itself and would not return to its pre-crisis level during the next 10 months. It was also revealed that stock indices in countries with lower level of economic development (e.g. Poland and Ukraine) will reflect only temporary fluctuations and return to its initial level within 10 forecast months, which confirms the hypothesis that their stock markets weakly react to monetary policy actions.

Based on scenario analysis, it was discovered that in the USA the expansionary monetary policy focused on interest rates management would be more beneficial for supporting the growth of the stock market during the next four quarters. However, monetary policy makers are significantly constrained by very low interest rates and may need to reshape their monetary policy or introduce additional fiscal stimulus for maintaining further growth. In order to mitigate a deceleration and facilitate the increase of stock indices in Poland and Ukraine, it would be more efficient to increase the money supply through expansionary monetary policy.

Finally, the study confirmed the hypothesis that monetary policy actions are further transmitted to the real economic growth through financial markets and other macroeconomic factors, including the control of corruption, net inflow of foreign direct investments, political and social shocks. It is worth noting that developing economies were highly vulnerable to social and political shocks, whereas the index of uncertainty appeared to be not significant for the economic growth of the developed countries.

Our empirical study helped to reveal the most efficient monetary policy tools for stimulating the growth of stock indices or mitigating the shocks inherent in capital markets for countries with different level of economic development, location and background. It was demonstrated that a weak response of stock indices to monetary policy actions in developing economies, especially through interest rate channel, reduces the ability of central banks to influence the evolution of capital markets using only monetary tools. In such an environment, other instruments of economic policy should be applied to stimulate the development of financial markets and facilitate the economic growth, including attraction of foreign investments, industrial recovery, maintaining political and social stability, development of stock markets infrastructure and banking sector stabilization. The implications of our empirical study may be useful for policymakers when implementing short-term action plans and constructing a long-term strategic roadmap for monetary and fiscal policies, especially in developing economies such as Ukraine.

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