Методи і моделі прогнозування

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МОНЕТАРНИЙ ТРАНСМІСІЙНИЙ МЕХАНІЗМ У КРАЇНАХ З НИЗЬКИМ РІВНЕМ ДОХОДУ ТА ЙОГО НИЗЬКА ЧУТЛИВІСТЬ

Аналізуються причини низького рівня чутливості основних каналів механізму монетарної трансмісії для країн з низьким рівнем доходу. Відзначається, що проблему низької чутливості імпульсу монетарної політики вбачають у короткій часовій історії макроекономічних рядів, що може зменшувати адекватність оцінок моделі, а також у недосконалій структурі фінансових ринків, значному контролі та втручанні центральних банків у валютний ринок. З огляду на ці гіпотези, з метою їх підтвердження була побудована модель структурної авторегресії SVAR. Проаналізувавши нещодавні дослідження у цій сфері, автор пропонує розглянути структурні обмеження як причини, що вплинули на зміни характеру і силу взаємовідносин між змінами механізму передачі шоку монетарної політики для таких країн. Серед головних чинників, що заважають ефективному проведенню центральними банками монетарної політики у країнах з низьким рівнем доходу, також слід назвати низький рівень розвитку фінансових інститутів та їх капіталізації, монополістичну конкуренцію на банківському ринку, а також недосконалість запровадженого монетарного режиму. Тому центральні банки цих країн повинні мати справу з порушенням традиційних взаємовідносин між макроекономічними змінами відповідно до економічної теорії та постулатів монетаризму. Зокрема, класичні порушення правила паритету купівельної спроможності є яскравим прикладом порушення цих взаємозв'язків. Паритетне ціноутворення на активи було спотворене через експансію фінансового капіталу, що спричинила зміни в умовах кредитування, в уподобаннях домогосподарств щодо заощаджень та в торговому балансі.

Як підхід до вимірювання взаємозв'язків між шоками змінних трансмісійного механізму було використано модель структурної векторної авторегресії (SVAR). Наприкінці статті коротко підсумовуються результати імпульсних реакцій змінних монетарної трансмісії для спостережуваних країн. Запропонована рекурсивна модель може бути застосована для моделювання функції реакцій монетарної політики для перехідної економіки з недосконалим фінансовим ринком. Наступним перспективним напрямом проведення дослідження з цієї проблематики стане включення до складу каналів передачі імпульсу монетарної політики таких змінних, як шок від монетарної політики, що здійснюється іноземними центральними банками, та шок від надходження фінансового капіталу.

К л ю ч о в і   с л о в а : трансмісія монетарної політики, шок монетарної політики, порушення правила цінових паритетів, країни з низьким рівнем доходу, SVAR

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THE LOW SENSIBILITY OF MONETARY TRANSMISSION MECHANISM IN LOW-INCOME COUNTRIES

The paper deals with the low sensibility of the main channels of the monetary transmission mechanism in in low-income countries. In the article, the hypothesis of low-responsiveness and disconnection properties between the variables of monetary transmission mechanism has been tested. For that purpose, into the sample, 6 low-middle income countries were included among which were Algeria, Bangladesh, China, Nigeria, Poland and Ukraine. Thus, with help of building a structural theoretical model, which is appropriate for low-income countries accordingly to their economic structure and institutions imperfectness, evidences were obtained that supported our assumptions.
As instrument of approving our hypothesis, the SVAR modelling approach was used with authors' restrictions on parameters of the monetary transmission model. The obtained results have suggested that the monetary impulse was poor to stabilize consumer prices fluctuations, foreign

exchange rate, at the same time influencing the increasing output gap, crediting slump and decrease in money supply. Also, the discretionary monetary policy approach was recognized as the main factor, in which make the pursuing of effective monetary policy as a very challenging issue for central banks in low-income countries. Estimations have approved the low level of credit channel responsiveness on interest rate impulse transmission and disconnection between prices level and real exchange rate fluctuations, which in line with theory of the law of the one price violations. Therefore, for to increasing efficiency of interest rate transmission, the rule-based approach of the determining key rate was suggested. Also, it was outlined that the problem of poor responsiveness of monetary policy transmission was merely regarded to the incomplete structure of financial markets, monopolistic competition in banking system and heavily controlled foreign exchange markets by central banks.

The proposed recursive empirical model can be applied to modelling monetary policy response function for transition economy with the imperfect financial market. The next perspectives of conducting research will be the including, into transmission channels, such the variables as the shock of monetary policies conducted by foreign central banks and the shock of financial capital spillovers.

K e y   w o r d s :   monetary policy transmission, monetary shock, purchasing power parity puzzle, low-income countries, SVAR

Introduction. The problem of low responsiveness of monetary transmission mechanism in low-income countries is mostly explained by a number of reasons: the low commitment of the central bank due to the lack of a trust of economic agents, structural transformation of the economy and poor development of financial markets. As a result, most channels of the transmission mechanism of a central bank's monetary policy became weaker and, thus, main targets are failed to be accomplished and a promotion of aggregate demand in fast-growing economies appears to be a very challenging issue by the reason of the absence of alternative sensible transmission channels. Thus, we may face a change in kind of conventional linkages within the monetary transmission mechanism, which usually works in advanced economies.

Also, the task of measuring response function of macro- and financial variables in a monetary transmission is further complicated if we will consider the influence of foreign monetary policy shocks spillover effect and a comovement between monetary policy shocks across the financially susceptible emerging countries. If emerging economy is more open and vulnerable, then the more monetary shocks spillover will be observed and cross-country comovement will be strengthened.

And it is common for various economic systems with , which including in a deep financial integration to infringe the rule of parity between purchasing power and uncovered interest parity, which puzzles leads to changes in the response sign of consuming and savings due to the irrational behaviour of economic agents in respect of the magnitude of real exchange rate volatility.

All the above mentioned encouraged us to formulate the goal of current research which consists in investigating obstacles in a way of monetary policy transmission in low-income countries and we set the subsequent task to consider in this paper, which lays on the examination of low responsiveness of the monetary transmission mechanism in low-income countries and recognizing the main factors of low impulse responsiveness of different channels.

Literature overview. We rely particularly on the findings of scientists, who have discussed the features of monetary transmission in the low-income less developed countries. Berg, Portillo and Unsal (2010), Andrle et al. (2013), who chose the theoretical approach. They developed a DSGE with the 4-equation structure for Kenya, Tanzania and Uganda. From this study, we took the assumption on the low responsiveness of credit channel to monetary policy shock in particular country. Next study, which was influential for us, had been provided by Obafemi and Ifer (2015) and they had constructed FAVAR (Factor-Augmented Vector Autoregression Model) for Nigeria [1], which was enlarged by

financial market factor's massive. Their paper has a common feature with previous work in that the authors additionally used, to estimate monetary transmission, the disaggregated dynamic stochastic general equilibrium model (DSGE).

Mishra, Montiel, Pedroni and Spilimbergo (2012) and Mishra and Montiel (2013) survey a large literature on the effectiveness of the monetary transmission mechanism (MTM) in low-income countries (LIC). They find that standard empirical methods, in the form of Structural vector autoregressions (VARs) applied to macroeconomic data, are consistent with weaker and less reliable MTMs in low-income countries than in high-income and emerging economies. And we will apply this approach in our research due to the lack of experience in calibrating DSGE models for LIC.

Authors find the following reasons for small responsiveness of MTM in LIC. The first argument, it is a short history of macroeconomic data series. Also, due to the incomplete database, they mean that monetary policy instruments tend to have small, but significant estimated effects on aggregate demand. However, these impacts are not precisely estimated, which leaves considerable statistical uncertainty about the true MTM. Mishra and et al. suggest two broad possible explanations for these findings [2, p. 117-118]:

1. "Facts on the ground" indicate that formal financial markets are small and poorly arbitraged in these countries, and many low-income countries (hereinafter LICs) maintain a regime of managed exchange rates. As a consequence, the link between the short-term interest rates that central banks can control and the variables that matter for aggregate demand (such as long-term interest rates, the exchange rate, prices on assets etc.) may be weak or absent. Especially the bank lending channel may tend to be weak if the formal financial sector is small, financial frictions are sharp and have a high impact on financial stability of financial institutions, and the banking industry is characterized by imperfect competition.

2. "Limitations of the method" explains that the MTM is not, in fact, weak, but the non-theoretically justified methods typically used to evaluate the MTM empirically are not capable of measuring its strength of impulse performance accurately in the research environment characteristic of LICs. If all above mentioned takes place, then it is the VAR evidence in LICs that is weak and unreliable, not the MTM itself.

In line with all said above, under the low sensitiveness of MTM, we understand low responsiveness or the disconnection between variables in a monetary transmission mechanism in low-income countries comparatively to high-income ones due to monetary regimes imperfectness and underdevelopment of incomplete financial market. The foreign exchange rate misalignments with prices and money supply, the disconnection between interest rates and CPI, uncovered interest rate puzzle provide ground to this low level of the monetary policy impulse transmission. Also, the imperfectness of financial institutions contributes to the strengthening of these effects.

Therefore, we must assume, which restrictions on interrelations among variables in MTM for low-income countries will be fair for employing in Structural VAR model in a next section.

As for Ukraine, the most influential research was provided by Paczynki Wojciech (2004), where, among challenging issues for Ukrainian monetary regulator, he recognized the absence of an appropriate structural model and emphasized on the lack of instruments for delivering monetary policy impulse response through interest rate channel [3, p.12]. The author suggested to addresses the experience of composing EDGE (Empirical Dynamic General Equilibrium) model in Finland, a small-scale macroeconomic model of Estonia, the Czech Republic and Poland. We added Poland in the countries panel with the aim to explore the effectiveness of MTM in the new growing economies in Europe. We have included also Poland.

The methodology of SVAR model building. Of course, the greatest impact on us was made by works devoted to modelling Structural vector autoregressions, well known as SVAR. Ananchitikul N. and Seneviratne D. have measured the response of domestic credit to changes in domestic monetary policy, and have accounted for the apparently weak credit channel at aggregate level [4, p. 14]. They have named this specification as a macro-level model. In this macro-level analysis, a vector autoregression (VAR) is applied to quarterly macroeconomic, seasonally adjusted data from nine Asia economies (Hong Kong SAR, India, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan Province of China, and Thailand) and five Latin America emerging markets (Brazil, Chile, Colombia, Mexico and Peru), and other emerging markets (Hungary, Lithuania, Romania, Russia, Turkey, South Africa), covering the period from the first quarter of 1995 to second quarter of 2014. Global variables and domestic variables included in the VAR are global commodity price index, US output, U.S. interest rate, domestic interest rate, domestic output, domestic prices, real bank credit, and the real effective exchange rate, where the global variables are assumed to be endogenous.

Next research is provided by Bin Grace Li, Stephen O'Connell, et al. (2016). It introduces a linearized stationary DSGE in four macroeconomic variables: the GDP gap, the inflation rate, the real exchange rate, and the nominal interest rate [5, p. 6-7]. The used panel comprised such low-income countries including as Kenya, Tanzania and Uganda, where revealed 5 effects on the inference of various sources of weak a monetary transmission where revealed, some of which are plausibly related to the structure of LIC economies and others to the characteristics of monetary policy regimes themselves.

In the quarterly model DSGE, proposed by Oksana Demchuk, Tomasz Łyziak et al. (2011) for Poland, the following variables were used: CPI, investment, consumption, GDP, WIBOR 1M rate and nominal effective exchange rate (NEER) [6, p. 23]. Authors consider the broad money as an endogenous variable, which is probably a little drawback of this econometric exercise.

In selected issues on Algeria prepared by IMF staff members, Amina Lahreche and Andrew Jewell, to the endogenous variables massive, had included log-linearized CPI, GDP, nominal effective exchange rate, required reserves and change in deposit auctions, discount and deposit auction rates [7, p. 10]. We think, that it was useful to assess effects of imposing banking normative on deposit base, but we want to explore mostly the response of broader money aggregates on monetary policy shock transmitting. But also exists another approach to modelling monetary transmission channel.

In the paper of Sadia Afrin (2016), to the needs of a monetary transmission modelling, such variables as nominal interest rate, M2 money, nominal effective exchange rate (neer), and output were all included in the transmission model. Deposit Money Bank's (DMB) credit to the private sector has been considered as the bank lending variable and the Consumer Price Index (CPI) as the aggregate price variable. The model also did not include any variable relating to the asset price channel, such as the share price index or house price index due to its insignificance for Bangladesh economy [8, p. 16]. This approach is closer to our approach, which will be applied in this paper, but we will additionally include the capital market variable with the aim to measure its significance for monetary transmission.

The Montiel, Mishra, Pedroni and Spillembergo (2012) approach is very useful in our research due do its systematic character and consistency. Reproducing their practice, we were interested in exploring the effectiveness in LIC countries at the first step of monetary policy transmission through the crediting channel, which produced impulse from monetary policy innovations to bank lending rates. We did not set an objective is to investigate whether the effects of monetary policy shocks on bank lending

rates systematically differ in low-income countries from what they tend to be in advanced and emerging economies, but we were very keen to explore whether these differences are consistent with conventional economics. In this scientific research, we abandoned employing the foreign monetary policy shock impulse into the recursive structure model (1).

The model proposed in this paper will synthesize the best of all above mentioned approaches and thus will include the following massive of endogenous variables: central bank interest rate, change in crediting levels, the real effective exchange rate, monetary base, nominal GDP, share index, and CPI.

The scheme of impulse movement is shown in fig.1, on which we will base our recursive model. Let make some remarks on the main idea of the mentioned graph. Monetary policy impulse transmits a signal, through the change in the changing worth of direct and indirect central bank instruments, and delivers ones to the variables of credit, money, foreign exchange markets and GDP. Firstly, the discount rate passes impulse to short-term loan rates and then has an influence on long-term and retail credits rates. At the same time, discount rate affects the change in the yields of deposit certificates issued by Central Bank, which changes the saving preferences of commercial banks and thus affecting the volume of excessive bank liquidity. In response, the money supply changes as well, which makes pressure on consumer prices shock. Through refinancing operation and sterilization intervention, Central Bank injects or absorbs liquidity in needed amount thus influencing money aggregate M3 and sizes of the volumes of the interbank foreign exchange market. This channel, by its own credit nature, directly impacts on the size of retail crediting and GDP growth. Foreign exchange intervention and Dutch auctions adjust the volumes of foreign exchange currencies on the interbank market, which define the future nominal foreign exchange rate. This impulse transmits nominal rate to the consumer prices moving them in the direction towards the targeted level.

But such instruments as refinancing, direct REPO and interventions are of a certain cost for the society, because they require from Central Bank to have a sufficient size of assets on its balance sheet and international reserves, which leads to increase agent in debt burden and foreign exchange rate shock, and sequentially in consumer prices shock.

Due to that reason, we have considered only one case of monetary transmission as transmission impulse from discount rate changing by monetary policy board, ommitting other direct regulating instruments. This could help to reveal the existing low sensitivity and disconnection problems among variables in MTM of LIC.
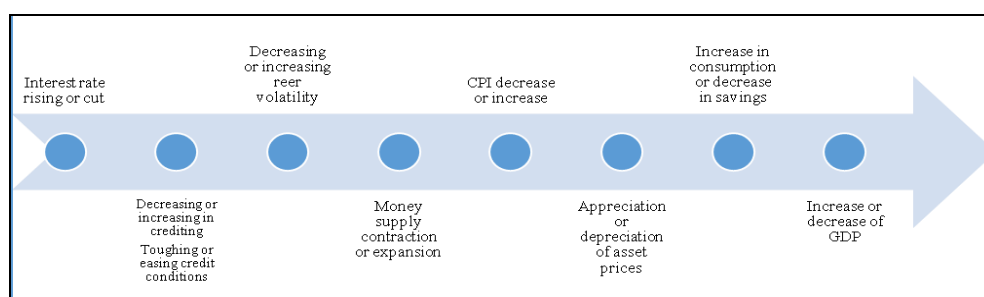
Fig. 1. Monetary transmission scheme in a theoretical aspect

Source: developed by summarizing sources [1-8].

For estimating the response between variables of MTM we will use a Structural vector autoregressive or SVAR model, where we will obtain, with help of Cholesky matrix, factorization of the structured matrix ordered accordingly to the level of the

strength of interrelation between shocks of exogenous and endogenous variables. The structure of SVAR will be as follows:

$$\begin{pmatrix} r_{t,i} \\ cr_{t,i} \\ reer_{t,i} \\ ms_{t,i} \\ g_{t,i} \\ p_{t,i} \\ sx_{t,i} \end{pmatrix} = A(L)^{-1}BY_{t-n} + \begin{pmatrix} e_r \\ e_{cr} \\ e_{reer} \\ e_{ms} \\ e_g \\ e_p \\ e_{sx} \end{pmatrix}, \qquad (1)$$

$$A(L)^{-1}B = \begin{bmatrix} * & 0 & 0 & 0 & 0 & 0 & 0 \\ * & * & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & * & 0 & 0 & 0 & 0 \\ 0 & * & * & * & 0 & 0 & 0 \\ * & * & * & * & * & 0 & 0 \\ * & * & * & * & * & * & 0 \\ 0 & * & * & * & * & * & * \end{bmatrix} \qquad (2)$$

Where i is the number of country in a panel, n - number of lags, r_{it} - interest rate, cr_{it} - credit change to basis year 2008, $reer_{it}$ - real effective exchange rate index, ms_{it} - money supply in levels to 2008, q_{it} - change in nominal GDP, p_{it} - consumer price index, sx_{it} - equity index, e_j - residuals from j-shock contribution. The asterisks in second equality indicate unrestricted to null value elements: for these elements, there will be computed coefficients. In such specification, we think it has two advantages: the absence of a mandatory obligation to set starting values for coefficients as in the dynamic stochastic model, in one hand, and on the other, it is more compactable.

The data panel included time series from 1993 to 2016 on a quarterly basis, retrieved from IMF International Financial Statistics and World Bank World Development Indicators data series releases. For World Bank data series, we have conducted a quarterly polynomial interpolation with help of function "interpSpline" in package "splines" in R software.

The reason by which we put credit ahead of output goes from the assumption that a quick pass-through of credit channel to aggregate demand takes place, as following the models of Safaei and Cameron (2003) and Berkelmans (2005). About foreign exchange rate channel, we want to test the sign of a response between interest rates, domestic credit, a lag of the real effective exchange rate, money supply and equity index with the aim to reject or justify the misalignments, which in some extent has evoked by foreign exchange rate volatility.

Country panel VAR model are estimated by putting variables in logarithms (the exception was made only for interest rates), assuming a recursive Cholesky decomposition with the ordering of variables as listed above.

Next, the impulse response function will be given in the following representation:

$$y_t = B \sum_{n=1}^{\infty} e_{j,t-n} \qquad (3)$$

where j is parameter instrument from set Y.

We will simulate 100 possible draws of impulse response function and only leave the reliable ones under MLR (Maximum Likelihood Ratio) identification test, which imposed a hypothesis on the significance of all priors. Also, the appropriate lag operator will be estimated with help of the Akaike informational criterion.

The proposed structural restrictions in the SVAR model is our author's view on the true level of response between variables of a monetary transmission in low-income countries, which will be proven in the section devoted to presenting empirical results.

The further structure of the paper is as follows: the next section Countries panel provides a description of chosen countries panel accordingly to their level of national income per capita and level of banking sector concentration due to simple and fair logic, that poor intermediation and limited competition in the marketplace may jeopardize the effectiveness of transmission of monetary policy to bank lending rates and provide evidence of a poor interest rate transmission. In the paragraph devoted to disclosing Empirical results will be described the results of SVAR modelling of identifying monetary shocks in our structural panel VAR context. In the concluding part, we will summarize all the above theoretical issues mentioned and match them with obtained empirical results.

Countries panel. We have left our choice on a group of low-middle income countries (accordingly to the new World Bank classification of countries by GDP per capita ratio), which with a similar history of the development of monetary regime and share of liquid reserves to total assets in the banking system. Accordingly, to Nasha Ananchotikul and Dulani Seneviratne (2015), the rate of negative classified assets in a system, on one hand, or share of liquid reserves, on the other hand, has a significant effect on the deterioration of credit channel responsiveness in a monetary transmission process. Therefore, increasing stake of NPL will scratch the effectiveness of transmission of the central bank policy impulses and provide high volatility of the real effective exchange rate, interest rates, real economic activity and stock indices.

We have chosen heterogeneous countries in terms of economic structure. The panel comprises Algeria, Bangladesh, Nigeria, Poland and Ukraine. Two economies in the panel were heavily dependent on proceedings from oil trade, it's Algeria and Nigeria, where such proceedings account for 15% and 50% of PPP adjusted GDP respectively [13]. Bangladesh is the mostly rural economy whose main exports include seafoods, rice, tea, and wheat, but also with a very big stake of textile export, small sale of gas and crude oil, and at the same time, being the share of sophisticated machinery lower than 1%. Ukrainian and Polish economies are agriculturally oriented having the shares of this sector 3.3% and 11.8% respectively with a growing share of servicing industry (from 8% to 19%), where the sophisticated industry of high-technology and software development accounts for 7,27% (2015) and 8,46% (in 2016).

The level of income in these countries varies from 2 310 (for Ukraine) to 12 680 US dollars (evidenced in Poland)[1]. We can admit that, during recent 4 years, the income per capita has gotten worse in Ukraine by 22,3 %, while for the other countries in the panel have experienced long series of increase in this figure: for Poland, at the rate of 4,4% annually within 10 years, which before slightly decrease in 2016, for Algeria at annual level of 3,7%, for Nigeria by 7,6% annually, but then income's value has slightly eased in 2016 on the level of 12,4%, and finally Bangladesh demonstrated growth at 9,1% of annual rate. Nevertheless, in 2017, situation has changed in a way that income in Ukraine increased on 17 % in 2017 from 2015 and now it overtakes this indicator in Bangladesh in terms of growth. The income level is a very important pattern for monetary transmission responsiveness due to reason that income spent by individuals takes part in making consumption costs or investment and then returns in the form of bank loans, thus supports the stimulating of an economic growth or hinders the monetary transmission.

If we speak about the problem of the financial sector of these countries, as we have mentioned above, it relates to the issue of undercapitalized and incompleteness of ones in terms of various financial instruments, which are to play the role of investment in-

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[1] Accordingly to World Development Indicators in 2016 and Atlas method of measurement.

struments, designed for firms and households. Given Bangladesh's nascent secondary bond market and smaller stock market capacity, non-financial firms usually rely on banks for financing. Therefore, the growing size of Bangladesh's banking sector and the bank competition indices increasing steadily to 35,9% annually during last 15 years indicate that the bank lending channel for Bangladesh is an interesting case to study.
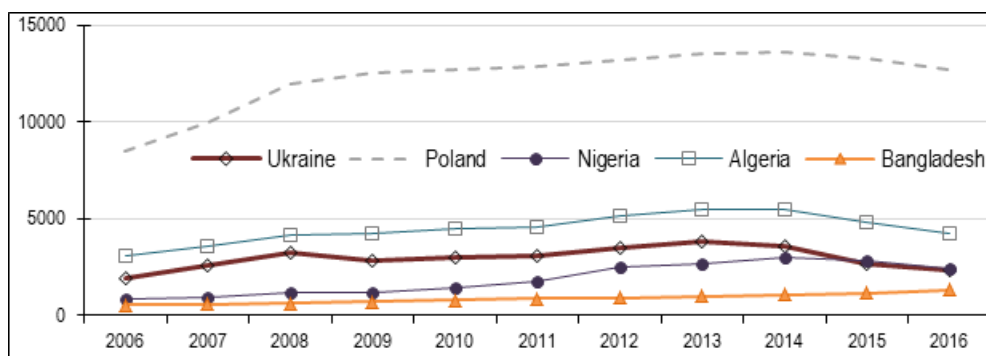
Fig. 2. GDP per capita ratio, in purchasing power parity US dollars measurement

Source: World Bank, World Development Indicators [14]
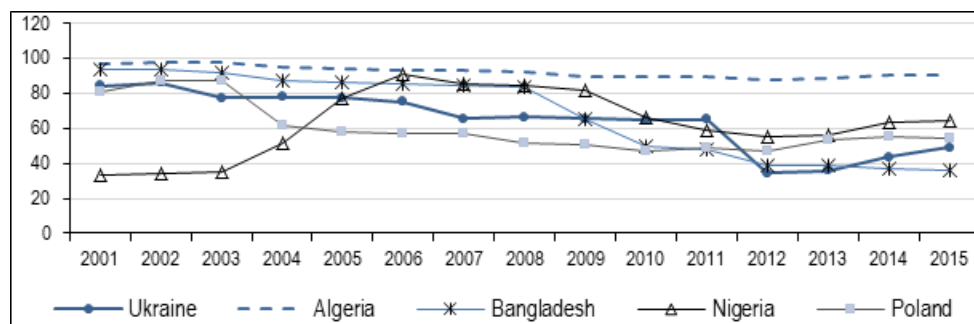
**Fig. 3. The share of the 5 biggest banks in the banking system
in observed countries,** *%*

Source: World Bank Global Financial Development data series [13].

In Algeria, the rate of Lerner index that measures the level of banking competition was at the level of 0.5, which makes obstacles to a sensible monetary transmission. In Nigeria, a stake of 5 main banks control at the banking sector as you may see on fig. 3 accounting for more than a half of whole assets, which indicates high oligopoly and, thus, may reduce the sensibility of bank lending channel due to low responsiveness of deposit and credit size growth at biggest banks to monetary policy of Central Bank. For Ukraine and Poland, this share is 39,2% and 38,2% (fig. 4) respectively in 2015, and thus the banking systems in these countries was characterized as a highly concentrated, which also reduces the sensibility of credit response to monetary policy adjustments.

Also, this countries panel varies in monetary policy regimes and stage of their development. The most progressive monetary policy regime is employed in Poland, which has to meet 5 necessary conditions for implementation of euro into the money circulation from and commits to meet inflation target within ECB headline level. Ukraine, after a forced step to release national currency rate into the free-floating, decided to gradually implement inflation targeting regime, which nowadays allows the opportunity to intervene at foreign exchange market. Other countries in the panel picked up the monetary

targeting regime with the high level of central bank intervention [8, p.14, 7, p.12, 1, p. 94]. Therefore, one country of the panel is pursuing a liberal regime of monetary regulation, while the other four have kept a very high level of interference into the financial market by Central Banks in times of foreign exchange market crisis and financial turmoil. In such manner, we have supported heterogeneous approach, which consists in comparing erosion of MTM under bipolar monetary policy regimes.
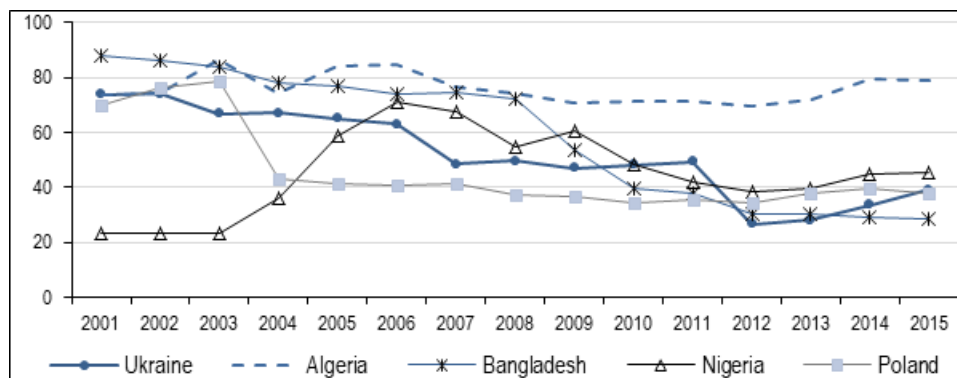

Fig. 4. Concentration level at the banking system in observed countries, *%*

Source: World Bank Global Financial Development data series [13].

The next figure demonstrates the average rate of reserving requirements in the banking system, which measured as a ratio of liquid reserves to total assets.

As to the sustainability of banking systems of observed countries, the level of liquid assets share in the system has convincingly spoken. The band of variation within the panel was from 10 to 20 % of reserves to banks' assets. The level of NPL varies from 60 % to 73%, which indicates to a high vulnerability of banking systems to monetary policy shocks and financial spillovers.

Also, we have included, as a yardstick, the modelling result for the Chinese economy as the second influential transitive economy in causing financial spillovers in all countries in the panel.

Research results. The data panel included time series covering 24 years of the period, which comprises time from 1993 to 2016 on a quarterly basis, truncated to equal samples in 95 quarters (if we take into account one lag). The first technical note to our modelling process is next. Due to low importance of stock exchange market in Algeria (accordingly to latest statistical publications, it has accounted for only 12 percentage points to GDP or 190 mln. US dollars in absolute terms in 2016 [16], while total deposits in banks account for more than 52%) the massive of stock prices was excluded from *recursive equation* (1). For Ukraine and Bangladesh transmission models, we kept the stock price indices due to a risen stake of the equity market in these countries in from 8,3-11,9% and 4,8 to 34,5% respectively[2]. Thus, with greater foreign exchange market and capital movement liberation, the attractiveness of investment into capital market of Ukraine and Bangladesh will grow, and so will the ratio of the significance of equity pricing to GDP will also gradually rise.

If we refer to the correlation analysis, we may summarize the following results (Appendix A.2). The non-standard results, which can be the best explanation of the monetary transmission low sensitiveness featured for low-income countries, were based on a strong positive correlation between the interest hike and changes in CPI.

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[2] From 2005 to 2017 accordingly to World Development Indicators of World Bank.

Apologetics of the Keynesian theory states that it happens due to rising negative expectations of economic agents, thus, in the next periods, prices will return to equilibrium level. Unfortunately, the price level very seldom goes in a backward direction by the reason of its non-stationary nature. In turn, domestic prices reach their equilibrium at a new level, obtained after consumer price shock propagation. It is an important conclusion, but such negative sign of a causal relationship is common for the mature economies. Our task is to find out such kind of causalities, which are only inherent for low-income transition economies.
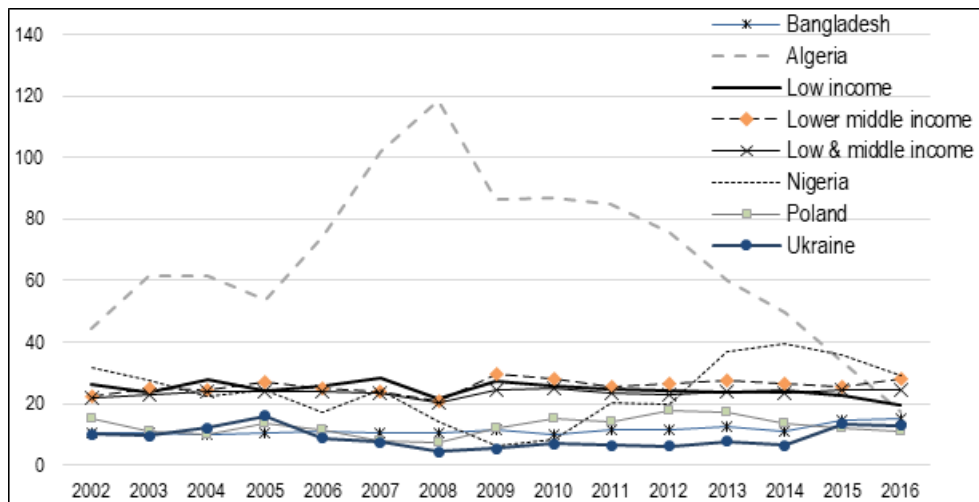

Fig. 5. Banks' liquid reserve to assets ratio, *%*

Source: World Bank World Development Indicators [13].

Next, the credit channel was proved to be negatively responded to movement in time series of broad money, thus, in transition economies, credit isn't the main source of expanding liquidity and monetary base in a wide sense.

A surprisingly low level of interdependencies has been found out between the rising volatility of the real effective exchange rate and money supply. In the case of Bangladesh and Algeria, this causality was obtained with a negative sign. Economic growth pure depends on credit expansion in such countries as Ukraine, Algeria and Nigeria, whilst the more than half of the correlation level between growth acceleration and credit channel was observed in China, Poland and Bangladesh.

For 5 countries of the panel, we have modelled a VAR and then, on this basis, a SVAR model was built with help of the minimization of LR function and with the inclusion of time trend and the constant term, while, for Poland, due to obtaining unbounded predictive intervals, we have applied the model without time drift and the constant term, but with the same number of lags.

The likelihood ratio test shows that the identifying restrictions are valid in all countries' models. In the next paragraphs, we discuss applications of the estimated model i.e. causality test, autocorrelation and heteroscedasticity test, impulse responses and variance decomposition to various innovations.

Further, after building the model, we have tested the one on existing of causality relationships in monetary transmission variables. On table 1, the Granger univariate test results were shown.

In accordance with the alternative hypothesis, which was approved by conducting special statistical tests and proclaimed that between monetary variables exists a deep

and robust interrelationship, evenly persistent to a violation of PPP (Purchasing Power Parity) and UIP (Uncovered Interest Rate Parity) puzzles.

The credit (except for China and Algeria, where monetary targeting is implemented), REER in case of Ukraine, Algeria, Nigeria and Bangladesh, GDP (in all countries), CPI (in Nigeria) and stock index are strictly exogenous. The interest rate time series is proven to be endogenous for Ukraine, Nigeria, Algeria and Poland, while, for Bangladesh and China, this factor is more dependent on the transmission of various shocks by nature. Therefore, we see that the more monetary policy is independent of other macroeconomic determinants than price stability the greater casual relationships between interest rate and macroeconomic indicators exist. It shows that in such countries, where approved a fact of multicausal relationships between macroeconomic variables, the multitargets monetary policy regime will be observed in these countries including such as foreign exchange targeting, the regime of monetary targeting and dual mandate on promoting economic growth or financial stability. But by its nature interest rate must be dependent only from inflation forecast. Also, we believe that money supply depends more on the values of its moving average, despite the fact that the value of critical statistics in cases of Ukraine, Bangladesh and China allowed to reject this hypothesis.

Table 1

Granger causality test on significant covariation relationships between monetary transmission variables

Country	Test statistics						
	interest	credit	reer	broad money	GDP	CPI	Stock index
Ukraine	30,75	5,71	10,96	0,31	0	0,04	0,00
critical value	37,96	2,26	18,06	0,00	8,76e-06	0,00	0,93
Algeria	2,09	10,16	2,01	0,07	2,88e-09	0,08	-
critical value	2,83	0,55	3,15	0,02	0,74	0,01	-
Nigeria	1,06	0,62	0,77	0,59	0,38	1,94e-03	0,05
critical value	1,06	3,53	2,08	0,38	0,71	0,59	0,73
Poland	4,03	5,04	4,78	0,06	6,29e-05	0,40	0,25
critical value	4,92	1,04	1,31	0,00	4,62e-05	9,04e-05	1,00
Bangladesh	4,62	0,04	1,46	0,40	0,44	1,00	0,00
critical value	0,98	0,03	5,72	0,00	1,00	0,19	0,88
China	7,02	6,29	9,03	1,56	2,47e-04	1,64e-04	0,11
critical value	4,37	4,54	1,73	0,00	2,02e-06	1,86e-09	0,16

Source: author's estimations based on [12-17].

For instance, Graziani A. (2003) [9] emphasized on a principal exogenous nature of money supply time series. But we see that critical statistics of broad money time series in Ukraine, Nigeria, Poland and Bangladesh significantly differs from Fisher distribution. Therefore, we documented the first non-standard result of classical casual relationships between such variables in MTM for developing low-income countries.

The most non-stationary time series were traditionally the REER, the money supply, output and inflation rate.

Stationary series of interest rate were stationary in the first difference and credit growth obtained in levels, and the stock index was stationary in levels for almost all countries without time drift and constant term (Appendix C.2).

It might be explained by the fact that the magnitude of volatility on capital markets in low-income countries was not so significant and was not necessarily threatened by spillovers from foreign financial markets due to the difference in the profitability of loan instruments with developed economies.

Therefore the volatility of indices of capital markets in these countries is not so high and not dependent on time.

Figure B.1 in Appendix B presents the impulses responses to a one standard deviation shock to the interest rate in Ukraine, where the baseline is solid line, along with the 95 percent (red coloured dashed line) confidence bands. We can admit that asset channel, the exchange rate channel and crediting volume are poorly dependent on interest rate innovation in Ukraine. The most hit on interest rate shock has the REER, credit, broad money and output in the next composition - 1,59, 1,47, 1,59 p.p. and 1,37 p.p. respectively.

The response of crediting to restrictive monetary policy was in the downward direction in the size of 20 p.p. until to the fourth quarter, while broad money has sharply increased by 33 p.p., but then it declined to start from the 3rd quarter. The real exchange rate starts to depreciate in the 3rd quarter and the rebounds to pre-shock level in the next quarter. Regarding GDP it has increased by 20 p.p. in the second quarter and only in the 3rd quarter it has been started to decline. The price shock translated into sharp increase in the 2nd quarter and then decreased in the 3rd quarter. The equity prices resulted in a 9 p.p. increase and then it began to decrease slightly. But we recognize that asset market in Ukraine isn't sufficiently enough developed, thus it is insufficient for monetary policy transmission.

Also, we conclude that for the creditors to change the credit conditions by creditors and for the borrowers to altering their needs by borrowers in borrowing require altogether at least 3 years after the implementation of the new policy rate.

Terms of trade in first have started to consolidate firm only after 4th quarter. The rise of interest rate led to a 7 p.p. decrease in the inflation rate and maintaining output growth pace before shock propagation. Also, we admit that monetary policy in restrictive mode will provide modest strengthening of the national currency in Ukraine, but in a medium-term perspective.

Figure B.2 in Appendix B presents the impulses' responses to a one standard deviation shock to the interest rate in Poland along with the 95 percent (red dashed line) confidence bands. For Poland, we have expected higher sensitivity for price channel, crediting, money supply and asset channel. The CPI channel is shown to be the most sensible in terms of innovations size and demonstrated a slight decline in 4th quarter. Then its response significantly increased in 8th quarter, i.e. the greatest effect from monetary policy will be reached in the second year.

This result contradicts to the conventional belief that growing interest rates affect prices towards rate rising influences in a price decline. Plausibly, such trend is in line with the anti-deflationary mode of conducting monetary policy in Poland. Assets were depreciating on a 214 b.p. in long-term starting from 1st quarter and starting to ease from 3rd quarter until to the third year. Therefore we can confirm the long duration of long-lasting life of monetary policy shock effect on the asset channel in this country.

Credits slightly decline, while broad money sharply declines in the second quarter and then does not expand till the 12th quarter. Predictive intervals are narrowing after 2 years of shock propagation to 3% in one side due to the enhanced autocorrelation statistics and heteroscedasticity robustness check by 5%[3].

REER remains almost unchanged in response to regulator policy, only with maximum response in 3rd year, which was depreciated at 33 p.p. The upper margin of REER volatility is 67 p.p. in the 5th quarter. Indeed the GDP responded in declining manner with showing sign of rebounding in the 9th quarter after the shock. Thus, the restrictive monetary policy only gains at 46 p.p. in size of inflation reduction and loses in GDP, credit volumes, and equity prices and does not affect the real effective exchange rate. REER is also disconnected with the level of gross consumption.

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[3] It has been compared statistics value of ARCH test as in Lütkepohl, H. (2006).

Nevertheless, the Polish case, due to developments in employing inflation targeting regime after a continuous period of perceiving European Monetary Mechanism, shows greater than in other countries credit and interest rate channels responsiveness and also disconnection problem is present between some macroeconomic variables.

The results for other countries are also supporting our starting point. In Nigeria crediting has in the first 2 quarters slightly increased and in 3rd quarter modestly slid down on 2 p.p., but then steeply contracted till the 12th quarter. Only on the 13th quarter bank lending volume was restored. Bank lending in Algeria responded with a 74% decline in the first 13 quarters, after the implementation of contraction monetary policy. In Bangladesh, situation is similar: the decrease fashion has been continued till to the 4th quarter, after that it settled down. In China, interest shock in first 5 quarters contributed to crediting decline, reaching the bottom at 2 p.p. In response to the credit decrease, the broad money also plunged in all observed countries, but with different lags of response: in Algeria it reacted immediately and lasted until the third quarter, in Nigeria till to the12th quarter, and in Bangladesh it contracted during 4th quarters. The half-life of interest rate shock duration for China on money supply was 6 quarters or a one and a half of a year. Price level decreased in Bangladesh's, and China's cases, but not in except of Algeria and Nigeria. In Poland and Ukraine, with fully-fledged inflation targeting regime, prices reacted in the former case with a decline, and in the later case with an increase way, but the volatility of prices did not exceeded 1,48%. The low volatility of REER may be explained by monetary policy shock that we tend to associate relate it to with the huge disconnection property between interest rate channel and foreign exchange rate.

GDP has significantly contracted in Algeria from first quarter after monetary policy shock and lasted 12 quarters. In Nigeria, economic slump started from the 2nd quarter and ended in the 9th quarter. For Bangladesh, the interest shock also contributed to the early contraction that started in the second quarter (1,7%). Therefore, aggregate demand plummets along with price inflation will produce a GDP gap in these economies, which will rise under inflation pressure increase. Thus, on one half the effect of the restrict monetary policy was positive only for the Chinese economy, where prices have been declined, but output also declined. As a comparison in Ukraine, the GDP started to decline from the second quarter and, for Poland, the loss amounted to 4 p.p. in the 6th quarter.

Stock prices firstly increased in Bangladesh, and Nigeria, then eased starting from 2nd and 4th quarters respectively. Chinese asset price channel responded by quick sinking with restoring confidence rising in the eighth quarter.

Summarizing all above, interest rate policy in all countries does not have sufficient effect on price and volatility of foreign exchange rate level, creates a gap in nominal GDP, after bank lending contraction and money supply reduction.

Therefore, central banks of these countries have to deal with a violation of the conventional relation between macroeconomic variables in accordance with economic theory and postulates of monetarism. Furthermore, the classical PPP puzzles have been also observed as in advanced countries and a key instrument to overcome this problem is to conduct transparent and consistent monetary policy with the aim to bring economic agents confidence in future price level changes and economic growth. Also the key rate of Central Bank should be determined in accordance with rule-based approach, but not by discretion.

Now we will focus on the results of factor decomposition of the impact monetary policy shock and other intermediate shocks in the transmission mechanism between aggregate demand and technology shock.

Table 2

Factor error variation decomposition of SVAR model specification for observed countries panel of aggregate demand and technology shock in the first lag, *%*

Variables/country	Ukraine	Poland	Algeria	Nigeria	Bangladesh	China
interest rate	0,03	16,92	2,74	0,81	0,85	31,43
credit	1,28	33,11	76,95	1,38	5,78	8,65
REER	0,73	9,97	0,32	0,33	0,88	7,97
Money supply	4,12	0,06	13,57	2,13	1,17	1,20
GDP	93,83	39,93	6,42	95,36	91,32	50,74
CPI	0,00	1,4·e-30	0,00	0,00	0,00	0,00

Source: author's estimations based on [12-17].

In the demand schedule, we see that, in the first quarter after an economic contraction, economic growth was the most influential factor in reducing the power of influence was in a technology shock, as in line with Santoro et al. (2014) in all countries in the panel with a variation from 76% to 96%. After the economic growth, in technological shock decomposition, the most significant in first quarter contraction was the money supply decrease as in Ukraine (4,1%) and Algeria (13,6%), interest rate shock as in Poland and China (16,9 and 31,4% respectively), and credit shrinking in Algeria, Poland and China (77, 33,1 and 8,7% respectively). Real exchange rate shock was the most influential factor in Poland and China at stakes of approximately 9% and 8% respectively.

Table 3

Factor error variation decomposition of SVAR model specification for observed countries panel of aggregate demand and technology shock in the fourth lag, *%*

Variables/country	Ukraine	Poland	Algeria	Nigeria	Bangladesh	China
interest rate	0,35	48,11	61,97	0,95	80,49	22,25
Credit	2,23	18,52	18,16	1,60	4,80	26,03
REER	1,57	5,94	14,96	0,35	0,20	7,36
Money supply	5,11	0,16	3,15	2,46	0,32	5,08
GDP	90,17	27,06	1,65	94,29	13,91	38,97
CPI	0,47	0,21	0,12	0,18	0,27	0,22
stock index	0,10	0,01	-	0,17	0,00	0,09

Source: author's estimations based on [12-17].

Starting from the 4th quarter, the impact of consumer prices increased, and, due to this, on the output and stock index fluctuations also amplified. The measured impact varies accounts from 12 to 47 p.p. for prices and up to 10 p.p. for equity indices. The most influential economic contraction due to the real exchange rate devaluation was observed in Algeria (14,9%), China (7,4%) and Poland (5,9%) in the 12th month after a term of trade shock. The stake of interest rate shock increased in Poland to above 48% as well as in Algeria and Bangladesh to 62 and 80,5% respectively. The own shock of production weakened in Poland, Algeria, Bangladesh and China.

In the 10th quarter, the power of interest rate shock rose in China, Poland, Algeria, Ukraine but has eased in and Nigeria. It should be noted Note, that countries, where evidenced slump after interest rate hike shock were placed in the order of descending weight of that impulse. Effect of real exchange rate fluctuation damage widens over time in Poland, Algeria and China. For Ukraine, REER volatility became insignificant for maintaining economic growth path and equals only 1,6%.

Later the indicative test for the responsiveness of monetary transmission mechanism became we have computed the structure of consumer price variance disturbances or known in economic literature as a cost-push shock (table 4).

Table 4

**Factor error variation decomposition of SVAR model specification
for observed countries panel of cost-push shock in fourth lag,** *%*

Variables/country	Ukraine	Poland	Algeria	Nigeria	Bangladesh	China
interest rate	11,43	9,11	10,23	3,44	4,51	1,20
credit	4,38	20,13	47,33	4,03	34,51	0,87
REER	1,02	55,37	2,42	0,91	1,14	2,03
Money supply	1,04	1,85	26,85	0,68	2,02	1,08
GDP	10,02	7,47	0,03	1,00	52,96	5,20
CPI	72,05	6,08	13,15	74,15	4,86	89,59
stock index	0,06	0,00	-	15,79	0,00	0,04

Source: author's estimations based on [12-17].

In a first quarter, the composition of shocks was in favour of GDP shock (Ukraine, Nigeria and China), interest rate shock (Poland and Bangladesh) and credit shock in Algeria. But then, in the fourth quarter, the main factors of maintaining price stability became the real effective exchange rate (from 1,02% to 55,3%), broad money (variation of shares from 1,04% to 26,9%) and equity index fluctuations (up to 16%). Nevertheless, to purify the path-through effect of REER and asset prices at the beginning of the year, at the end of the first year after the shock, the impact of these variables becomes more significant. Thus, the intervention of monetary policy authorities in these countries has to be applied, while it is not important in advanced economies with perfect and complete financial markets.

At the end of research, we have compared results obtained from ordinary unrestricted VAR and Structural VAR model. This exercise will showed the importance of such a model specification. Therefore, let us make some comments on changes in impulse response power of variables in monetary transmission, if we apply the structural model with accounting general price parity violation rules and low sensibility of price channel for low-income countries to interest channel impulse.

For Ukraine, Algeria, Bangladesh, Nigeria and Poland, responsiveness of credit channel has improved. For China's credit, channel response was still insignificant, but the test statistics gave a sign of improving. We think that, under the conventional monetary transmission model framework or monetary policy normalization, the crediting level in China at a more significant level will depend on Peoples' Bank of China's interest rate policy comparatively to other countries of the panel, which has no evidence then in the observed time period.

Disconnection in a real exchange rate volatility in the first quarter was been reduced in China, Poland, Nigeria and Ukraine. But for other countries exchange rate is indifferent to an interest rate transmission. The price responsiveness strengthens in Poland and Bangladesh, and at but a lower degree in other countries. Therefore, the low sensibility of MTM is predominant in our case. Finally, the sensibility of the asset price channel increases in all cases, exceptionally in the case of Poland. The coefficients of models and with significance test statistics could be provided on request delivered by the inquiring.

Thus, such identification of structural model as proposed in the specification (2) has interestingly resolves the problem of low responsibility of credit channel and asset prices disconnection due to the rising significance of disconnected variables such as a crediting, a foreign exchange rate, a money supply, a consumer price index and an equity index.

Discussion results and conclusions. We have obtained interesting results on the sensibility of transmission channels of monetary policies conducted in low-income countries. We have faced two well discussed in this field issues, such as like poorly developed financial markets and limitations on the application of existed monetary transmission

models, which works well only for developed and high-income countries. Also, it was evidenced, that monetary stimulus and contractions differently influence on the reactions of the credit, foreign exchange rate, asset channels and final consumption patterns. Empirical estimation has shown that contractionary monetary policy in all countries does not have sufficient effect on price and foreign exchange rate level, creates a gap in a nominal GDP, causes a bank lending contraction and a subsequent reduction in money supply. Thus, we have described the way by which impulse of the central bank in monetary policy rate in low-income country transmits to macroeconomic variables in form of proposed restrictions employed in the Structural VAR model. Also, we concluded on huge drawbacks of a contractionary policy for low-income countries, whose lose are much bigger then gain comparatively to high-income ones. Furthermore, we get a conclusion that approved the available disconnection properties between interest rate channel, prices and exchange rate, which we think appear due to the reason that the discretionary monetary policy approach is prevailing in these countries, rather than the more transparent and consistent rule-based approach. We admit that credit impulse has slowly increased its importance in all countries, which was taken into account in our research, but interest rate transmission in the unrestricted model is still less significant that it needs to be for conducting effective monetary policy. Another perspective of exploring this challenging problem is to include the variables of a financial market and foreign monetary policy spillovers due to reason that low-income economies in recent years tend to be more open for product and capital movements.

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Appendices

A. Data

Table A.1. Description of chosen data sample

Data	Description	Metadata long definition	Source
interest	in %, the annual rate	Lending rate is the bank rate that usually meets the short- and medium-term financing needs of the private sector.	International Monetary Fund, International Financial Statistics and data files.
CPI	in levels, 2008=100	Headline inflation, annual change.	National sources
broad money	in levels, 2008=100	Broad money (accordingly to IFS report of IMF) is the sum of currency outside banks and reserves.	International Monetary Fund, International Financial Statistics and data files.
GDP	in levels, 2008=100	Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2010 U.S. dollars.	World Bank national accounts data, and OECD National Accounts data files.
credit	in levels, 2008=100	Domestic credit to private sector refers to financial resources provided to the private sector by financial corporations, such as through loans, purchases of nonequity securities, and trade credits and other accounts receivable, that establish a claim for repayment.	International Monetary Fund, International Financial Statistics and data files, and World Bank and OECD GDP estimates.
stock index	in levels, 2008=100	Equity index.	World Bank data, Bloomberg,
reer	in case of Nigeria in levels, y-o-y, in logs	Real effective exchange rate is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs. Index is constructed in such manner, that increasement shows the revaluation, while otherwise- the depreciation.	International Monetary Fund, International Financial Statistics.
	in otherwise, index (2010=100)		
then all sample variables	*get in first differences and logarithmically smoothed*		

Table A.2. Correlation matrix of monetary transmission variables time series for observed countries panel

| Country	Variables	interest rate	credit	REER	Money supply	GDP	CPI	Stock index
Ukraine	interest	1	0, 5907	0, 6611	-0, 4049	0, 3429	0, 9572	-0, 4967
	credit	0,5907	1	0,8384	-0,0052	0,1341	0,6938	0,3179
	REER	0,6611	0,8384	1	0,0279	0,2422	0,7938	0,4104
	Money supply	-0,4049	-0,0051	0,0279	1	-0,4163	-0,3155	-0,2962
	GDP	0,3429	0,1341	0,2422	-0,4163	1	0,3496	0,3887
	CPI	0,9572	0,6938	0,7938	-0,3155	0,3496	1	-0,0210
	Stock index	0,4967	0,3179	0,4104	-0,2962	0,3887	-0,0210	1
Algeria	interest	1	-0,6594	-0,0515	-0,17752	-0,48385	0,9427	-
	credit	-0,6594	1	-0,0491	-0,2154	0,2025	-0,4418	-
	REER	-0,0515	-0,0491	1	-0,1095	-0,4999	-0,1092	-
	Money supply	-0,1775	-0,2154	-0,1095	1	0,1665	-0,2213	-
	GDP	-0,4839	0,2025	-0,4999	0,1665	1	-0,4866	-
	CPI	0,9427	-0,4418	-0,1092	-0,2213	-0,4866	1	-
Bangladesh	interest	1	0,0548	-0,1427	0,0829	0,0000	0,3709	-0,4967
	credit	-0,3042	1	-0,1728	0,0417	0,68 89	-0,5699	0,1827
	REER	0,3029	-0,1728	1	0,0514	-0,3205	0,2964	-0,7551
	Money supply	0,2117	0,0417	0,0514	1	0,0778	0,1915	-0,2689
	GDP	-0,4205	0,6889	-0,3205	0,0778	1	-0,4955	0,39
	CPI	0,3861	-0,5699	0,2964	0,1915	-0,4955	1	-03284
	Stock index	-0,3056	0,1866	-0,7551	-0,2689	0,3900	-0,3284	1
China	interest	1	-0,3160	-0,1710	0,5960	-0,5171	0,2199	0,8622
	credit	-0,3160	1	0,8414	0,0772	0,8052	-0,5792	-0,1802
	REER	-0,1710	0,8414	1	0,1640	0,6827	-0,5391	0,0610
	Money supply	0,5960	0,0772	0,1640	1	-0,0040	-0,1427	0,6654
	GDP	-0,5171	0,8052	0,6827	-0,0040	1	-0,5189	-0,3168
	CPI	0,2199	-0,5792	-0,5391	-0,1427	-0,5189	1	0,2246
	Stock index	0,8622	-0,1802	0,0610	0,6654	-0,3168	0,2246	1
Nigeria	interest	1	-0,1583	0,3965	0,3738	-0,2922	0,8657	-0,0360
	credit	-0,1583	1	0,0059	0,3296	0,0154	-0,2969	0,1400
	REER	0,3965	0,0059	1	-0,0930	0,0051	0,4167	0,3038
	Money supply	0,3738	0,3296	-0,0930	1	-0,0132	0,2588	-0,0509
	GDP	-0,2922	0,0154	0,0051	-0,0132	1	-0,2524	0,2764
	CPI	0,8657	-0,2969	0,4167	0,2588	-0,2524	1	0,0586
	Stock index	-0,0360	0,1400	0,3038	-0,0509	0,2764	0,0586	1
Poland	interest	1	-0,1655	0,4167	0,7209	0,2432	0,9786	0,4152
	credit	-0,1655	1	0,1186	0,1502	0,4289	-0,0777	-0,0054
	REER	0,4167	0,1186	1	0,5809	0,2489	0,4069	0,2110
	Money supply	0,7209	0,1502	0,5809	1	0,5890	0,7449	0,2060
	GDP	0,2432	0,4289	0,2489	0,5890	1	0,3252	0,1186
	CPI	0,9786	-0,0777	0,4069	0,7449	0,3252	1	0,3874
	Stock index	0,4152	-0,0054	0,2110	0,2060	0,1186	0,3874	1

Source: author's estimations based on [12-17].

**B. Structural VAR model of monetary transmission
in observed low-income countries**

**Fig. B.1. Structural VAR model for Ukraine impulse response functions
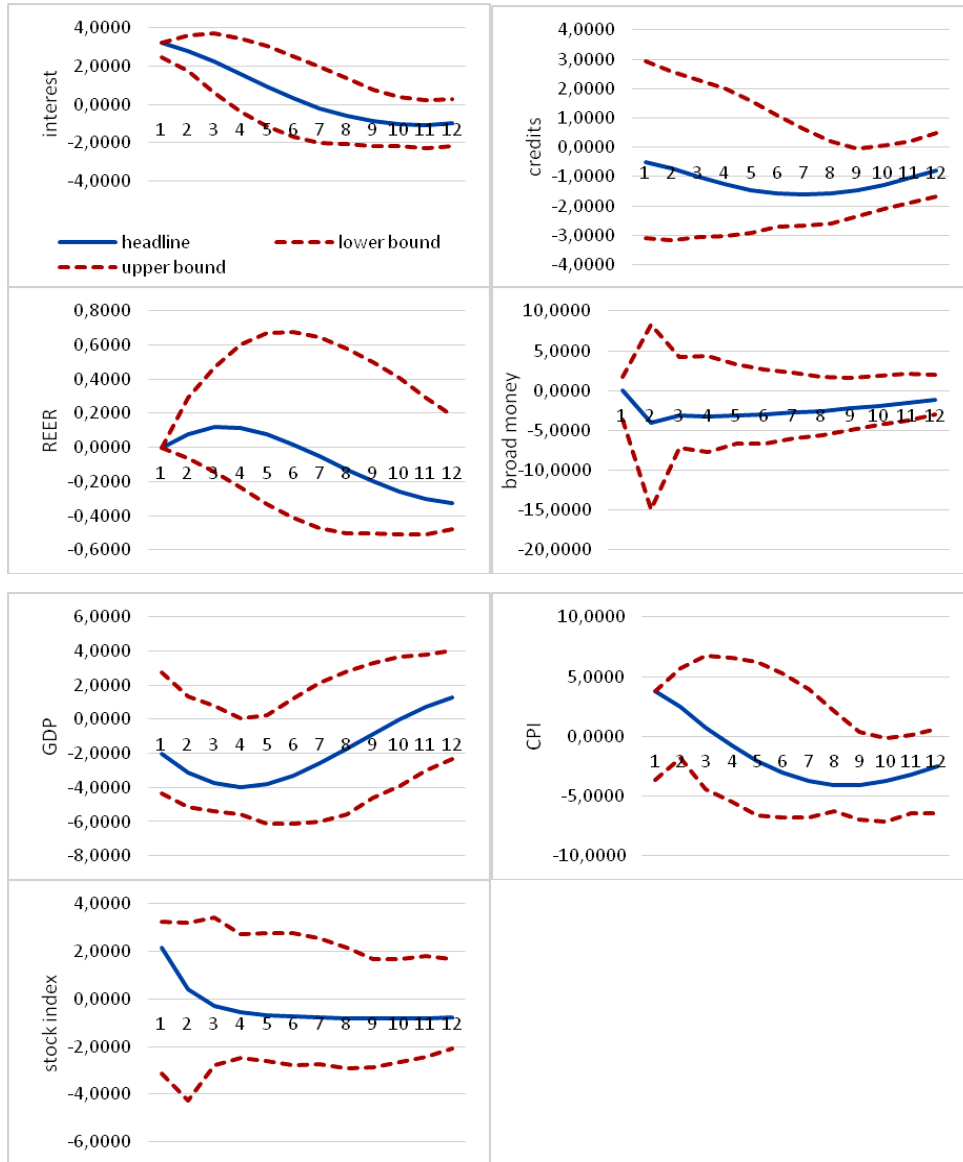with error bands on one standard deviation**

*Ortogonal Impulse Response from Interest rate
Ukraine*
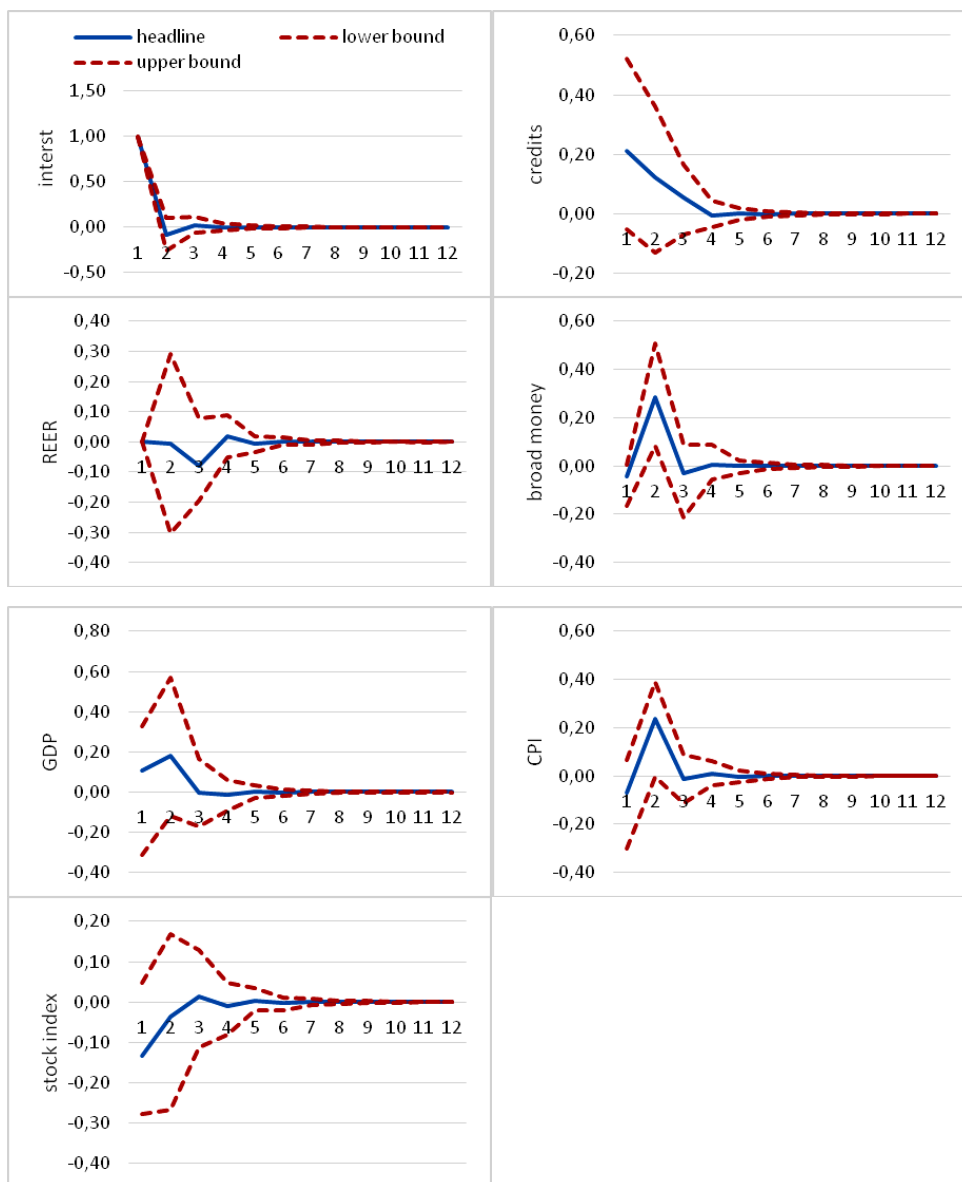
Source: author's estimations.

**Fig. B.2. Structural VAR model for Poland impulse response functions
with error bands on one standard deviation**

Ortogonal Impulse Response from Interest rate

Poland

Fig. B.3. Structural VAR model impulse response functions of monetary transmission in a rest of observed low-income countries

Ortogonal Impulse Response from Interest rate

Algeria

Ortogonal Impulse Response from Interest rate

Nigeria

Ortogonal Impulse Response from Interest rate

Bangladesh

Ortogonal Impulse Response from Interest rate

China
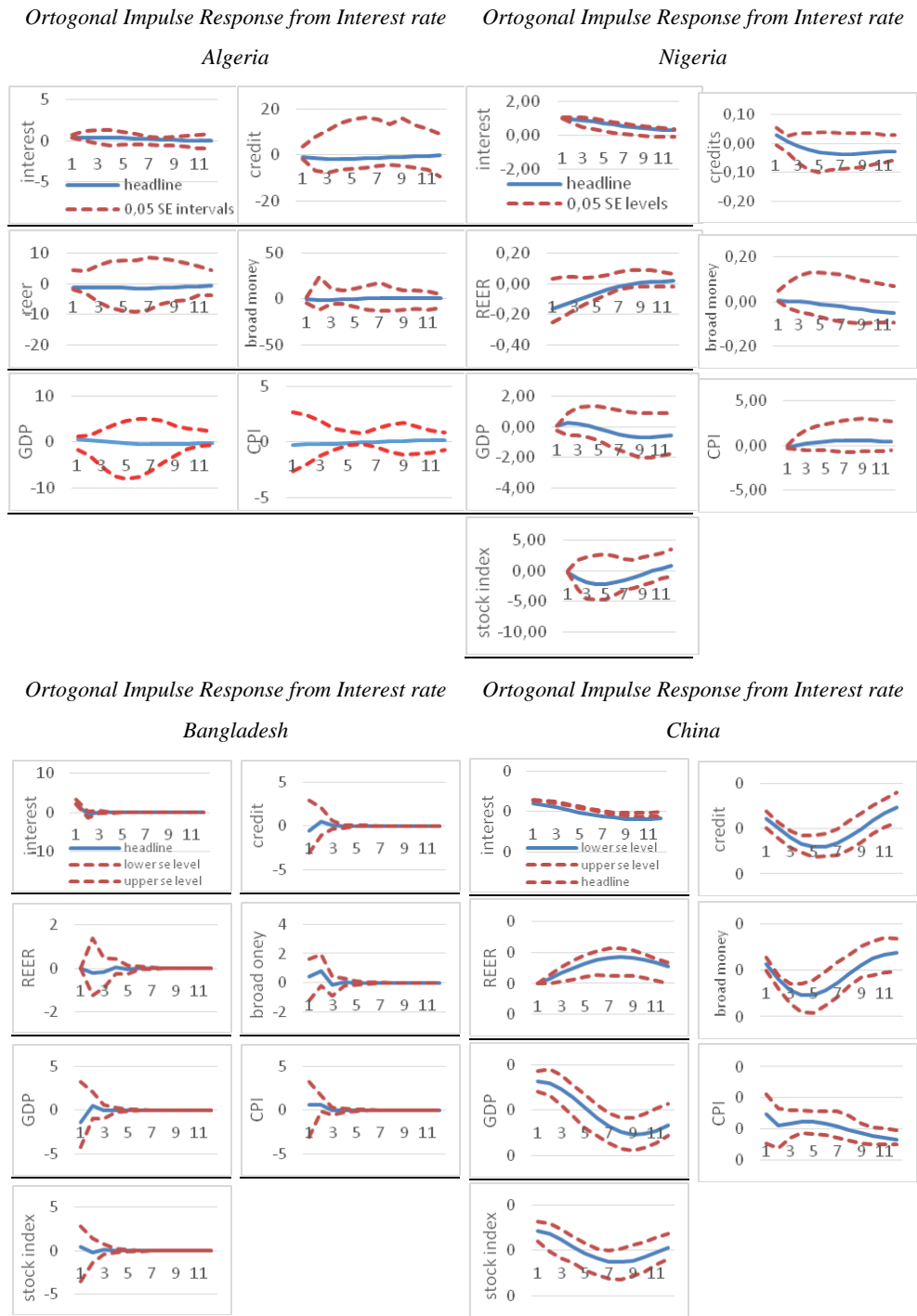
95% Bootstrap Confidence Interval, 100 runs

Source: author's estimations

C. Statistical treatment of cointegration and autocorrelation
of sampled time series

Table C.1. Dickey-Fuller test for I(0)

Country	Test statistics							MacKinnon critical value (.05 significance level)
	interest	credit	reer	broad money	GDP	CPI	Stock index	
Ukraine	-7,20	-3,22	-4,87	-12,38	-4,87	-11,92	-3,58	-3,5
Algeria	-6,59	-5,19	-5,44	-7,07	-7,62	-6,89	-	-3,5
Bangladesh	-3,68	-4,21	-6,40	-11,53	-4,41	-9,58	-3,68	-3,5
China	-3,82	-5,68	-5,73	-4,11	-4,61	-7,72	-5,95	-3,5
Nigeria	-8,56	-17,12	-3,29	-5,73	-11,34	-12,72	-8,56	-3,5
Poland	-3,75	-4,76	-4,44	-3,82	-7,94	-3,05	-3,75	-3,5

Source: author's estimations.

Table C.2. Dickey-Fuller test for the first difference I(1)

Country	Test statistics							MacKinnon critical value (.1 significance level)
	interest	credit	reer	broad money	GDP	CPI	Stock index	
Ukraine	-3,17	-5,44	-1,38	-3,40	-7,35	-5,60	-8,72	-3,15
Algeria	-8,54	-8,54	-8,97	-7,07	-7,62	-6,89	-	-3,15
Bangladesh	-6,73	-8,21	-14,53	-8,23	-8,30	-7,84	-11,73	-3,15
China	-9,60	-8,41	-9,16	-12,39	-9,84	-6,92	-8,37	-3,15
Nigeria	-8,79	-8,79	-8,46	-8,80	-6,38	-10,72	0,80	-3,15
Poland	-8,12	-10,86	-11,99	-7,86	-8,67	-5,43	-11,36	-3,15

Source: author's estimations.

Table C.3. Jarque-Berra test on normality and exogeneity of innovations e_{tj} distribution

Country	Test statistics							χ^2 statistics (.05, 2)
	interest	credit	reer	broad money	GDP	CPI	Stock index	
Ukraine	0,0941	*129,7841*	*23,967*	1,849	*18,01533*	3,669455	1,027975	4.7770
Algeria	*57.3860*	1.1037	3.9792	*54.4531*	0.5884	*4.9094*	-	4.7770
Bangladesh	3,4931	1,8435	*6,2366*	1,2366	1,9088	*23,6954*	1,8179	4.7770
China	*6,0042*	2,4621	*70,3228*	*31,1925*	4,6790	*86,6855*	20,6130	4.7770
Nigeria	0,9141	0,4805	1,0429	2,2224	1,0824	4,2169	2,2470	4.7770
Poland	1,9628	*55,7582*	0,1702	0,9882	*277,3306*	*29,0645*	*18,5230*	4.7770

Note: italic font has been used for demonstrating the persistence of the autocorrelation in disturbances of j shock

Source: author's estimations.