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THE CONTRIBUTION OF MONETARY POLICY TO MITIGATING THE CONSEQUENCES OF THE WORLD ECONOMIC CRISIS IN POLAND

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Review paper

Abstract: The economic authorities of each country seek to maintain the expansion phase through the implementation of various economic policy measures, namely, to prevent or mitigate the recessionary phase in economic development. In that context, it is of considerable importance to understand how monetary policy decisions affect the movement of macroeconomic variables. The paper aims to examine and evaluate the contribution of monetary policy to mitigating the effects of the global economic and financial crisis, using the Autoregressive Distributed Lag model, by analysing the impact of the real exchange rate, reference interest rate and money supply on the level of economic activity in Poland. Econometric analysis encompasses the period from 2006 to 2017. The research results suggest that there is a significant relationship between real economic activity and the real exchange rate both in the short and long term, but not between the reference interest rate and the money supply.

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Introduction

One of the main goals of the economic policy makers of each country is to achieve internal (price stability and full employment) and external balance (balance of payments), with steady economic growth. The global economic and financial crisis that emerged in the United States in 2007 swiftly spread from the most developed countries to the whole world, generating significant economic disruption. Although it reached its peak in most European countries in 2009, by 2008 many countries were showing classic signs of an economy in recession: economic growth stalled and turned negative, demand for labor decreased, unemployment rate rose, banks became restrictive in lending and capital inflows declined. In these circumstances, economic authorities most often find swift responses and solutions within monetary policy.

In order to be able to apply effective monetary regulation instruments and respond quickly to emerging disorders, monetary policy, as an important segment of economic policy, must be sufficiently flexible (Dušanic, 2001). The degree of flexibility of monetary policy is, to a significant extent, determined by the exchange rate regime applied. The exchange rate regime affects not only the movement of the exchange rate, but also the volume of money supply and the level of interest rates, on which price stability, economic growth and employment depend. Due to the monetary authorities' orientation to defend the official exchange rate, fixed exchange rate regimes leave no flexibility for monetary policy to respond to economic shocks, especially the negative ones, through the use of monetary instruments. The floating exchange rate regimes not only mitigate the effects of external shocks on the national economy by changes in the nominal exchange rate, but concurrently free up the monetary policy to achieve the country's internal and external economic goals.

The experience of Poland has shown that this country has successfully dealt with the global economic and financial crisis by applying a floating exchange rate regime. The Polish economy is one of the few that has escaped the recession, but due to the problems of the Eurozone countries, due to the dependence on exports to the markets of those countries, it was going through a phase of somewhat slower economic growth accompanied by mild deflationary pressures. The research on the behavior of monetary authorities reveals that during the crisis the National Bank of Poland, in order to stimulate investment activity and spending, reacted by applying a traditional monetary policy instrument and the reference interest rate, in a manner resulting in a shift towards its reduction. Moreover, the research has shown that in addition to the monetary expansion mechanism and in order to prevent recession, the monetary authorities of Poland also used a mechanism to devalue the national currency, allowing a significant nominal depreciation of the zloty.

The reference interest rate reduction policy, including the policy of weakening the national currency against the dominant world currencies, suggests that, under the influence of the world economic and financial crisis, in line with economic

theory, the National Bank of Poland has opted to increase the aggregate supply of money as to prevent recession and improve macroeconomic performance. However, monetary policy can have a positive effect on real economic trends if it is synchronised with other segments of economic policy and if the appropriate monetary regulation instruments are applied in a timely manner (Dušanic, 2001). In view of this, the aim of this paper is to examine and evaluate the scope of monetary policy in preventing the recessionary phase in Poland's economic development. In other words, the paper should analyse, reveal and explain the extent to which the instruments of monetary regulation, including the movement of the nominal zloty exchange rate, contributed to maintaining the stability of the Polish economy, under the influence of the crisis. The current monetary policy framework, financial market development, growing trade and financial openness, in the context of the global economic crisis, the policy of increasing aggregate supply of money aimed at stimulating aggregate demand, had a positive impact on the output, without creating considerable inflationary pressures.

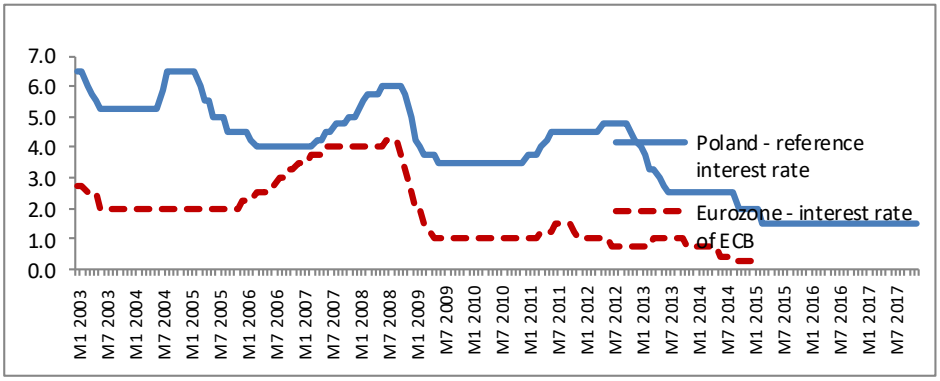
The paper consists of the three parts, in addition to the Introduction and Conclusion. The first part of the paper discusses the macroeconomic performance of Poland and analyses the response of monetary authorities to the global economic crisis. *The second part* of the paper presents an overview of the main results of the previous research of the effects of Poland's monetary policy on basic macroeconomic indicators. The third part describes the data sources and research methods and by using a statistical tool and, by examining the impact of the real exchange rate of the zloty, the monetary aggregate M1 and the reference interest rate on real GDP movements, it evaluates the effectiveness of Poland's monetary policy, in the circumstances of and after the global economic crisis. The Conclusion summarizes the key findings of the research.

1. Development of monetary policy and macroeconomic performance of Poland

The exchange rate regime has a significant impact on the degree of independence of monetary authorities in regulating the issue of money and in conducting monetary policy in order to achieve economic goals. During its transition path, Poland has very successfully adapted its exchange rate policy in order to achive internal and external balance. At the beginning of the transition process, Poland used a fixed exchange rate regime in a conventional form to curb inflation and restore macroeconomic stability. After the initial macroeconomic stability was established, the high inflow of capital from abroad, encouraged by price stabilization and continued structural reforms, led to strong economic growth. Monetary authorities have embarked on the gradual abandonment of fixed and acceptance of more flexible forms of exchange rate regimes - the crawling peg, the crawling band, and finally the floating exchange rate regime that still in use today

(Bańbuła, et al., 2011). In an advanced phase of transition, in April 2000, Poland finally switched to the freely floating exchange rate regime, under the pressure of a growing foreign trade deficit caused by relatively high economic growth rates, based on foreign capital inflows and domestic consumption growth that relied heavily on imports, combined with a gradual but not rapid decline in inflation which pressured the appreciation of the real exchange rate of zloty. In implementing monetary policy, Poland already started implementing inflation targeting strategy in 1999. In order to maintain the inflation rate within the projected inflation corridor, which has been at a constant 2.5% ± 1 p.p. since 2004, the central bank uses the reference interest rate as the basic instrument in conducting monetary policy. The Central Bank of Poland has maintained its ability to intervene in the foreign exchange market if it deems necessary to achieve the inflation target. This means that the central bank sets a key short-term reference interest rate, allowing the market to further determine other interest rates in the economy.

Chart 1. Reference interest rate of the NBP and ECB, annual percentage



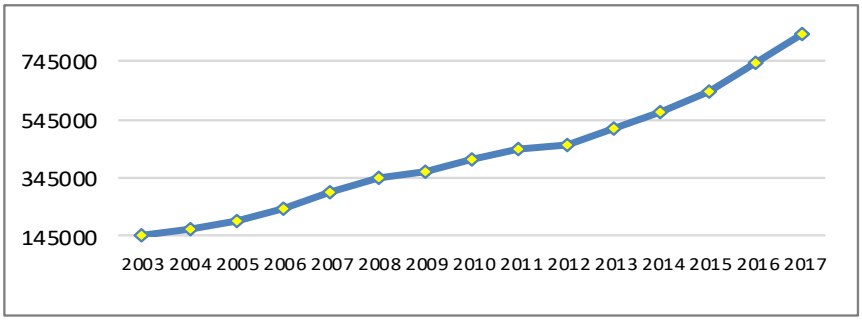
Source: Authors' analysis on the basis of data from International Financial Statistics – IMF (2018).

Analyses show that Poland has been successfully coping with the global economic and financial crisis by applying a floating exchange rate regime. The Polish economy is one of the few that has escaped the recession. In the context of the global crisis, the research reveals that monetary authorities of Poland, in an effort to secure stable economic growth through the impact on aggregate demand (investment and consumption), made frequent reductions in the reference interest rate, which, in the relatively short term, was reduced to 3.5% in October 2009, compared 6% in October 2008, and remained at that level until the end of 2010 (Chart 1). However, the reference interest rate was kept at a slightly higher level than the reference rate of the European Central Bank (ECB), which dropped from 3.75% to 1% over the period. Such a reference interest rate policy of the NBP had

its positive side, because through the influence on interest rates in the money market it attracted foreign capital and at the same time discouraged its outflow.

In the circumstances of the reduced inflow of capital, the fall in the reference interest rate had a positive effect on maintaining the tendency of money supply growth. Money supply, as measured by monetary aggregate M1 (Chart 2), in the 2008 crisis, increased significantly compared to the previous year.

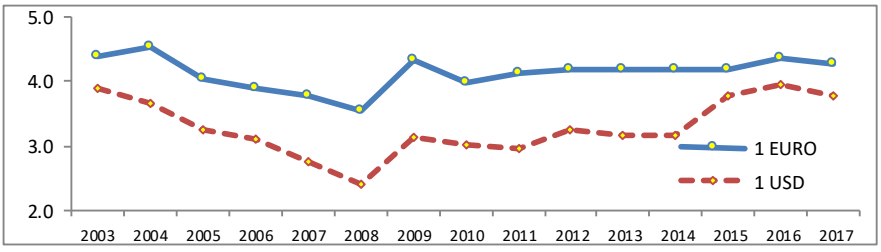
Chart 2. Money supply, measured by monetary aggregate M1, average annual amount, mill. PLN



Source: Authors' analysis on the basis of data from NBP (2018).

The rise in the money supply has certainly had a significant impact on the nominal exchange rate movement, with the fall in the reference interest rate. Almost at the same time as the monetary authorities were making shift in interest rate policy, a strong nominal depreciation of the zloty followed, so that in 2009 compared to 2008, the average annual value of the zloty fell by 23% against the euro and 29% against the dollar (Chart 3). This leads to the conclusion that the monetary authorities of Poland, in addition to the mechanism of monetary expansion, also used the mechanism of the national currency devaluation, allowing significant nominal depreciation of the zloty, on the pretext of preventing recession and short-term improvement of macroeconomic performance.

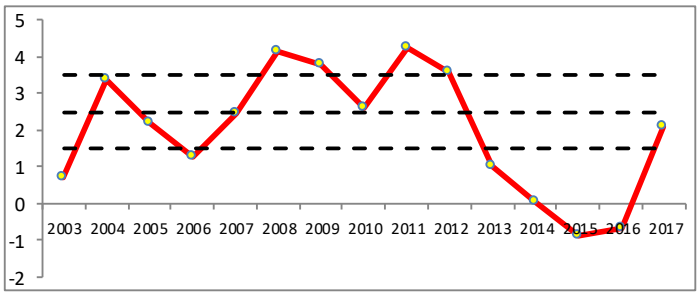
Chart 3. Nominal exchange rate PLN/EUR and PLN/USD, annual average



Source: Authors' analysis on the basis of data from International Financial Statistics - IMF (2018).

Chart 4 shows the movement of consumer prices in Poland, and it can be observed that the fall in the reference interest rate and the strong nominal depreciation of the zloty, contrary to the suggestions of economic theory, were not accompanied by a significant rise in prices, viz. by strengthening inflationary tendencies. On the contrary, the average annual inflation rate dropped from 4.2% in 2008 to 3.8% in 2009. However, it should be noted that the inflation rate is above the projected inflation corridor.

Chart 4. Consumer price movements in Poland, percentage change

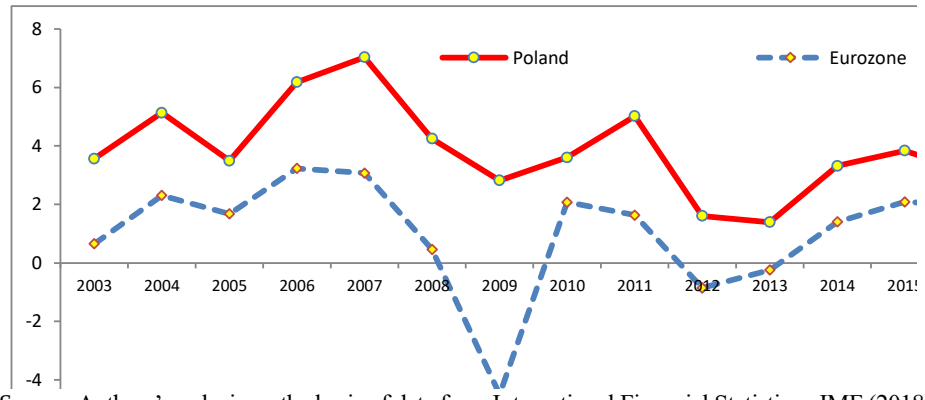


Source: Authors' analysis on the basis of data from International Financial Statistics - IMF (2018).

Given that during the crisis, the inflation rate was above the projected inflation corridor, the movement of the reference interest rate, as the main instrument of monetary policy, suggests that, in the context of formal inflation targeting, the focus of monetary policy was not on controlling and keeping the inflation rate at the low level. In her paper, Mackiewicz-Łyziak (2017) concludes that due to the influence of the crisis there has been a change in the preferences of the monetary authorities of Poland in terms of giving more importance to production over prices. Namely, in contrast to the prerecession period, in which the reference interest rate was adjusted to ensure price stability, in times of crisis, production becomes more important. The research results reveal that interest rates were around 2 p.p, in the first quarters after the crisis began, less than they would be if the central bank had not changed its preferences under the influence of the crisis.

While under the influence of the global economic crisis, many countries have recorded a decline in economic activity, Poland has achieved positive real GDP growth rates (Chart 5). Through reducing net capital inflows and export demand, the global economic and financial crisis has slowed, but not halted, Poland's economic growth so that the real GDP growth rate was reduced from 7% in 2007 to 2.8% and 3.6% in 2008 and 2009, respectively. The recovery of the world economy, which meant an increase in exports for Poland, but also an increased inflow of capital, had a positive effect on economic activity, so that in 2010-2011, real GDP grew at an average rate of 4.3% per year, which can be estimated as a relatively high performance.

Chart 5. Real GDP growth rate in Poland and the Eurozone



Source: Authors' analysis on the basis of data from International Financial Statistics - IMF (2018).

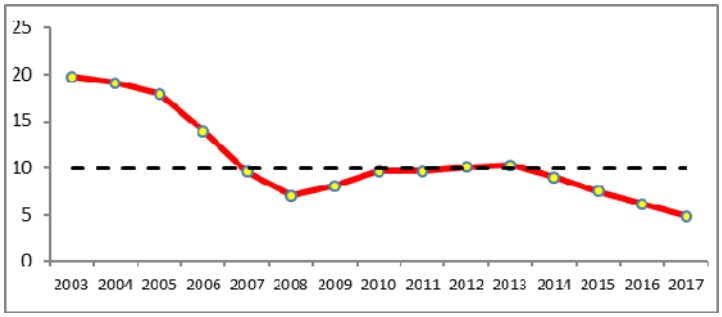
Growing economic activity, fueled by capital inflows and increased export activity, pressured inflation rate to rise, breaking the projected inflation corridor by 4.2% in 2011. Believing that a continuation of the policy of reducing the reference interest rate and/or keeping it low would affect further warming of the Polish economy, which already had relatively high growth rates, the monetary authorities decided in early 2011 to gradually increase the reference interest rate, so it stood at 4.5% at the end of the year.

Due to the problems of the eurozone countries affected by the new second wave of the crisis in 2012 and 2013 and owing to the high dependence on exports (about 53-56% of total exports) to markets and the inflow of capital from these countries, Poland was going through a phase of slower growth with real GDP growth rates of 1.6 to 1.4%, respectively. Practically, the crisis affecting the European financial system has produced difficult borrowing by Polish banks abroad, which has led to a decrease in the volume of loans. This resulted in a decrease in investment and, in combination with a negative effect on exports, led to a significant slowdown in real GDP growth. In order to revive investment and economic activity, such a situation required changes in monetary policy. Under the pressure of slow economic activity, a policy of reducing the reference interest rate ensued so that from October 2012 to the end of 2017 the reference interest rate dropped from 4.75% to 1.5%.

Expansive monetary policy, with some time lag, has contributed to the growth of economic activity. Macroeconomic data show that between 2014 and 2017 there was a real economic growth with an average annual GDP growth rate of 3.7%. Despite the expansionary monetary policy, the relatively slow recovery of the euro area countries' economy, followed by declining oil and food prices in the world markets, was followed by deflationary pressures that resulted in a fall in inflation and its transition into deflation, which lasted from 2014 to 2016.

The specificity of developments in the real sector of the Polish economy stems from movements in the unemployment rate. The global economic and financial crisis has not produced a significant increase in unemployment, without causing considerable distortions in the labor market, in terms of deterioration, so that the unemployment rate at the level of about 10% remained in the 2009-2013 period. Chart 6, which depicts the unemployment rate, clearly shows that since 2014 the tendency of its decline has been established, so at the end of the mentioned period it was about 5%, which is its lowest level since 1991, classifying thus Poland among the countries with low unemployment rate.

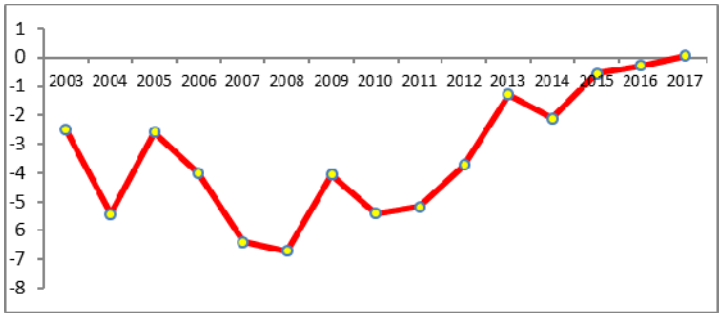
Chart 6. Unemployment rate in Poland



Source: Authors'analysis on the basis of data from International Financial Statistics - IMF (2018).

As regards the external plan, the general tendency of the nominal depreciation of the zloty, followed by the disinflation process since 2012, meant greater purchasing power in the country than abroad, which discouraged imports and had a positive effect on the competitiveness of the Polish economy's export sector, thereby contributing to a tendency for a gradual decrease in the current account deficit, which was completely eliminated in 2017, for the first time since 1991 (Chart 7).

Chart 7. Current account balance, % GDP



Source: Authors'analysis on the basis of data - IMF (WEO 2018).

2. Literature review

Numerous studies are available that have analysed the impact of monetary policy on basic macroeconomic variables in Poland. Lyziak et al. (2008), using monthly data, performed an analysis of the monetary policy transmission mechanism in Poland for the period from early 1997 to March 2006. The impact of changes in interest rates and exchange rates on industrial production and consumer prices has been analysed. The research results show that production, with some time lag (up to 12 months maximum), responds to a short-term interest rate shock. The impact of the PLN/EUR exchange rate on production is greater than the impact of the PLN/USD exchange rate, which confirms the importance of trade with EU countries, especially the euro area. Furthermore, the results suggest that the impact of monetary policy on loan supply is weak.

Demchuk et al. (2012) assess the basic characteristics of the monetary policy transmission mechanism in Poland during 1998-2011. The results based on both monthly and quarterly data show that interest rates have a statistically significant impact on prices and the real economy (industrial production, GDP). In particular, negative monetary shock causes a significant drop in GDP after 4 quarters and a rise in prices after 6 quarters. The shock of interest rates leads to a statistically significant decrease in investment and consumption, with investments showing a significantly stronger response than spending. In addition to that, the rise in interest rates was followed by appreciation of the zloty, followed by a significant depreciation - as a result of deteriorating economic fundamentals.

Analysing the impact of interest rates and exchange rates on production and prices in the Polish economy, in the period from 1996 to 2012, Arratibel & Henrike (2013) noted that the sensitivity of production and prices to interest rates and foreign exchange rate is variable over the time. A change in the exchange rate, defined as appreciation of the nominal effective exchange rate of 1% over time, has a significantly different effect on production. In the period from 1996 to 2000, the negative impact of the exchange rate on production prevailed (due to the impact of appreciation on the decrease in exports), while the positive impact of the exchange rate on production (through the influence of appreciation on the reduction of interest rate) prevails during 2000-2008. The results also indicate that the effects of changes in interest rates and exchange rates on prices have been declining over the time, thus confirming the general conclusions presented in the literature on reducing inflation following the appreciation of the zloty.

In their work, Kapuściński et al. (2014) analyse the monetary transmission mechanism in Poland, from 2001 to 2013. Analyses show that the impact of the exchange rate on export volumes has been diminishing over the time - in 2013, the exchange rate explained about 23% of export growth, compared to almost 40% in 1998. According to the authors' estimates, 10% depreciation of the real effective exchange rate results in an increase in GDP growth of about 0.3 p.p., after one

quarter. Furthermore, empirical results indicate that changes in interest rates have a statistically significant effect on economic activity (GDP and industrial production). An analysis of the effectiveness of monetary transmission channels in Poland shows that the exchange rate was the most effective monetary transmission channel by November 2008. The financial crisis has significantly reduced the efficiency of both monetary and exchange rate channels by 55% and interest rate channels by 50%. The decline in the efficiency of interest rate channels can be attributed to cyclical factors: prolonged low economic activity in developed countries combined with increased uncertainty discourages companies from investing despite adjusted monetary policy.

3. Empirical Research

a. Data and research methods

In order to examine the effects of monetary policy on the Polish economy, the paper analyses the impact of the real exchange rate, the reference interest rate and the monetary aggregate M1 on real GDP growth. To obtain acceptable and logical results, other determinants of economic growth that are otherwise used in research where economic growth is a dependent variable are also used. These are first, gross fixed capital formation, budget deficit and economic growth in the EU countries, as a variable of environment.

Variables expressed in absolute values in econometric analysis are used in logarithmic values. In order to ensure an adequate length of the time series and thus the reliability of the research results, quarterly data for the period 2006-2017 are used in the analysis. With a view to isolating the seasonal effect, variables that are seasonally adjusted are used, viz. the one that do not contain the so-called "seasonal effect".

The economic growth of the European Union certainly has an impact on the economic growth of Poland, which in this case can be considered as a variable of the external environment. Poland's gross domestic product accounts for only about 3% of the European Union's GDP. The initial assumption about the impact of individual variables on Poland's economic growth is that higher real economic growth in EU countries also means higher real GDP growth in Poland. The assumption is that larger investments mean greater economic growth, with investments having not only direct, but also indirect, multiplier effects. Theoretical opinions on the impact of the budget deficit on economic growth are divided. However, given the fact that the analysis period is a crisis period and the size of the Polish economy, the assumption is that a larger budget deficit negates the growth of aggregate demand and thus the growth of domestic production.

Table1. Explanation of variables, method of measurement, data source

Variable	Type of variable	The variable code	Measurement method	Data source
Economic growth	Dependent	lnrgdp	GDP at constant prices, seasonally adjusted, logarithmic values	Eurostat
Gross fixed capital formation	Independent	inv	Gross fixed capital formation in% of GDP, seasonally adjusted	Eurostat
Budget deficit	Independent	gov	Budget deficit in% of GDP, seasonally adjusted	Eurostat
Economic growth in EU countries	Independent	lnrgdpeu	GDP constant prices, seasonally adjusted, logarithmic values	Eurostat
Monetary aggregate M1	Independent	lnm1	Money supply, monetary aggregate M1, logarithmic values	International Monetary Fund
Reference interest rate	Independent	irr	Interest rate of the Central Bank of Poland	International Monetary Fund
Real exchange rate index	Independent	lnreer	Index of real effective exchange rate, in logarithms	International Monetary Fund

Source: Authors.

It can be expected that lower reference interest rates and higher cash supply in the period of crisis mean higher economic growth, in line with the theoretical assumptions set out above, which are characteristic of the crisis periods. The real exchange rate is a product of the nominal exchange rate and the price ratio in the country and abroad. According to the methodology of calculating the real effective exchange rate used by Eurostat, growth indicates appreciation of the real effective exchange rate. The appreciation of the real exchange rate can ultimately have both a positive and a negative effect on economic growth. If the effect of the appreciation of the exchange rate on the fall of exports and thus the fall of GDP dominates, the effect will be negative. If the positive effect of the appreciation of the exchange rate on the fall in the interest rate and the consequent growth of economic activity dominate, the effect of the appreciation of the real exchange rate on the GDP will be positive (Arratibel & Henrike, 2013).

Empirical analysis involves the analysis of the cause and effect relationship between independent and dependent variables during the 2006-2017 period in Poland. The method to be used in the analysis of the data time series depends on

the results of the unit root test. If the variables are integrated of order 0 and order 1, it is most appropriate to use Autoregressive Distributed Lag Models (ARDL). The ARDL cointegration approach is used to analyse short-term dynamics and long-term relationships between time series of variables with different order of integration, but the order of integration has to be less than 2. Therefore, the variables can be of different order of integration, I (0), I (1) or a combination of these two orders of integration. Long-term correlation of variables, ie cointegration is tested using F statistics (Wald test). The long-term series of variables are said to be cointegrated, that is to have a long-term relationship, if the value of F statistics exceeds the upper limit for the defined level of statistical significance.

The regressors in the ARDL model can include the time lag of the dependent variable and the current values and values with the lag of the independent variables, namely:

$$y_t = \mu + \sum_{i=1}^{n} \alpha_i y_{t-i} + \sum_{i=1}^{m} \beta_i x_{t-i} + \varepsilon_t \quad (1)$$

Certain transformations of the previous equation (Asteriou & Hall, 2016) yield the following equation:

$$\Delta y_t = \mu + \sum_{i=1}^{n-1} \alpha_i \Delta y_{t-i} + \sum_{i=1}^{m-1} \beta_i \Delta x_{t-i} - \pi \bar{e}_{t-1} + \varepsilon_t \quad (2)$$

The coefficient π is of the primary importance in equation (2), that is, the error correction coefficient commonly referred to as the adjustment coefficient. It shows how much the deviation from the equilibrium is corrected in each period. If, for example, it is 0.5, it means that 50% of the deviation from equilibrium is corrected in each period (Asteriou & Hall, 2016).

b. Research results

The selection of the optimum number of lags for variables is of considerable importance for the application of the ARDL model, given that the goal is that the error-term has a normal distribution, ie to avoid the problems of heteroskedasticity, autocorrelation, and failure to satisfy residual normality conditions. According to the final prediction error (FPE), the Akaike Information Criterion (AIC), the Schwarz Bayesian Information Criterion (SBIC), and the Hanan and Quinn Information Criterion (HQIC), the optimal number of lags for each variable was selected. The results of selecting the optimum number of lags for individual variables are shown in Table 2 and were used to test the existence of a unit root.

The selection of an adequate econometric technique depends on whether the time series of the data used in the analysis are stationary or non-stationary. In

stationary time series, the shocks are temporary and over the time their effects are eliminated, that is, the series return to their long-term mean values. Non-stationary time series are characterized by the existence of a constant component, therefore the mean and/or variance of the non-stationary time series are time dependent. Non-stationary time series are said to have a unit root. Non-stationary time series can become stationary after d numbers of differences, when they are said to be integrated of order d (Asteriou & Hall, 2016). The use of least-squares methods on non-stationary time series causes the problem of spurious regressions, and the unit root test is a prerequisite for choosing an adequate method for testing the interdependence of variables in the model. The most commonly used test to determine the existence of a unit root in a time series, that is, to determine the order of integration is the DF test (Dickey-Fuller test), which starts from a simple AR (1) model, and the null hypothesis is that the time series has a unit root, that is, it is non-stationary.

Whether the coefficient with a variable with one time lag in a simple AR (1) model is equal to one (the variable is non-stationary) or less than 1 (the variable is stationary). The values of the DF test obtained are compared with the critical values originally calculated by the author of the DF test. If the value of the DF test is less than the critical value, the null hypothesis of the existence of a unit root is rejected and the variable is found to be stationary. When testing the existence of a unit root, the procedure, that is, the diagram defined by Dolado (Juan J. Dolado), was used and the optimal number of lags shown in Table 2 was reduced by one since the differentiation of variables (ADF test form) reduced the number of lags by 1. The results of the unit root tests are shown in Table 2 (Asteriou & Hall, 2016).

Table 2. Optimal number of lags for variables of models and Dickey-Fuller unit root test

Variable	Economic growth	Gross fixed capital formation	Budget deficit	Economic growth in EU countries	Monetary aggregate M1	Reference interest rate	Real exchange rate index
Variable code	lnrgdp	inv	gov	lnrgdpeu	lnm1	irr	lnreer
Optimal lag number	2	4	4	2	3	2	2
Dickey-Fuller unit root test	-3.327	-2.516	-1.008	0.192	-3.046	-3.004	-4.762
Order of integration of variables	I(0)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)

Source: Authors

The results of the unit root test indicate that all variables are integrated of order 1, with the exception of real GDP growth (lnrgdp) and real exchange rate index (lnreer). Given that the variables are 0 and 1 of order integration, it implies that is the most adequate to use Autoregressive Distributed Lag (ARDL) models. The optimum number of lags used in the estimation of the ARDL model was defined using the BIC information criteria (Bayesian information criteria).

With a view to identifying potential problems of multicollinearity between variables, a correlation matrix is shown below (Table 3). The analysis shows that there is no strong correlation between the independent variables and therefore the multicollinearity problem will not be inherent in the model. It is interesting to analyse the correlation between money supply, real exchange rate and the reference interest rate. Money supply is negatively correlated with the real exchange rate and the reference interest rate, which is to be expected.

Table 3. Correlation matrix between independent variables

Variable	lnrgdpeu	inv	gov	lnreer	irr	lnm1
lnrgdpeu	1					
inv	0.0962	1				
gov	0.2591	0.0551	1			
lnreer	0.4392	0.1666	-0.059	1		
irr	0.4136	0.199	-0.2111	0.7093	1	
lnm1	-0.4517	-0.1351	0.2995	-0.5592	-0.7845	1

Source: Authors

The ARDL cointegration test is based on the Wald test (F statistics). The null hypothesis is that there is no cointegration between the variables, and testing is conducted by comparing the results of the F test with two critical values. The lower critical value of the test assumes that all variables are integrated of order I (0), namely, there is no cointegration between the variables, while the upper limit of the test assumes that all variables are integrated of order I (1), that is, there is cointegration between variables. If the value of the F test is less than the critical value, it can be concluded that there is no cointegration between the variables, whereas a higher value of the F statistic than the critical value means that there is cointegration between the variables. The test is without conclusion if the value of the F statistic is between the lower and the upper critical value of the F test. The results of the ARDL "bound" cointegration test are shown in Table 4. The test results are shown for the dependent variable, which is the real GDP growth in Poland and the four different combinations of independent variables. The target variables, which reflect the mechanisms of monetary policy impact, namely the real effective exchange rate, the real interest rate and the money supply, are introduced into the model gradually (one by one).

As the estimates of the long-term model have shown, all three control variables, namely real economic growth in EU countries, gross fixed capital formation and government expenditure have a positive impact on economic growth in Poland, which is in line with expectations. Higher real economic growth in the European Union, higher investment and higher government expenditure are affecting real economic growth in Poland. The error correction coefficient is negative and lies within the theoretical limits of 0 to - 2, implying that the variables have long-term cointegration, and its height shows that deviations from the long-run balance level are very quickly corrected.

The ARDL Bound Test shows that in all three evaluated models the value of the F statistic is greater than the critical value[1], implying that there is a cointegration between the variables. Adjusted coefficients of determination show that over 93% of variations in the dependent variable can be evaluated by the selected dependent variables. The normality test of residual indicate that the residual normality assumption is satisfied, the p value of the Jarque-Bera test is greater than 0.05. The model specification is good, as shown by the Ramsey reset test, while the Durbin-Watson test and Breusch-Godfrey LM test show that there is no problem of autocorrelation of residuals. The Breusch-Pagan/Cook-Weisberg test and the White test show that variance is constant, namely, the model is not inherent in the problem of heteroskedasticity. The model does not contain structural fractures, the coefficients in the time series are stable over time, as shown by the sbcusum test.

The real exchange rate was used in the first model as a variable that can be influenced by the Central Bank of Poland, at least in the short and medium term, until deviations from the theory of purchasing power parity are eliminated (Salvatore, 2013). The real exchange rate has a significant impact on Poland's economic growth in the long run, at a level of significance of 1%. Growth in the real exchange rate index means real GDP growth in Poland, where a higher index of the real exchange rate of 1% means higher real GDP growth rates in the long run, ranging from 0.866% to 0.833%, depending on the model used. This implies that the positive effect of appreciation of the real exchange rate on economic growth, through a decrease in interest rates, in the long run outweighs the negative effect of appreciation of the real exchange rate on economic growth, through a decrease in exports.

The reference interest rate and the money supply, as measured by the monetary aggregate M1, do not have a significant impact on real economic growth rates in Poland in the long run. This means that in the long run monetary policy cannot stimulate economic growth through its measures. This conclusion is consistent with the monetarist's claims about long-term neutrality of money.

[1] In the first model, at a significance level of 1%, the higher critical value was 5.72, and 5.23 in the second and third.

Table 4. Long-term impact of the monetary policy on the real economic growth in Poland

Long term variable of models:	ARDL(4,1,4,3,4)	ARDL(4,1,4,3,4,0)	ARDL(4,1,4,3,4,0)
Error-correction term (L.lnrgdp)	-1.012***	-0.812***	-1.112***
	(0.178)	(0.210)	(0.204)
Relative GDP growth in the EU, in logarithms (lnrgdpeu)	0.934***	0.972***	0.912***
	(0.102)	(0.126)	(0.095)
Investments in, % GDP (inv)	0.016***	0.018***	0.016***
	(0.003)	(0.003)	(0.002)
Government expenditure in % GDP (gov)	0.003*	0.003*	0.003**
	(0.001)	(0.002)	(0.001)
Real exchange rate, index, in logarithms (lnreer)	0.875***	0.866***	0.883***
	(0.115)	(0.139)	(0.104)
Real interest rate (irr)		-0.007	
		(0.006)	
Monetary aggregate M1, in logarithms (lnm1)			0.081
			(0.074)
Observations	48	48	48
R-squared	0.966	0.969	0.967
Adj. R-squared	**0.939**	**0.942**	**0.939**
Jarque-Bera test λ^2	0.567	0.771	0.496
Ramsey RESET test (prob>F)	0.799	0.651	0.887
Durbin-Watson d-statistic	2.128	2.106	2.159
Breusch-Godfrey LM test (prob> λ^2)	0.398	0.332	0.310
White's test for heteroscedasticity (prob> λ^2)	0.432	0.432	0.432
Breusch-Pagan / Cook-Weisberg test (prob> λ2)	0.998	0.857	0.947
Test for structual break-sbcusum (t stat)	0.243	0.737	0.420
ARDL Bounds Test (F – stat)	**8.996**	**8.457**	**7.664**

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors.

An analysis of the short-term impact of independent variables on economic growth indicates that there is a positive impact of real economic growth in the previous three quarters on real economic growth in the current quarter. The short-

term impact of real economic growth in EU countries is surprising. Although the analysis showed that in the long run, greater real economic growth in EU countries also means greater economic growth in Poland, a short-term analysis shows the negative impact of real economic growth in EU countries on Poland's real economic growth (D.lnrgdpeu variable is negative). Investments also have a negative impact on economic growth in the short term, however, the intensity of the impact decreases with increasing delays in the variable, which is logical, so that in the long run the impact of investments on Poland's economic growth would be positive. The government expenditure has a positive effect on economic growth in the short term, as in the long-term context.

Table 3. The short-term impact of monetary policy on real economic growth in Poland

Short-term variables of the model:	**ARDL(4,1,4,3,4)**		**ARDL(4,1,4,3,4,0)**		**ARDL(4,1,4,3,4,0)**	
LD.lnrgdp	0.482**	(0.179)	0.271	(0.215)	0.560***	(0.196)
L2D.lnrgdp	0.662***	(0.161)	0.462**	(0.197)	0.726***	(0.173)
L3D.lnrgdp	0.653***	(0.128)	0.560***	(0.136)	0.694***	(0.134)
D.lnrgdpeu	-1.311***	(0.326)	-1.540***	(0.345)	-1.366***	(0.330)
D.inv	-0.021***	(0.005)	-0.018***	(0.005)	-0.023***	(0.005)
LD.inv	-0.017***	(0.004)	-0.015***	(0.004)	-0.019***	(0.004)
L2D.inv	-0.014***	(0.003)	-0.012***	(0.003)	-0.015***	(0.003)
L3D.inv	-0.009***	(0.003)	-0.008***	(0.003)	-0.010***	(0.003)
D.gov	0.003	(0.002)	0.003	(0.002)	0.002	(0.002)
LD.gov	0.007***	(0.002)	0.008***	(0.002)	0.006***	(0.002)
L2D.gov	0.004*	(0.002)	0.005**	(0.002)	0.004*	(0.002)
D.lnreer	0.037	(0.215)	0.251	(0.245)	-0.061	(0.236)
LD.lnreer	-0.320	(0.229)	-0.062	(0.271)	-0.403	(0.244)
L2D.lnreer	-0.561***	(0.193)	-0.359	(0.223)	-0.634***	(0.206)
L3D.lnreer	-0.633***	(0.149)	-0.504***	(0.164)	-0.692***	(0.161)
Trend	0.008***	(0.002)	0.006***	(0.002)	0.008***	(0.002)
Constant	-13.409***	-2.904	-11.092***	-3.140	-15.221***	-3.422

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

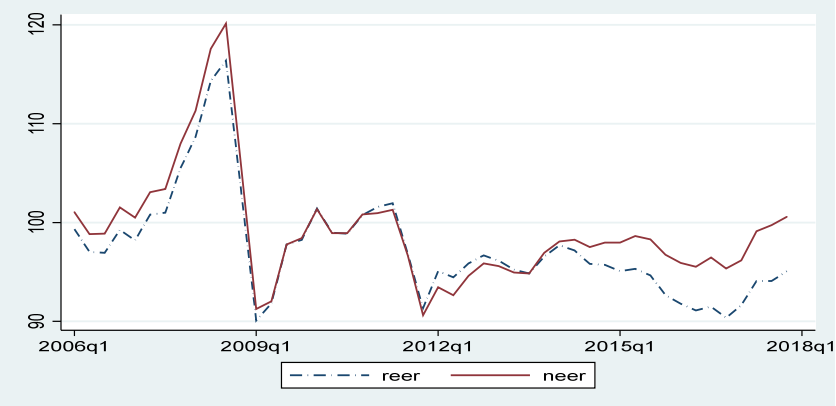
Source: Authors

An interesting finding is the impact of the real exchange rate in the short term. Specifically, the analysis showed that long-term appreciation of the real exchange rate has a positive impact on economic growth, while short-term coefficients are negative, and short-term coefficient variables with the second and third lags (L2D.lnreer and L3D.lnreer) are significant at the significance level of 1%. This implies that appreciation of the real exchange rate in the short term has the effect of reducing Poland's real GDP, that is, depressed real exchange rates can be

stimulated by higher real economic growth rates. The conclusion is that the negative effect of appreciation of the real exchange rate on economic growth, through a decrease in exports, in the short term outweighs the positive effect of appreciation of the real exchange rate on economic growth, through a decrease in the interest rate.

Based on Chart 8, which shows indices of nominal and real effective exchange rates, it can be concluded that there is an almost perfect correlation in the movement of these two indices, except for the last three years of the analysis. The correlation coefficient is 0.92. The most significant depreciation of the nominal and real effective exchange rate of the zloty occurred in 2009 compared to 2008, when the average annual value of the zloty fell by 23% against the euro. Therefore, the adjustment of the exchange rate in the direction of amortization of the external shock, as one of the advantages of a floating exchange rate, is evident in the example of Poland.

Chart 8. Poland's nominal and real effective exchange rate index



Source: The results of the analysis using a statistical tool – *STATA 15*.

The global economic crisis in 2008 influenced the movement of real GDP growth rates, but it is still realistic to assume that due to the strong depreciation of the zloty, it did not cause a significant fall in real GDP growth rates. Due to the fall in world demand and exports, the nominal exchange rate of the zloty automatically declined by about 2.5% in 2009 compared to 2008, but it is quite certain that the fall in exports and other "automatic" mechanisms could not have affected the weakening of the zloty by 23%. Money supply as measured by the monetary aggregate M1 in the 2008 crisis increased significantly, which certainly (with a fall in the reference interest rate) had a notable impact on the nominal and real effective exchange rate.

Conclusion

The conducted research confirmed that the global economic crisis that emerged in the USA in 2007, which rapidly spread from the most developed countries to the whole world, had a negative impact on the Polish economy, but in a manner that did not result in the decline of real economic activity, but its somewhat slower growth. The research results indicate that in the short term there is a negative impact of real economic growth of European Union on the real economic growth of Poland. Nevertheless, the adjustment of the exchange rate in the direction of amortization of the external shock, as one of the advantages of the implementation of the floating exchange rate, is evident in the example of Poland. The results obtained in this paper with the help of the ARDL model confirm that, in the short term, changes (depreciation) of the nominal exchange rate of the Polish zloty occurred spontaneously due to the action of market forces but, encouraged by monetary authorities, contributed to stimulating economic activity and preventing the recession. It can be assumed that the global economic and financial crisis, primarily due to the significant depreciation of the nominal and real exchange rate of the zloty recorded in 2009 compared to 2008, did not lead to a significant decline in real GDP growth rates. In other words, the research results suggest that depreciations of the nominal zloty exchange rate, accompanied by adequate changes in the real exchange rate, weakened the negative impact of the global crisis on Poland's economy and thus significantly mitigated internal disturbances.

Contrary to expectations, the research results did not confirm the existence of a significant influence of the reference interest rate on the movement of real GDP. One reason for the insufficient impact of the reference interest rate on real GDP movements may be that market interest rates were already at a relatively low level. Money supply, as measured by the monetary aggregate M1, does not have a significant impact on real rates of economic growth in Poland, which is in line with the monetarists' claims about long-term neutrality of money.

Taking into account the overall results of the analysis, it can be concluded that the policy of the floating exchange rate implemented by the National Bank of Poland allows for the amortization of the consequences of a negative shock from the environment in the short term, while in the long term, the strengthening of the currency under the influence of the market presents an additional stimulus to economic growth.

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DOPRINOS MONETARNE POLITIKE UBLAŽAVANJU POSLJEDICA SVJETSKE EKONOMSKE KRIZE U POLJSKOJ

Rezime: Ekonomske vlasti svake zemlje nastoje da putem primjene različitih mjera ekonomske politike održe fazu ekspanzije, odnosno da spriječe ili ublaže recesionu fazu u privrednom razvoju. U tom kontekstu, razumijevanje kako odluke o monetarnoj politici utiču na kretanje makroekonomskih varijabli je od posebne važnosti. Rad ima za cilj da uz pomoć ARDL modela (engl. *Autoregressive Distributed Lag),* preko ispitivanja uticaja realnog deviznog kursa, referentne kamatne stope i novčane mase na kretanje realnog BDP-a, istraži i ocjeni doprinos monetarne politike ublažavanju posljedica svjetske ekonomske i finansijske krize na nivo ekonomske aktivnosti u Poljskoj. Ekonometrijskom analizom obuhvaćen je period od 2006. do 2017. godine. Rezultati istraživanja sugerišu da, kako u kratkom tako i u dugom roku, postoji značajna veza između realne ekonomske aktivnosti i realnog deviznog kursa, ali ne i referentne kamatne stope i novčane mase.

Ključne riječi: Poljska, monetarna politika, ekonomska kriza, devizni kurs, kamatna stopa, BDP.

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