FINANCIAL MARKETS IN CEE COUNTRIES AND THEIR ROLE IN TRANSMISSION OF EURO AREA MONETARY POLICY SHOCKS

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ABSTRACT

This paper uses the VAR methodology to analyse stock, bond, and exchange rate markets in six Central and Eastern European (CEE) countries. First, we study the influence of shocks occurring in each market on domestic economic conditions. Next, a counterfactual simulation analysis is carried out to discern the role of financial markets in the transmission of European Central Bank (ECB) monetary policy shocks into CEE economies. The results have implications for both present monetary policy-making and future euro adoptions, as well as for investors concerned with financial assets of CEE countries. While examining the estimated responses of domestic output and inflation to changes in stock, bond, and exchange rate prices, we draw conclusions on the relatively lower importance of the bond market and higher importance of stock and exchange rate markets in the economies. The study of transmission channels also points to stock markets as the main channel of transmission, especially in the case of transmission to the output. Transmission of monetary shocks to inflation takes place mainly through stock and exchange rate markets. There is also strong indication on considerable diversity across CEE countries taking place.

JEL CLASSIFICATION & KEYWORDS

INTRODUCTION

In an increasingly globalized world, the problem of international spill-over of monetary policy effects that may complicate domestic policy-making and increase the volatility of the real economy has drawn the attention of both policy makers and researchers. Many author shave analysed the problem of international transmission of monetary policy shocks, concentrating mainly on the transmission following those in the US (e.g., Canova 2005; Kim 2001; Kim and Yang 2012). However, it also seems plausible that the policy decisions of the European Central Bank (ECB) could significantly affect countries outside the euro area. That would seem especially likely in the case of countries from Central and Eastern Europe (CEE) that joined the European Union within the last decade. Their strong trade and financial ties with the euro area, together with their relatively small size and the openness of their economies, make them plausible examples of strong dependence on foreign (euro area) monetary policy shocks.

Of the different possible channels of international monetary shock transmission described in the literature, rapidly integrating financial markets seem to constitute the most probable channel through which transmission of the euro area monetary policy shocks could take place. There is a strong notion about advancing global integration and the development of financial markets through which monetary

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spill-overs take place, and that increasing impact the real economy.

This paper investigates the importance of three financial markets-the stock market, government bond market, and exchange rate market-in the transmission of euro area monetary policy shocks to CEE countries. Based on the vector autoregressive (VAR) model, we look for answers to several questions. First, we study the importance of changes in the three financial markets to the determination of economic conditions in CEE countries. We then check how these markets behave after a change in euro area monetary policy. Finally, we study the role of the financial markets in the transmission of monetary policy shocks to CEE countries, and look for determinants of each market's importance.

The results of our analysis include a few important implications, both for policy-makers and for investors interested in assets from CEE countries. On the policy-making side, information on the channels through which foreign monetary shocks can be transmitted to a domestic economy provides a hint for indicators that can be used in policy functions to account for changes in foreign monetary policy stances. In addition, better understanding of the present channels of transmission of euro area monetary policy effects and their determinants provides information that can be used to predict changes in effects connected to the future adoption of the euro in the analysed countries. On the investor side, knowing the effects that foreign monetary policy has on domestic financial assets helps in portfolio strategy formulation. In that context, the most important information contains knowledge on the assets most affected, and on the direction of that influence.

The rest of the paper is structured as follows. In Section 2 we present a short description of the role of financial assets in monetary policy transmission. Section 3 describes the model used in the analysis, as well as the data. Section 4 reports the empirical analysis results, and Section 5 studies the determinants of the role of each financial market in shock transmission. In Section 6,based on the results from previous sections, economic theory and previous research, we explain the possible effects of euro adoption on the analysed financial markets, and of the transmission of euro area monetary policy shocks to these economies. Section 7 concludes and provides policy implications.

Financial markets and monetary transmission

The literature includes extensive explanations regarding the possible channels of transmission of monetary policy shocks. Most of the studies concentrate on domestic monetary policy shocks and domestic transmission (e.g., Bernanke & Blinder 2013 for the US; Ganev et al. 2002 for CEE countries; Peersman & Smets 2001 for the euro area), but the analyses can often be adapted for the international transmission of shocks (e.g., Kim 2001). Some studies, such as Ehrmann & Fratzscher (2006), explicitly analyse the

global transmission of monetary shocks, and consider financial markets as the main channel. In this paper, we look at three financial markets in CEE countries (i.e. the stock market, bond market, and exchange rate market), and attempt to explain their relative importance in determining countries' economic conditions and in transmission of monetary policy shocks.

Study of these markets is closely related to the theory on channels of monetary transmission. Asset prices (stock, real estate, bonds, etc.) are important variables in the wealth channel of transmission developed by Ando and Modigliani (1963). According to this channel, interest hikes cause a fall in the value of assets, leading to lower consumption, and thus output. In this paper,due to data restrictions, we carry out analysis for stock prices and bonds only.

A well-functioning sovereign bond market is also an important condition for proper transmission of monetary policy decisions (Cour-Thimann & Winkler 2013). There is a close link between the price of government bonds and prices of other assets. Thus, changes in the price of government bonds can both directly and indirectly affect the balance sheet of financial institutions. The price of government bonds is also closely connected to the cost of borrowing in the economy.

The study of long-term interest rates (bond yields) has one more important implication. In the real economy, little depends on overnight money market interest rates. Many transactions refer to the rates of longer maturities. By influencing overnight interest rates, the central bank hopes also to induce a change in longer maturities. Thus, bond yields can be interpreted as a proxy for the level of the long end of the yield curve, and can be used as a measure of its influence on the economy.

While studying the effects of monetary policy on interest rate time structure, however, Evans & Marshall (1998) point out that the effect of monetary policy on interest rates diminishes as maturity increases. They conclude that rather than level of long-term interest rates, monetary policy affects the slope of the yield curve. Therefore, we introduce the difference between 10-year bond yield and short-term interest rate to the analysis as a proxy for the slope of the yield curve in order to assess the role of changes in the slope in transmission of foreign monetary policy shocks.

The stock market, aside from its role in the wealth channel of transmission, also plays a crucial role in the transmission of monetary policy shocks to firms' investments, according to Tobin's q theory. Moreover, stock prices play an important role in the broad credit channel of transmission developed by Bernanke & Gertler (1989). Because of their role as collateral, stock prices, like bond prices, are one of the factors determining the cost and availability of credit. A drop in collateral value due to an interest rate hike results in lower borrowing power, and therefore leads to lower consumption and investment in the economy.

The exchange rate also plays an important role in the broad credit channel. Depreciation of domestic currency means deterioration of the assets denominated in foreign currency and an increase in foreign-currency denominated debt burden, which leads to lower availability of credit. As Eichengreen et al. (2007) point out, this process is especially important for developing countries with a large share of credits denominated in foreign currency;this applies to some of the CEE countries in our sample.

Empirical methodology and data

This section describes the econometric methodology and data used in order to determine the relative importance of each financial market, as well as its role in monetary policy transmission. Our econometrical strategy is based on a VAR framework.

Empirical model

Our empirical methodology is based on the assumption that euro area variables are not influenced by any variables of a single CEE country. Furthermore, as the number of variables needed to accomplish the aims of our research is rather large, we also attempt to limit the number of variables included in one model. Therefore, we employ two-step analysis based on a VAR framework to study role of financial markets in CEE countries, as well as their role in the transmission of euro area monetary policy shocks.

As the first step, we construct an equation to identify euro area monetary policy shocks. We estimate a reduced-form VAR model of the form:

$$y_t = B(L)y_{t-1} + u_t \qquad (1)$$

Where y_t is a vector of euro area variables, $B(L)$ is a matrix polynomial in lag operator L, and u_t is a vector of serially uncorrelated structural disturbances with a mean of zero and a covariance matrix $_u$. Cholesky decomposition of the reduced-form covariance matrix is used to identify structural innovations.

For the second step, we use identified euro area monetary policy shock as an exogenous variable in each CEE country model. Again, we estimate the reduced-form VAR model, which this time takes the form of:

$$x_t = C(L)x_{t-1} + D(L)\,_m + e_t \qquad (2)$$

where x_t is a vector of CEE variables, $_m$ is the euro area monetary policy shock estimated with equation (1), $C(L)$ and $D(L)$ are matrix polynomials in lag operator L, and e_t is a vector of serially uncorrelated structural disturbances with a mean of zero and a covariance matrix $_e$. Structural innovations for CEE countries are identified with the Cholesky decomposition of the reduced-form covariance matrix.

Aside from estimated euro area monetary policy shock, each VAR equation for CEE countries also contains exogenous variables controlling for the world economic and monetary situation.

Before carrying out the specific analysis on the channels of transmission of monetary policy shocks, we ask a question about the importance of the considered variables in each economy. In order to check how strongly the chosen financial market variables influence each CEE country, we analyse impulse response functions for each country's output and inflation after the financial variables' shocks.

Next, we move to a more detailed analysis of transmission channels. First, we check the reactions to EONIA rate shocks in order to present sensitivity of local financial markets to euro area interest rate changes. Then, we carry out counterfactual simulation analysis, which was introduced into VAR methodology by Bernanke et al. (1997) and Sims & Zha (2006). We fix the considered financial market variable at its base values throughout the simulation. The absence of endogenous reactions of the considered variable to a shock is equal to the situation in which the examined variable does not transmit shocks. By comparing changes in output and inflation after EONIA shocks in the constrained

and unconstrained models, we can observe how important the variable is for the transmission of shocks.

Data and country sample

To construct a block of the euro area variables used to identify euro area shocks, we follow Peersman & Smets (2001) and use data on euro area aggregate output, inflation, money market short-term interest rate, and real effective exchange rate. Additionally, we include one more variable in the system - economic sentiment survey data - in order to control for market sentiments, future expectations of market players,and as a summary of the data the ECB might also take into consideration while deciding their monetary policy stance. Thus, we achieve a five-variable euro area model with the ordering: output, inflation, economic sentiment indicator, short-term interest rate, and real effective exchange rate.

The vector of data for each CEE country follows previous studies on domestic monetary policy transmission mechanisms (e.g. Ganev et al. 2002), and consists of domestic output, inflation, money market short-term interest rate, and exchange rate to euro.

In each VAR specification,we also include additional variables exogenous to both the euro area and domestic blocks: the world commodity price index and US short-term nominal interest rate. The purpose is to control for world economic and monetary developments that are independent from developments in both the euro area and CEE countries, but that influence them and may be responsible for co-movements in the two regions.

The VAR model is estimated using monthly data. The indicator of output is the industrial production index excluding construction. Inflation is measured with the harmonized index of consumer prices (HICP), all-items index. The interest rate used in the case of the euro area is average monthly observations of EONIA. For CEE countries, we use monthly averages of day-to-day money market interest rates provided by Eurostat. The real effective exchange rate of the euro area is based on consumer price indices of 42 trading partners as a deflator. The exchange rate towards the euro is formed as the price in the national currency for 1 euro. The economic sentiment in euro area is measured with the Economic Sentiment Indicator, which is a weighted average of the components of the confidence indicators for industry, services, consumers, construction, and retail trade provided by the European Commission DG ECFIN. The data for the euro area are taken from ECB databases, while the data for CEE countries are taken from Eurostat. Only data on industrial production for the Czech Republic are taken from IMF IFS database. The proxy for the bond market situation is the 10-year government bond yield and stock market situation by share price index, both from the IMF IFS database. For world variables, we use the All Commodity Price Index, including both fuel and non-fuel price indices from the IMF and US federal funds effective rate obtained from Datastream.

All data are seasonally adjusted and in their logarithms (except for interest rates). All variables in our VAR specification are in their levels. Therefore, we allow for implicit cointegration relationships in the data. However, as Sims, Stock, and Watson (1990) state, we still achieve consistent estimates of the parameters.

The CEE countries used in the analysis are Bulgaria, the Czech Republic, Hungary, Latvia, Lithuania, and Poland. The country sample is chosen from the CEE states that have

joined the European Union, but not yet adopted the euro[1]. Out of the group, three countries maintain a fixed exchange rate regime (Bulgaria and Lithuania - currency board to euro, Latvia - fixed peg to euro) and the other three have a floating exchange rate regime (managed floating combined with inflation targeting in the Czech Republic, Hungary, and free float and inflation targeting in Poland). The exchange rate is excluded from the analysis for currency board countries - Bulgaria and Lithuania. The data period depends on the country,due to considerations about data availability and date of introduction of current exchange rate regime,but starts between April 2000 and February 2002. The sample periods for all countries end in December 2013.

We estimate our VAR with 4 lags,following results for the Akaike information criterion for the euro area model. We opted against a different number of lags for each country in order to ensure higher comparability of results across countries.

Empirical results

In this section, we present the results of our empirical analyses. First, we analyse the importance of changes in the financial markets studied in each country's economy. Then, we check how the financial markets react to EONIA shocks. Finally, we attempt to explain the specific role of each channel in transmission of foreign monetary policy shocks.

Responses of domestic variables to financial market shocks

In order to determine the influence of stock, bond, and exchange rate markets on the economic situation of CEE countries, we estimate the impulse response functions, presenting reactions of each country's output and inflation to the shock in the considered variables.

Figure 1a presents the responses of each country's output and inflation to bond market shocks. The induced shock means an increase in the 10-year government bond yield, and a drop in its price. The results are diversified. After the positive bond yield shock, we observe a fall in the output of Bulgaria, the Czech Republic, Hungary, and Poland. In Latvia there is practically no reaction, while in Lithuania after around 12 months output starts to increase. The increase in bond yields does not change the inflation rate much in most cases. It leads to lower inflation only in Lithuania and Poland.

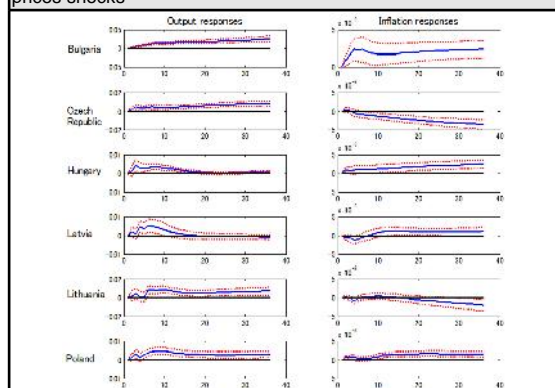Figure 1a: Responses of CEE countries' output and inflation to bond yields shocks
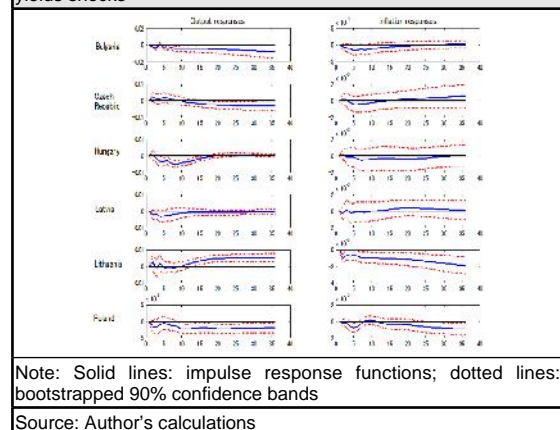
Note: Solid lines: impulse response functions; dotted lines: bootstrapped 90% confidence bands

Source: Author's calculations

[1] Latvia adopted the euro in January 2014, and Lithuania in January 2015. However, because the data we use end in December 2013, we treat both countries as non-euro CEE countries.

Next, we analyse the impulse responses to stock market shock presented in Figure 1b. The results imply that the stock market is an important factor in the economy of all the analysed countries. In Bulgaria, Hungary, Latvia, and Poland, stock prices shocks have a significant impact on both output and inflation. In Hungary and Latvia, the effect on output lasts for around a year, while in other countries it is persistent. In the Czech Republic and Lithuania, the reactions of output to a stock market shock are significant and persistent as well, but inflation in these countries falls after stock price increase.

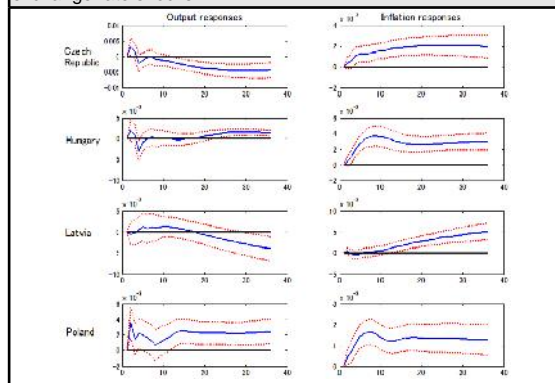Figure 1b: Responses of CEE countries' output and inflation to stock prices shocks

Note: Solid lines: impulse response functions; dotted lines: bootstrapped 90% confidence bands

Source: Author's calculations

Finally, Figure 1c contains responses to exchange rate shocks. Exchange rate depreciation has mixed influence on output in CEE countries. Only in Hungary and Poland is there some evidence of output increase after a weakening of the domestic currency. In the Czech Republic and Latvia, exchange rate depreciation even leads to a fall in output in the middle run. The exchange rate changes have, however, quite an important impact on inflation. In all the countries, we observe a statistically significant increase in the inflation rate. This result leads to additional implication, not directly connected with the main topic of this paper, that currency depreciation policy might not bring desirable effects in the form of output increase, but the cost in the form of higher inflation rate is clearly visible in all of the countries.

Figure 1c: Responses of CEE countries' output and inflation to exchange rate shocks

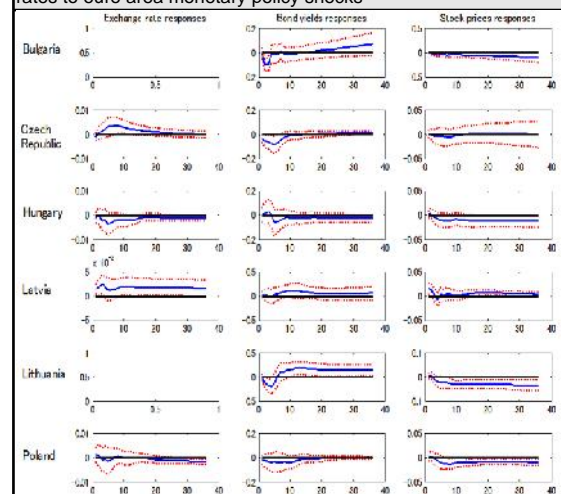Note: Solid lines: impulse response functions; dotted lines: bootstrapped 90% confidence bands

Source: Author's calculations

To sum up, the results of the analysis for impulse response functions imply that financial market variables influence different parts of the economy differently. There is also large diversification of results across the countries considered. Changes in stock prices exerted a considerable influence over Bulgarian and Polish output and inflation, as well as Czech and Lithuanian output, and Hungarian and Latvian inflation. Exchange rate shocks play an important role in changes of inflation in all the countries considered. Bond yield influence seems to dominate in Lithuania, and also has some meaning for Bulgarian, Czech, and Polish output.

Responses of financial variables to euro area monetary policy shocks

Before going into explicit analysis of the role of financial market variables in monetary policy shocks transmission, we first check how these variables react to euro area monetary policy shocks. This analysis provides important information for both domestic monetary policy-makers and investors' portfolio strategies. Variables that only slightly react after the shocks are possibly weak indicators for domestic policy making. Moreover, knowledge regarding the direction and strength of reaction to foreign monetary policy changes helps prediction of future movements in asset prices, and therefore is useful for portfolio risk diversification strategies and future forecasts carried out by central banks.

Figure 2: Responses of bond yields, stock prices, and exchange rates to euro area monetary policy shocks

Note: Solid lines: impulse response functions; dotted lines: bootstrapped 90% confidence bands

Source: Author's calculations

Figure 2 presents the responses of exchange rate, stock prices and bond yields to EONIA shocks. The results for exchange rates follow expectations only in the case of the Czech Republic and Latvia, where we observe depreciation of currency after a foreign interest rate hike. In Hungary and Poland, currency reacts weakly to euro area monetary policy shocks, but the reaction takes the direction of appreciation.

Bond yields increase significantly in Lithuania. In Bulgaria and Latvia there is a slight movement towards growth as well. In other countries, there is almost no change in yields in response to a positive EONIA shock. Stock prices react decisively to EONIA shocks in Bulgaria, Hungary, Lithuania, and Poland. In these countries, a continuing fall can be observed. In the Czech Republic, there is no reaction of stock prices to the

EONIA hike,while in Latvia, a slight increase can be observed.

To sum up, out of the analysed CEE financial markets, the stock market reacts most significantly after a change in euro area monetary policy. Exchange rate also shows a substantial reaction, but in some cases the direction of change is opposite to expectations. Bond yields' response to euro area monetary policy shocks is, on the other hand, negligent.

Role of financial markets in foreign monetary policy transmission

Finally, we proceed to the analysis of the importance of each of the considered variables in the transmission of monetary policy shocks. For this, we present the results of the counterfactual simulation analysis for the financial market variables. We fix the chosen financial market variable at its base value (so that it does not react to any endogenous shocks in the model). Such specification can be interpreted as a situation in which the constrained variable does not transmit the shocks. Thus, in order to assess the role of each financial market in the transmission of euro area monetary policy shocks, we compare responses of output and inflation to monetary policy shocks in the constrained and unconstrained specifications.

Figure 3 presents the results of the analysis of transmission channels after euro area monetary policy shocks: responses of each country's output and inflation to EONIA shocks in the benchmark specification (blue solid line), as well as in a situation when one of the variables is fixed at its initial value (black solid lines with markers). The analysis of the derived impulse responses provides some interesting observations.

First, the stock market appears to be the most important channel of transmission of foreign shocks in Bulgaria, Lithuania, and Poland. In these countries, output falls in the situation when stock prices fail to transmit shocks are weaker than in the case when they react normally. Thus, changes in stock prices additionally depress the economy in CEE countries after a contractionary monetary policy shock in the euro area. In Bulgaria, Hungary, and Poland stock price moves seem to also depress prices.

Second, the bond market channel usually does not play an important role in transmission of EONIA shocks to output and inflation in CEE countries. There is no country in which much difference could be observed between the benchmark result and that in which bond yield values stay fixed at their initial levels.

Third, the exchange rate channel plays a rather important role in shock transmission in the case of the Czech Republic, Hungary (especially for inflation), and Latvia. However, in the case of Poland, the role is very small. What's more, in many cases the exchange rate seems to be an additional source of shock to the economy rather than a shock absorber. That is the case for output in all considered countries, as well as for inflation in Hungary and Poland.

In the alternative model specification, we also look at the role of the change in slope of yield curve in the transmission of euro area monetary policy shocks. At the level of the long end of the yield curve, bond yields (long-term interest rates) do not seem to play an important role in monetary policy shock transmission to CEE economies, leaving the debate on the role of yield curve in an economy only partially

Figure 3: Counter-factual simulation analysis results for euro area monetary policy shocks
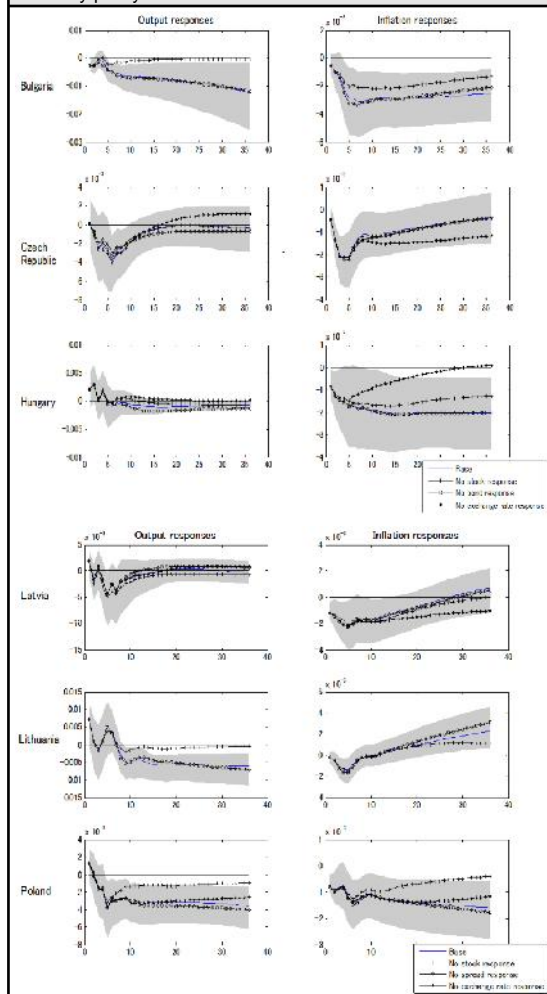
Note: Solid lines: impulse response functions; shadowed area: bootstrapped 90% confidence interval
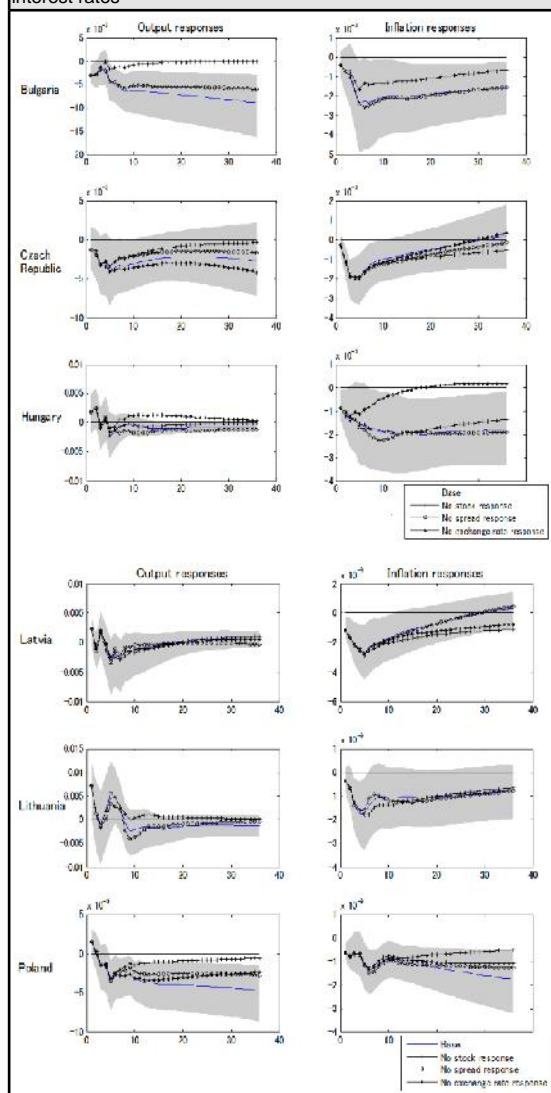
Source: Author's calculations

answered. Therefore, we look also at the role of changes in yield curve slope, substituting the bond yield in the VAR model with the difference between the 10-year bond yield and short-term interest rate (called the "spread" from now on).

Figure 4 presents the results from the analysis. As before, the solid blue lines show the responses of each country's output and inflation to EONIA shocks in the benchmark specification, and solid black lines with markers describe the output and inflation responses in the situation in which one of the variables is fixed at its initial value.

The analysis of the role of the spread in euro area monetary policy transmission shows that in most cases, there is little difference compared to the case of 10-year bond yield levels. Changes in the spread after the shocks seem to play a more important role than long-term interest rate only in the transmission to Bulgarian output and Polish output and inflation. It also extends some influence in the case of transmission to Czech output. In other countries, the influence of both level and slope of yield curve is largely similar.

Figure 4: Counter-factual simulation analysis results for euro area monetary policy shocks and spread between long and short-term interest rates

Note: Solid lines: impulse response functions; shadowed area: bootstrapped 90% confidence interval

Source: Author's calculations

Table 1: Variables used as potential determinants for explaining effects of euro area monetary policy shocks in CEE countries

Variable name	Definition	Source
Country's openness		
Trade openness	Sum of country's exports and imports as a percentage of GDP	IMF IFS and author's calculations
Kaopen	Chinn and Ito index on capital market openness	Chinn and Ito (2011)
Relations with euro area		
Exports	Exports to euro area, as a percentage of total country exports	ECB Convergence Report
Imports	Imports to euro area, as a percentage of total country imports	ECB Convergence Report
Inward FDI	Inward direct investment coming from euro area, as a percentage of total country inward FDI	ECB Convergence Report
Outward FDI	Outward direct investment flowing to euro area, as a percentage of total country outward FDI	ECB Convergence Report
Portfolio liabilities	Portfolio investment liabilities connected to euro area, as a percentage of total	ECB Convergence Report
Portfolio assets	Portfolio investment assets connected to euro area, as a percentage of total	ECB Convergence Report
Trade	Exports and imports to euro area, as a percentage of total country trade	ECB Convergence Report
FDI	Inward and outward direct investment coming from and flowing to euro area, as a percentage of total country FDI flows	ECB Convergence Report
Portfolio	Portfolio investment assets and liabilities connected to euro area, as a percentage of total	ECB Convergence Report
Financial markets depth and characteristics		
Capitalization	Stock market capitalization, as a percentage to GDP	World Bank
Corporation securities	Debt securities of corporations, as a percentage to GDP	ECB Convergence Report
MFI credit	MFI credit to non-government residents, as a percentage to GDP	ECB Convergence Report
Claims of euro area MFIs	Deposits and debt securities issued by domestic MFIs held by euro area MFIs as a percentage of total liabilities of domestic MFIs	ECB Convergence Report
Foreign claims	Claims on non-residents held by depository institutions, as a percentage to total assets	IMF IFS and author's calculations

Sources: IMF IFS; Chinn and Ito (2011); ECB Convergence Report, various years; World Bank

its financial markets. Table 1 presents the variables for each category with their definitions and sources.

The first columns of Table 2 hold the transformed results of the counterfactual simulation analysis. The presented values are averaged ratios of alternative scenario responses (when a chosen financial market variable does not transmit shocks) to the base scenario responses. Values higher than one indicate cases where the response of a country's output or inflation in the alternative scenario is stronger than its response in the base scenario (i.e., is higher for positive responses and lower for negative responses). Ratios lower than one indicate responses in the alternative scenario weaker than the base response. Thus, ratios close to one imply that the role of the analysed financial market in the transmission of shocks is more or less negligible. The more a ratio differs from one, the higher the influence of the analysed channel. Additionally, negative values point to the response in an alternative scenario being opposite to the response in base scenario.

It must be noted here that we do not carry out an analysis of the determinants of the exchange rate role in shock transmission. The reason why lies in the fact that two of the countries in the sample are excluded from the analysis of this channel due to operating under a currency board regime, making any casual observations even less accurate.

The remaining columns of Table 2 present data used as potential determinants of the financial markets' role in transmission of euro area monetary policy shocks to CEE economies. Based on the presented values, we carry out simple descriptive analyses and form some stylized facts

Determinants of financial market variables' role in shock transmission

Until now, we have been examining how financial markets react to euro area monetary policy shocks, and how shocks in the financial markets considered influence each country's output and inflation. Finally, we carried out the counterfactual simulation analysis in order to determine the role of financial markets in euro area monetary policy shock transmission. Now, the question arises as to what determines the role of each financial market in the shock transmission, as well as the differences across countries.

We look for the determinants of importance of each transmission channel in country characteristics, taking into consideration three main categories: the country's overall openness, its relation with the euro area, and the depth of

Table 2a: Differences between individual country and euro area responses to the shocks together with variables describing country relations with euro area

	Stock		Bond		Spread		Relations with euro area								
	Output	Inflation	Output	Inflation	Output	Inflation	Export	Import	Inward FDI	Outward FDI	Portfolio liab.	Portfolio assets	Trade	FDI	Portfolio
Bulg.	0.17	0.68	1.09	0.97	1.09	1.25	48.96	44.27	68.77	46.56	66.68	47.27	46.61	57.67	56.98
Czech Rep.	1.08	1.02	3.01	1.05	-2.66	1.8	67.81	63.11	82.01	67.34	50.75	65.97	65.46	74.68	58.36
Hung.	1.2	0.79	1.66	1.01	-1.44	0.31	60.99	54.89	68.53	35.6	64.26	57.93	57.94	52.07	61.1
Latvia	-1.25	0.04	2.98	0.64	3.04	-1.56	33.62	42.15	39.63	20.67	74.46	21.28	37.89	30.15	47.87
Lith.	0.33	0.93	0.95	1.35	0.85	0.99	40.03	39.81	38.06	49	73.89	66.46	39.92	43.53	70.17
Poland	0.5	0.59	1.08	1.04	0.86	0.94	57.07	57	74.29	42.02	50.49	38.01	57.04	58.16	44.25

Sources: Author's calculations; data from IMF IFS, Chinn and Ito (2011), ECB Convergence Report, World Bank

Table 2b: Differences between individual country and euro area responses to the shocks together with variables describing country financial market developments and overall openness

	Stock		Bond		Spread		Financial market characteristics					Openness	
	Output	Inflation	Output	Inflation	Output	Inflation	Stock market capitalization	Corporation securities	MFI credit	Claims of euro area MFIs	Foreign claims	Trade openness	Kaopen
Bulg.	0.17	0.68	1.09	0.97	1.09	1.25	15.27	2.26	49.24	15.37	14.09	121.1	0.64
Czech Rep.	1.08	1.02	3.01	1.05	-2.66	1.8	23.11	24.19	43.71	6.4	15.3	136.85	1.95
Hung.	1.2	0.79	1.66	1.01	-1.44	0.31	23.31	19.6	54.95	18.62	8.49	146.76	2.28
Latvia	-1.25	0.04	2.98	0.64	3.04	-1.56	8.49	1.69	65.21	11.4	23.75	99.5	2.36
Lith.	0.33	0.93	0.95	1.35	0.85	0.99	18.49	1.98	46.3	12.7	12.2	120.46	2.18
Poland	0.5	0.59	1.08	1.04	0.86	0.94	28.23	8.43	40.28	8.65	5.94	74.45	-0.14

Sources: author's calculations; data from IMF IFS, Chinn and Ito (2011), ECB Convergence Report, World Bank

on the determinants of the role of the stock market, bond market, and yield curve in the transmission of euro area monetary policy shocks.

The first observation is, as could be expected, the high importance of financial markets' depth in determining their role in the transmission of monetary policy shocks. In particular, the ratio of MFI credit to GDP is an important variable influencing the significance of the stock market channel, as well as transmission to inflation through the bond market and spread channels. We interpret the negative effect of higher ratio of MFI credit on the strength of the stock market in the transmission of shocks with the usual division of a country's financial system into banking-based and market-based systems. With this, less credit issued by banks means a less banking-based and more market-based system (a supposition that is also supported by the high negative correlation between stock market capitalization and MFI credit across the analysed countries). In the latter case, stock market changes have a higher probability of depressing the economic performance of the country, which is also the result in our exercise.

Not surprisingly, the level of stock market capitalization also seems to explain well the role of the stock market channel in euro area monetary policy shock transmission. The relation is positive, following the expectation that in countries with higher stock market capitalization, stock market fluctuations after the monetary policy shocks affect an economy more.

Additionally, the ratio of corporate securities to GDP seems to influence transmission of euro area monetary policy shocks to CEE countries' output via stock market channel and channels connected to the country's yield curve. The relation with the strength of the stock channel is positive, indicating that the depth not only of the stock market but also of the private securities market brings forth a higher role for the asset channel in transmission of foreign monetary policy shocks to the economy. In the case of channels connected to the yield curve, both level of long-term interest rate and spread are negatively related to the depth of the markets. Deeper securities markets mean lower dependence of corporations on bank lending, and thus changes in interest rates, leading to weaker transmission of monetary policy to the real economy through the yield curve channel.

Moreover, level of foreign claims of the MFIs seems to play a rather important role in shock transmission, mainly through stock and bond channels. The negative relation can be explained by the fact that when banks keep more domestic assets than foreign ones, they are more affected by changes in domestic financial markets, including stock market fluctuations.

The CEE countries' relations with the euro area also seem to matter in the transmission of euro area monetary policy shocks through financial markets. The most affected seem to be stock market and spread channels. In particular, trade with euro area, and especially share of exports, increase strength of transmission through stock markets. Also, FDI flows and share of euro area portfolio investment assets extend similar impact on transmission through the stock channel.

The same variables seem to also hold considerable importance for transmission of euro area monetary policy shocks through each country's changes in yield curve. Although in the case of this channel the relations seem to be negative – the higher the share of trade, FDI flows, and portfolio investment with the euro area, the lower the importance of the changes in spread in the transmission. The difference, as compared to the stock market channel, might come from the fact that the country with higher trade and capital flows with the euro area will be more dependent on the economic and monetary situation of its transaction partner, and thus the economy might be more resistant to the changes in domestic interest rates. On the other hand, the stock market might be influenced directly by the incoming portfolio flows, or indirectly by the effects of trade and FDI on the economic situation and future expectations. It thus plays an important role in the transmission of foreign shocks to the domestic economy.

Meanwhile, a country's openness – either to trade or capital account – does not seem to determine the role of financial

markets in transmission of euro area monetary policy shocks to CEE economies. Only in the case of the spread channel did the data imply weakly that higher trade openness might be limiting the role of domestic yield curve changes in the transmission. The explanation follows closely the one for the role of relations with the euro area in the strength of the yield curve channel of transmission. The country that trades more in relation to GDP is more dependent on the economic situation of trading partners, and thus the economy might become less responsive to changes in domestic interest rates.

Summing up, the depth of CEE countries' financial markets plays an important role in determining the strength of transmission of euro area monetary policy shocks. Especially important is the depth of stock and securities markets, as compared to the depth of the banking system. Surprisingly, when it comes to the claims of foreign financial institutions, claims of euro area MFI do not seem to matter much compared to overall foreign claims. On the other hand, the results imply that in the case of the real economy, the overall country openness is somewhat irrelevant for the transmission of euro area monetary policy shocks, and what matters is the level of trade and capital relations with the euro area.

Impact of euro adoption

All of the considered CEE countries are formally required to adopt the euro in the future. Latvia did it already in January 2014, and Lithuania in January 2015. In the remaining countries, discussion on the subject is recurrent. Even though there has been no decision on exactly when the euro will be adopted, and most of the comments imply that it will not happen in the very near future (the analysed countries have yet to implement national plans for euro adoption and set a planned date for it), the fact that joining the euro area is a strategic aim of the CEE countries has not changed.

In the view of our analysis thus far, the likelihood of future euro adoption make us ask how the considered channels of transmission of monetary policy shocks will change after a country becomes a member of the monetary union. In this section, we first discuss potential changes to the markets due to adoption of the euro. Then, we discuss possible developments in the analysed determinant variables and their influence on the strength of transmission of euro area monetary policy shocks.

Before analysis of the influence of euro adoption on each transmission variable, we must emphasize that the nature of the monetary policy shock itself will change. Now, we consider EONIA shocks as foreign monetary policy shocks and analyse international transmission mechanisms. With euro adoption, these foreign shocks will instantly become domestic monetary policy shocks in the sense that EONIA will become the only domestic overnight money market interest rate. The transmission mechanism will also become more similar to that of the present domestic channels with the difference that there will be no direct feedback from individual country economic conditions to the monetary policy decisions[2].

Going back to transmission channels, euro adoption means, first of all, disappearance of the exchange rate channel in its present form. Individual country exchange rates cease to exist, and economies are affected only

[2] ECB makes decisions based on the aggregate euro area data calculated as a weighted average of the data from each euro area country. Due to the relatively small size of most of the analysed economies, their weight-and thus influence-on the aggregate data and ECB decisions will be rather negligible.

through changes in euro exchange rate of euro against other currencies, as well as a country's real effective exchange rate. Due to the large share of exports and imports of CEE countries taking place with other euro area countries, we can assume that the euro exchange rate to the dollar, for example, will not have an economic impact comparable with the present influence of domestic currency changes. Therefore, effects of euro area shocks on the economy might change considerably in the Czech Republic, Hungary, and Latvia, where exchange rate changes play an important role in shock transmission. The fact that in many cases,exchange rate fluctuations seem to be the source of additional shocks to the economy leads to the supposition that in giving up its own currency, a country might experience lower output and inflation sensitivity to ECB monetary policy shocks.

It is harder to predict what will happen with bond yields and stock prices after euro adoption. After introduction of the euro, money markets seem to integrate almost immediately, although some differences between market segments exist. De Bondt et al. (2005) note that introduction of the euro increased transmission of monetary policy via the banking system;they attribute this result to a fall in the volatility of the money market rate. However, the same changes cannot be expected in the case of longer-term interest rates.

The Maastricht criteria that each country must fulfill before joining the monetary union contain conditions regarding level and stability of long-term interest years. Therefore, during the time preceding euro adoption, CEE countries should show stable and low levels of bond yields, as was the case for incipient euro area member states before 1999. Angeloni & Ehrmann (2003) point to the convergence in interest rate co-movements in euro area countries that began even before euro introduction.

However, even if euro adoption does lower the average level and volatility of a country's bond yields, as well as increase the co-movements, the experience of present euro area members has shown that it does not necessarily persistently diminish their fluctuations. The spreads on government bonds of euro area countries just after the euro was introduced did almost disappear, pointing at investors treating all sovereign bonds as almost perfect substitutes for each other at the time. The situation changed, however, with the outbreak of the global financial crisis and European debt crisis, and for now it is hard to predict a return to the level of spreads from the first years of the euro area, in the case of either incipient or new euro area countries. The market expectations, global volatility, and liquidity,as well as each country's macroeconomic policy and fiscal stance,will most probably playa crucial role in the differentiation of bond yields across the countries.

When it comes to the stock market, common currency might possibly increase the correlation of some CEE stock market returns across euro area stock market returns (as found by Bartram et al. 2007 for some relatively large markets), although the effect might be rather low. It is also possible that participation in the monetary union decreases volatility of stock markets due to elimination of certain political risks affecting the market (as identified by Fratzscher & Stracca 2009 for Italy). Angeloni & Ehrmann (2003), on the other hand, find that after introduction of the euro, the impact of monetary policy on stock prices becomes more similar across countries. What's more, Adjaoute & Danthine (2003) among others, point out that equity risk premium may decrease after introduction of the euro, thus also reducing the cost of capital. In addition, the structure of equity returns might change, with country factors playing a less important

role compared to factors connected to the equity industry or sector.

The next problem we consider is how the identified determinants of the role of financial markets in transmission of euro area monetary policy shocks to CEE economies might possibly change after euro adoptions in these countries.

First, when it comes to the issue of the depth of financial markets, as such markets in the CEE countries are still considerably less developed than in the euro area, it seems plausible that they will keep developing, therefore increasing their influence on the transmission of shocks. Euro adoption can become an additional impulse to further the development of financial markets in these countries. Stock market capitalization, as well as ratio of MFI credit to GDP, might increase. There is also evidence on the increase in issuance of non-financial corporate securities after the introduction of the euro. However, as the effect of stock market capitalization and ratio of corporate securities is usually opposite to the effect of MFI credit according to our estimations, the final result on the changes in the strength of transmission is hard to predict.

Both the theory and data on incipient monetary union members indicate that after introduction of common currency,trade connections deepen (the endogeneity of OCA, described by Frankel & Rose 1997 and Rose 2000). Even though the CEE countries are already closely related to the euro area, and it is difficult to anticipate spectacular surges in trade, Engel & Rogers (1996) point that the positive effect of common currency on trade should be evident even for closely linked economies (US and Canada in their case). At the same time, however, at least for Poland,the analysis on export trends, which does not take potential euro adoption into consideration, predicts some geographical relocation of exports and future decrease of euro area's share in total exports.[3] Assuming the positive impact of euro adoption on trade, as well as on the FDI and portfolio flows between the euro area and CEE countries,the role of the stock market in shock transmission should strengthen, but the impact of the yield curve should weaken in the future.

CONCLUSION

The aim of this paper is to provide evidence on the influence of changes at three financial markets-stock market, government bond market and exchange rate market-on the macroeconomic situation in chosen Central and Eastern European countries, as well as on their role in the transmission of the European Central Bank's monetary policy shock to these economies. In order to realize the results, we employ VAR methodology, using counter-factual simulation analysis for the study of the channels of transmission.

The main results from the analysis of the influence of financial market shocks on the macroeconomic situation of CEE countries point at big differences in the most important variables depending on the country. Overall, however, we can conclude that out of considered variables, stock prices

[3] Report "Foreign expansion of Polish companies. Achievements, ambitions, perspectives", IV Grant Thornton Enterprise Forum, 21 April 2015 (in Polish: "Zagranicznaekspansjapolskich firm. Dokonania, ambicje, perspektywy", IV Forum Przedsi biorców Grant Thornton). The report shows that Polish export companies do not concentrate on the euro area only, but continuingly search for new markets. The export forecasts show a fall in the share of euro area exports in total Polish exports within the next few years, though the euro area will remain the main destination of Polish exports.

exert the highest influence on the economies of CEE countries. Bond yields changes are important mainly in Lithuania and Poland, especially for those countries' output. Exchange rates changes seem to significantly influence all countries' inflation, while affecting output to a smaller extent and only in some cases.

The analysis of the transmission channels also points to big diversity across the countries. On the whole, stock prices seem to be the most and bond yields the least important channel of transmission,but such generalization can be unjustified in some cases. Stock prices usually represent an important transmission channel of EONIA shocks to CEE countries' output, constituting an important source of output decline. Inflation changes occur mainly due to transmission of the shocks via stock and exchange rate markets.

Our results provide a few important policy implications. First, there is no one solution for all the CEE countries. Even though many investors and researchers tend to treat the region as a whole, and a few common patterns can actually be found, high diversity exists among the states. That holds true not only for the relevant channels of transmission and financial variables influencing output and inflation, but also for the characteristics of CEE countries' financial markets and relations with the euro area. Second, in case of the search for plausible explanations of the changes in domestic variables after euro area monetary policy shocks,it is important to consider different indicators depending on the policymaker's domestic variable of interest. In most of the countries, there is no single transmission channel that explains well the changes occurring in all domestic variables.

Our results allow us also to provide some implications connected to euro adoption in the CEE countries. The role of financial markets in the transmission of euro area monetary policy shocks should increase with time, and especially after acceptance into the monetary union. In many cases, this would mean the shocks would have a higher influence on a country's output and inflation than we can observe at the moment. However, because in at least some countries, exchange rate changes seem to constitute an additional source of economic shocks, the country's giving up its own exchange rate could also lead to a decline in the influence of shocks on the economy.

There are also some implications for the investors' side. The strongest reactions to changes in euro area monetary policy take usually place in stock markets. Bond and exchange rate markets also show a considerable response after EONIA shocks, but they are often smaller. Thus, changes in European Central Bank monetary policy are an important risk factor for portfolios with a high share of stocks, especially Bulgarian, Lithuanian, Hungarian, and Polish stocks, which react with the highest falls to monetary contraction in the euro area. Additionally, increase in euro area interest rate negatively influences prices of Lithuanian bonds and leads to depreciation of the Czech koruna.

Our results allow us to provide insight not directly connected with the main goal of this paper, but important for policy-makers nonetheless. It concerns a country's exchange rate policy. The analysis of effects of exchange rate on the economy informs us that depreciation of a currency rarely brings about positive output results. As predicted by the theory, even if output does increase,the rise is usually very short-lived. Moreover, the country will face a relatively high and persistent inflation rate increase following the depreciation shock. Therefore, we can conclude that the costs of policy aimed at increasing output through currency depreciation exceed the benefits. On the other hand,

of exchange rate as an additional source of shocks to the economy provide an additional argument for euro adoption in these countries.

Acknowledgment

REFERENCES

Adjaoute, K., & Danthine, J-P. (2003). European financial integration and equity returns: a theory based assessment. In: V. Gaspar, P. Hartmann, & Sleijpen (Eds.),The transformation of the European Financial System, European Central Bank.

Ando, A., & Modigliani, F. (1963). The life cycle hypothesis of saving: aggregate implications and tests. American Economic Review, 53, No 1, 55-84; http://www.jstor.org/stable/1817129

Angeloni, I., & Ehrmann, M. (2003). Monetary policy transmission in the euro area: any changes after EMU? ECB Working Paper Series, No. 240.

Bartram, S. M., Taylor, S. J., & Wang, Y-H (2007). The Euro and European financial market dependence. Journal of Banking and Finance, 31, 1461-1481.

Bernanke, B., & Blinder, A. (2013). The federal funds rate and the channels of monetary transmission. American Economic Review, 82, No 4, 901-921.

Bernanke, B., & Gertler, M. (1989). Agency costs, net worth, and business fluctuations. American Economic Review, 79 (1989), No 1 (March), 14-31.

Bernanke, B., Gertler, M., & Watson, M. (1997). Systematic Monetary Policy and the Effects of Oil Price Shocks. Brookings Papers on Economic Activity, 1: 1997.

Canova, F. (2005). The transmission of US shocks to Latin America. Journal of Applied Econometrics, 20, 2, 229-251.

Cour-Thimann, P., & Winkler, B. (2013). The ECBs non-standard monetary policy measures. The role of institutional factors and financial structure. ECB Working Paper Series, No. 1528.

De Bondt, G., Mojon, B.,& Valla N. (2005). Term structure and the sluggishness of retail bank interest rates in the euro area countries. ECB Working Paper Series, No. 518.

Ehrmann, M., & Fratzscher, M. (2006). Global financial transmission of monetary policy shocks. ECB Working Paper Series, No 616, April.

Eichengreen, B., Hausmann, R., & Panizza, U. (2007). Currency Mismatches, Debt Intolerance, and the Original Sin: Why They Are Not the Same and Why It Matters. In: S. Edwards (Eds.), Capital Controls and Capital Flows in Emerging Economies: Policies, Practices and Consequences. University of Chicago Press, 121-169.

Engel, Ch., & Rogers, J. (1996). How wide is the border?. American Economic Review, 86 (5): 1113-1125.

Evans, Ch.L., & Marshall, D.A. (1998). Monetary policy and the term structure of nominal interest rates: evidence and theory. Carnegie-Rochester Conference Series on Public Policy, 49, 53-111.

Foreign expansion of Polish companies. Achievements, ambitions, perspectives. IV Grant Thornton Enterprise Forum, 21st April 2015 (in Polish: "Zagranicznaekspansjapolskich firm. Dokonania, ambicje, perspektywy", IV Forum Przedsi biorców Grant Thornton).

Frankel, J., &Rose, A. (1997). The endogeneity of the optimum currency area criteria. The Economic Journal, Vol. 108, No. 449 (July 1998): 1009-1025.

Fratzscher, M., & Stracca, L. (2009). Does it pay to have euro? Italy's politics and financial markets under the lire and the euro. ECB Working Paper Series, No 1064, July 2009.

Ganev, G., Molnar, K., Rybinski, K., & Wozniak, P. (2002).Transmission Mechanism of Monetary Policy in Central and Eastern Europe. Center for Social and Economic Research Reports 52.

Kim, S., & Yang, D.Y. (2012). International monetary transmission in East Asia: Floaters, non-floaters, and capital controls. Japan and the World Economy, 24: 305-316.

Kim, S. (2001). International transmission of U.S. monetary policy shocks: Evidence from VAR's. Journal of Monetary Economics, 48: 339-372.

Peersman, G., & Smets, F. (2001). The monetary transmission mechanism in the euro area: more evidence from VAR analysis. ECB Working Paper Series, No. 91.

Rose, A. (2000). One money, one market: the effect of common currencies on trade. Economic Policy, Volume 15, Issue 30, pp. 7-46, April 2000.

Sims, Ch. A., Stock, J. H., & Watson, M.W. (1990). Inference in linear time series models with some unit roots. Econometrica 58, No 1, 113-144.

Sims, Ch.A., & Zha, T. (2006). Does monetary policy generate recessions? Macroeconomic Dynamics,10, 231-272.